**NeST-FMK-GEN.03**
**Version 1.0**
**October, 2018**
**Status: Released**


# **IndEA** Adoption Guide

## A Method Based Approach

Ministry of Electronics and Information Technology
Government of India

## Change History

| Sr. No | Author | Version No. | Release Date | Change Details |
|---|---|---|---|---|
| 1 | | | | |
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# Metadata of the Standard

| S. No. | Data elements | Values |
|---|---|---|
| 1. | **Title** | **IndEA** Adoption Guide: A Method Based Approach |
| 2. | **Title Alternative** | |
| 3. | **Document Identifier** | NeST-FMK-GEN.03 |
| 4. | **Document Version, month, year of release** | Version 1.0; October, 2018 |
| 5. | **Present Status**<br>*(Draft/Released/Withdrawn)* | Released |
| 6. | **Publisher** | Ministry of Electronics and Information Technology (MeitY), Government of India (GoI) |
| 7. | **Date of Publishing** | October 2018 |
| 8. | **Type of Standard Document**<br>*(Standard/ Policy/ Technical/ Specification/ Best Practice /Guideline / Framework /Procedure)* | Best Practice; Guideline |
| 9. | **Enforcement Category**<br>*(Mandatory / Recommended)* | Recommended |
| 10. | **Creator**<br>*(An entity primarily responsible for making the resource)* | NeST (STQC) |
| 11. | **Contributor**<br>*(An entity responsible for making contributions to the resource)* | **1.** MeitY<br>**2.** NIC<br>**3.** C-DAC<br>**4.** STQC |
| 12. | **Brief Description** | |
| 13. | **Target Audience**<br>*(Who would be referring / using the Standard)* | See Inside |
| 14. | **Owner of approved Standard** | MeitY |
| 15. | **Subject**<br>(Major Area of Standardisation) | Enterprise Architecture |
| 16. | **Subject. Category**<br>(Sub Area within major area) | Institutional Mechanism |
| 17. | **Coverage. Spatial** | INDIA |
| 18. | **Format**<br>*(PDF/A at the time of release of final Standard)* | PDF |
| 19. | **Language**<br>*(To be translated in other Indian languages later)* | English |
| 20. | **Copyrights** | MeitY |
| 21. | **Source**<br>*(Reference to the resource from which present resource is derived)* | 1. IndEA<br>2. TOGAF® |
| 22. | **Relation**<br>*(Relation with other e-Governance standards notified by MeitY)* | Accompanying Document to India Enterprise Architecture (IndEA) Framework |

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# 1. Introduction

In developing IndEA, the Working Group was acutely aware that for successful adoption, guidance would be needed to help state governments, ministries and departments in the governments at various levels to adopt a structured approach when making use of IndEA in developing their enterprise architectures. Therefore, this guide expected to fill a clear gap in current capability and drive the adoption of IndEA in an effective manner.

## a. Scope & Purpose

This guide covers the following:

- Briefly explains government enterprise architecture and its relevance to India's e-governance initiatives;
- Summarises pioneering enterprise architecture initiatives in the government sector, with a view to set the context and provide insights into what has been done and where to look for practical examples;
- Summarises IndEA, and elaborates the way to use the Reference Models by government entities to develop their own architectures; and
- Provides further guidance through reference to other relevant material and content based on first hand field-tested experience.

Note that this document is not a step-by-step methodology to develop enterprise architecture.

## b. Related Documents

This document is to be read in conjunction with the following:

- **India Enterprise Architecture Framework.**
- **ePragati Vision Document**[1].
- **The Open Group Architecture Framework (TOGAF) Management Overview**[2].
- **TOGAF Leader's Guide in Establishing and Evolving an EA Capability**[3].

A complete list of references is provided in Section 8.

## c. Intended Audience

This guide is primarily intended for the following groups:

- All central government ministries, state governments and local governments especially those that do not currently have an enterprise architecture initiative or are just in the early stages of their enterprise architecture development;
- Senior government officials who have been tasked to oversee and guide enterprise architecture initiatives to augment their understanding and promote active commitment; and
- Government Leaders, Chief Architects, Analysts and Designers seeking better, quicker and easier approaches to respond to the needs of their internal and external customers.

[1] http://e-pragati.ap.gov.in/documents/AP%20Enterprise%20Architecture.pdf
[2] TOGAF
[3] The Open Group Library

The following groups will also find this useful:

- Policy Analysts, Line-of-Business Managers concerned with maximizing business value of IT and business competitiveness;
- Consultants and practitioners desirous of new solutions and technologies to improve the productivity of their government clients;
- Business management, public policy and IS management educators interested in imparting knowledge about this vital discipline; and
- Electronic government professionals involved with organisational technology strategic planning, technology procurement, management of technology projects, consulting and advising on technology issues and management of total cost of ownership.

# 2. Government Enterprise Architecture in India

Though not widespread, there have been some efforts towards adoption of enterprise architecture within the government. As the experience derived from these initiatives has played a critical role in enriching the development of IndEA, the following three sub-sections summarise the cases of enterprise architecture in the Ministry of Panchayati Raj, Ministry of Drinking Water and Sanitation and Andhra Pradesh State Government. Collectively, they represent a vertical line of business (Ministry of Drinking Water and Sanitation), horizontal line of business (Ministry of Panchayati Raj) and a state government (Government of Andhra Pradesh).

## PANCHAYAT ENTERPRISE ARCHITECTURE FRAMEWORK(PEAF) [2011]

The 73rd Constitutional Amendment Act of India, 1992 was a landmark event that enabled decentralised and participative governance through Panchayats in the rural areas covering three-quarters of India's population. Panchayats function at the village, intermediate (block) and district levels. There are approximately 239,819 Gram Panchayats at the village level, 6,321 Intermediate Panchayats at Block level and 592 Zilla Panchayats at the district level. All these three tiers are represented by approximately 2.8 million elected representatives and 1 million functionaries.

The three-tier institutional structure of Panchayats offer India's rural villagers an opportunity to participate in the development of local area through their involvement in preparation, execution, monitoring of development plans and programmes. They also provide a platform to the citizens to directly interact with their elected representatives to ensure that their interests are effectively served and the public funds are properly spent. Panchayats, are symbols of decentralisation, governance and grassroots democracy.

The key identified objectives of e-Governance that formed the pillars of the PEAF in Panchayats included:

- Providing aid to decision making to the Panchayats;
- Providing the means to improve the internal efficiency and management of Panchayats;
- Better and convergent delivery of services to citizens; and
- Encouraging transparency, disclosure to citizens and open to social audit;

Following are the areas of operations of Panchayats, which formed a key input to the business architecture.

| | | |
|---|---|---|
| Agriculture, incl. extension | Drinking water | Cultural Activities |
| Land improvements, land reforms, consolodation, soil conservation | Fuel and fodder | Markets and Fairs |
| Minor irrigation, water management, watershed development | Roads, culverts, bridges, ferries, waterways, other means of communication | Health and sanitation hospitals, primary health centers, dispensaries |
| Animal Husbandary, dairying and poultry | Rural Electrification, Distribution of electricity | Family welfare |

| | | |
|---|---|---|
| Fisheries | Non-conventional energy | Women & Child Development |
| Social Forestry, Farm Forestry | Poverty alleviation program | Social welfare, welfare of handicaped and mentally retarded |
| Minor forest produce | Education, including primary and secondary schools | Welfare of the weaker sections, in particular of SCs & STs |
| Small scale industries, food processing industries | Technical Training, vocational education | Public Distribution System |
| Khadi, Village and Cottage industries | Adulty and Non-formal education | Maintenance of community assets |
| Rural Housing | Libraries | |

*Figure 2-1: Business Areas of Panchayats in India*

These business areas were then organised into business categories, core and enabling business functions to form the **PEAF Business Function Map** (see Figure 2-2), a key output of the business architecture. The business function map formed the basis for the rest of the architecture analysis and development. The business functions were decomposed to identify the business (G2C, G2B) services under the purview of Panchayats and analysed for efficiency, redundancies, delivery channels, stakeholders and payment mechanisms. The underlying business processes realising these services were analysed and improvements identified. The business functions and the services were mapped to the roles (covering the three layers of Panchayats) to identify gaps and overlaps. This also helped in identifying whether functional devolution of powers from the states to the Panchayats had happened or not, and bring clarity to the accountability structure. This is a key element in local and rural governance which was the original intent of the legislation enacted in 1992.

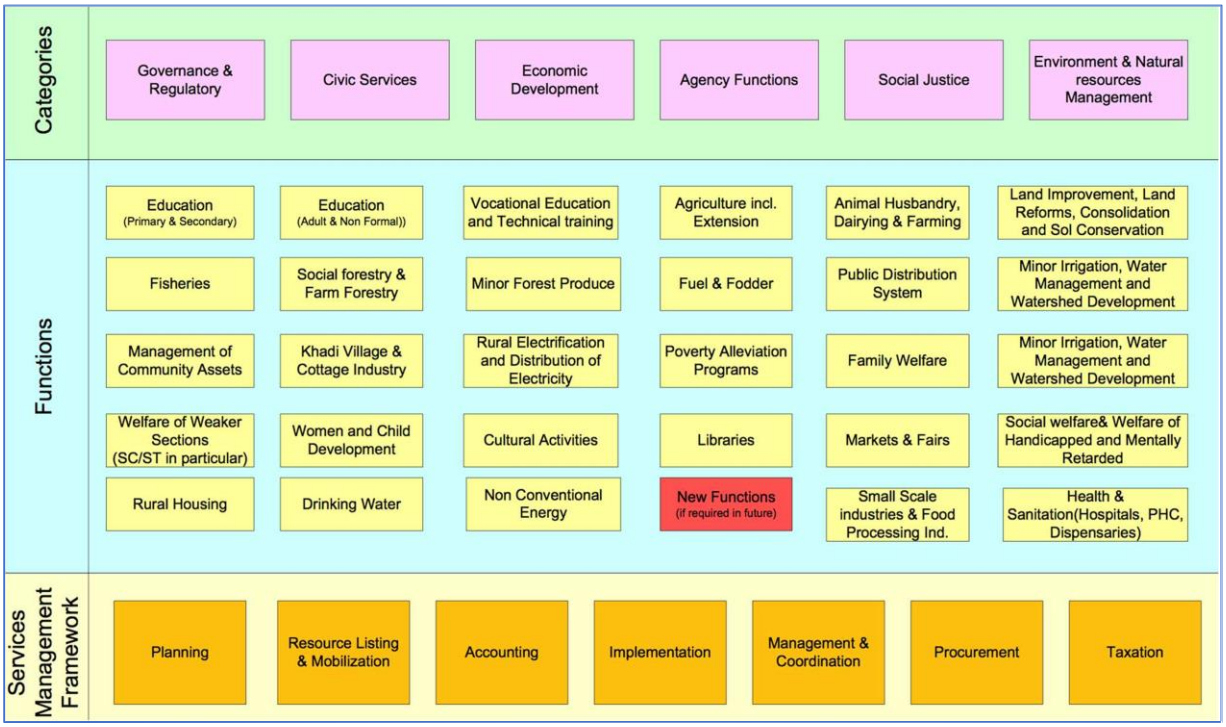


*Figure 2-2: Panchayat Enterprise Architecture Framework Business Function Map*

The objective of Data Architecture was to define the major types and sources of data necessary to support the business in a way that is - understandable by stakeholders, complete and consistent, and stable. Data structures were defined and their use by the business functions and services were analysed. The entire process of data creation, processing, storage and utilisation was studied, gaps identified and data flows were redesigned to enable seamless integration of data from multiple sources and in the required format.

Data architecture principles were established, existing databases (both master and transactional databases) were studied, data entity catalogue consisting of both common and specific data entities were defined. In order to understand how and which business processes used what data, the business processes were mapped to the data entities in the entity catalogue. This enabled identification of business processes with adequacy in data support. All of the above were consolidated and the data architecture stream of activity culminated in the development of the **target enterprise data model**.

In the application domain, architecture principles were established and their relevance to the context was confirmed. The target logical view of the applications was then defined to enable a clean separation of concerns. The process view of the application was then developed and studied to understand the run-time implementation of the applications, and to identify interventions in areas like load distribution, availability, server side tuning, pooling and orchestration of activities. The application communication view was created to understand the communication between the various layers and modules in the applications and adoption of standard communication protocols. From the business functions and business services, all types of business users were identified and their preferred channel of access was mapped out. The entire application catalogue was analysed for commonalties and other aspects. Figure 2-3 shows the **application architecture view.** Each application was decomposed into its modules and functions, and mapped to business processes and

data entities. This created **a three-way mapping between business, data and application perspectives** to provide a more holistic integrated view and enabled identification of gaps, overlaps and other inefficiencies.

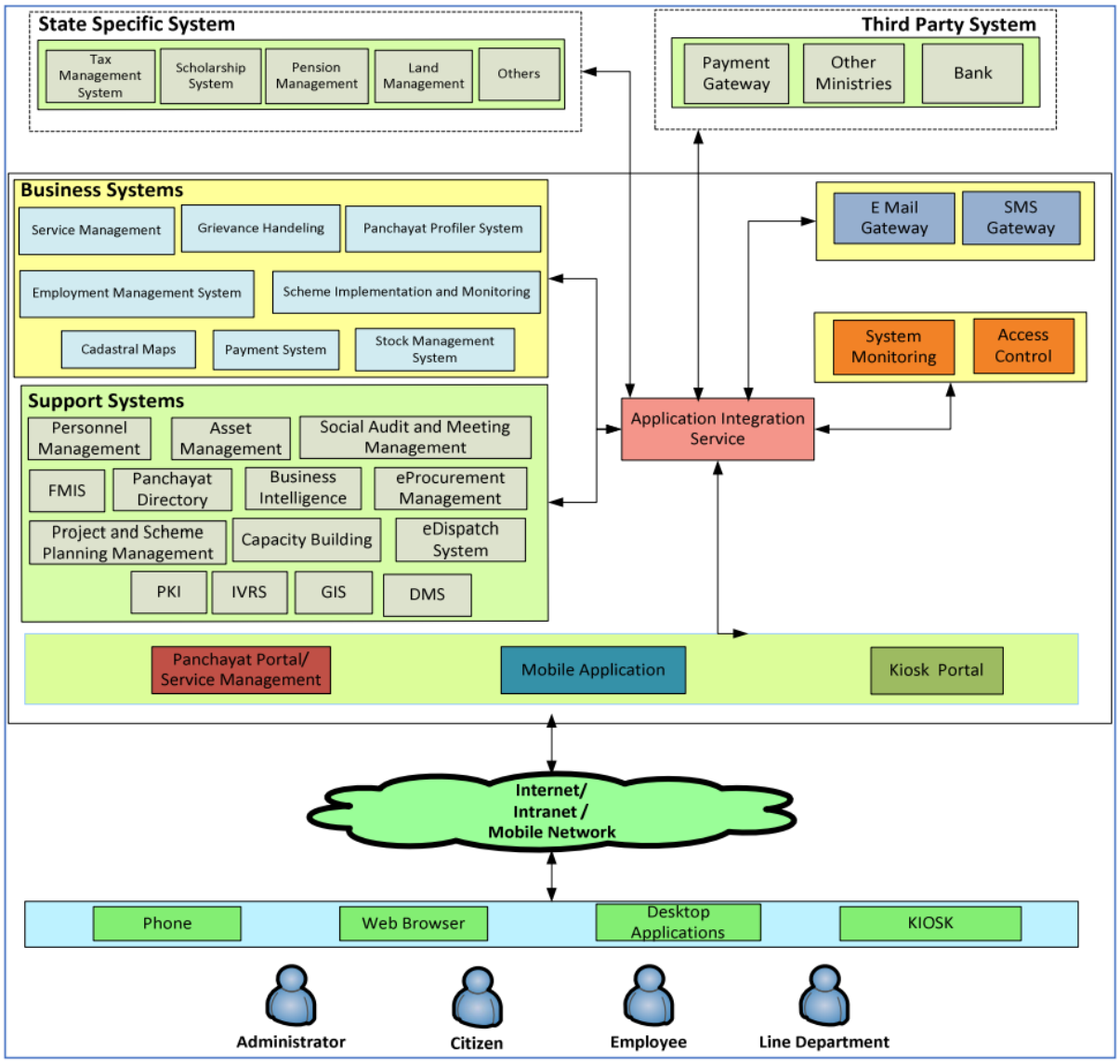


*Figure 2-3: Panchayat Enterprise Architecture Framework Application Architecture View*

The applications were further analysed to identify reusable components, called the application building blocks (ABB). The intent being, ability to assemble future applications from a registry of application building blocks that is accessible to the entire organisation. In doing this, **144 functional building blocks and 47 common building blocks** were identified, through a process of listing, analysing, normalising and categorising. The integration aspects between the applications was captured in the integration view and this was important as several business services and business processes spanned multiple applications, and therefore required seamless exchange of data, coherent orchestration of application activities and support of multiple access channels to enable service delivery.

Given the vast and diverse geographical spread of Panchayats, the technology architecture focused on the critical aspect of deployment so that all the business services are available to the last mile. The principles for technology architecture were established to provide the broad contours and direction, and guide the process. To capture the largeness and complexity of the technology landscape, multiple views and viewpoints were developed and analysed to provide a holistic integrated perspective. These included covering aspects like environment and location, platform decomposition, network, computing and hardware, connectivity, security, application deployment and disaster recovery.

Following the TOGAF, the PEAF was designed and developed to provide the Panchayats the benefit of having a view on the structure of systems and infrastructure required to enable better delivery of services. Powered with this information and the methodology to analyse existing environments, PEAF was able to develop well-organised roadmaps and undertake cohesive rollout of systems and infrastructure for Panchayats.

For more information about this please contact the National Informatics Centre in Delhi.

**ENTERPRISE ARCHITECTURE IN THE MINISTRY OF DRINKING WATER AND SANITATION[2014]**

The Ministry of Drinking Water and Sanitation (MoDWS), is the main institution of the Government of India, which complements the efforts of the State Governments in providing safe drinking water and sanitation to the rural masses of our country. Programmes for Drinking Water Supply and Sanitation have been under implementation ever since the inception of the first five-year plan. The Department of Drinking Water Supply (DDWS) under the Ministry of Rural Development undertook a Computerisation Project under the 9th Five Year Plan for effective planning, monitoring and implementation of various activities under the Rural Water Supply and Sanitation Sector. DDWS later was assigned the status of a Ministry in 2011 and was renamed as Ministry of Drinking Water and Sanitation.

Today, the Ministry runs two social welfare programmes at the national level i.e. Swachh Bharat Mission - Gramin and Rural Drinking Water Programme. The objectives of both the programmes is to provide facilities of sanitation and water in rural India by way of giving financial assistance to the State Governments as both water and sanitation are within their purview. The Ministry is aiming at implementing a strong e-Governance system to improve the effectiveness and efficiency of the programmes to achieve its vision and goals.

The **MoDWS Enterprise Architecture** framework defines the methodology for development of all e-governance applications for the domain. It gives a comprehensive view of the enterprise from different perspectives and enables quick alignment of IT systems to its dynamic and ever evolving demands of business. The purpose of the enterprise architecture is to optimise across the enterprise the often fragmented legacy processes (both manual and automated) into an integrated environment that is responsive to change and supportive of the delivery of the business strategy.

Effective management and exploitation of information through IT is a key factor to enterprise success, and an indispensable means to achieving competitive advantage. The MoDWS enterprise architecture addresses this need, by providing a strategic context for the evolution of the IT system in response to the constantly changing needs of the business environment. Furthermore, a good enterprise architecture enables the achievement of right balance between IT efficiency and business innovation. It allows individual enterprise units to innovate safely in their pursuit of competitive advantage. At the same time, it ensures the needs of the organisation for an integrated IT strategy are met, permitting the closest possible synergy across the extended enterprise.

TOGAF methodology was selected to build the EA framework for MoDWS. The reason for choosing TOGAF over other architectural practices is because enterprises seeking Boundaryless Information Flow™ can use TOGAF to define and implement the structures and processes to enable access to integrated information within and between enterprises. Any enterprise undertaking, or planning to undertake the development and implementation of an enterprise architecture for the support of business transformation will benefit from use of TOGAF.

The primary focus is laid on the TOGAF ADM. Grounded in enterprise architecture, TOGAF ADM is commonly referred to as the actual methodology for the execution of enterprise architecture. TOGAF is in its ninth version and has evolved from a pure IT architecture framework to an enterprise architecture framework. Figure 2-4 provides details about ADM as it was tailored.

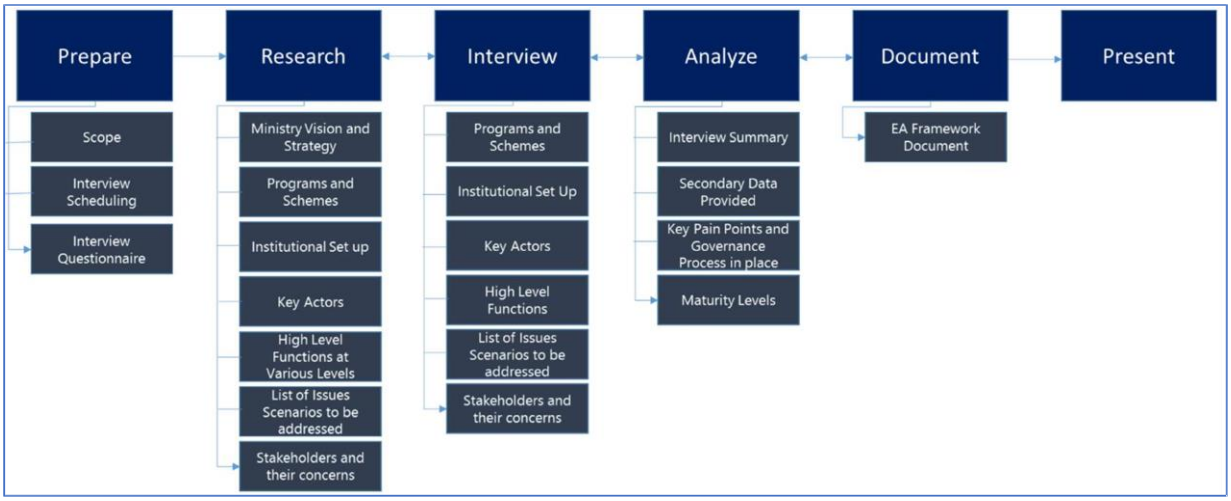


*Figure 2-4: Tailored Version of TOGAF ADM Used in MoDWS Enterprise Architecture*

A series of interviews were conducted and a myriad of informal exchanges with individuals in the Ministry, NIC team and across various functions and roles in different states to solicit opinions, perspectives, observations, and suggestions surrounding MDWS's architecture design needs.

A. Business Architecture: Business architecture articulates the existing business capabilities, governance structure, business processes, and business information. The business capabilities define what the Ministry and its line departments/field agencies do and the business process flow show how the capabilities are implemented. The business capabilities identified and documented in this report are a broader set, existing across all the states, confined to the states where the Public Health Engineering Departments (PHED) are responsible for rural drinking water supply and sanitation (90% of the states). The architecture framework was developed taking into consideration the functioning of the Ministry and the state PHEDs. The Business Architecture exercise is a prerequisite for architecture work in any other domain (Data, Application, and Technology). At the end of the exercise a **target business architecture** was established that described how the enterprise needed to operate to achieve the business goals, and respond to the strategic drivers set out in the business vision, in a way that addresses the request for architecture work and stakeholder concerns. The steps followed to arrive at the target business architecture are stated below:

*Page Upper Border1. Study the MDWS Vision;*

2. *Review business goals and strategies* to understand the strategic objectives of the MDWS through their "Strategic Plan-2011-22-Rural Drinking Water" and "Rural Sanitation and Hygiene Strategy 2011-2022";
3. *Arrive at the Ministry Vision Diagrams* based on the strategic priorities the vision diagrams are arrived at;
4. *Understand the Institutional Framework* and the key actors involved in attaining the vision;
5. *Assessing the current state and capabilities to* understand the high level functions performed at various levels and carve out the business capabilities of the MDWS through these functions and processes in place;
6. *Envisioning the future state* as in the strategy document for the Ministry of drinking water and sanitation;
7. *Compare Step 6 with Step 5* to identify gaps and create a heat map of the business framework;
8. *Highlight the impacted capabilities* to attain the target state; and
9. *Suggest process enablers* to attain the vision.

The impacted capabilities mentioned in step 8 above, were depicted by generating a heat map of the current business framework state as given below in Figure 2-5. The 'High Gap' areas were identified and the impacted capabilities were handled for achieving the target state.

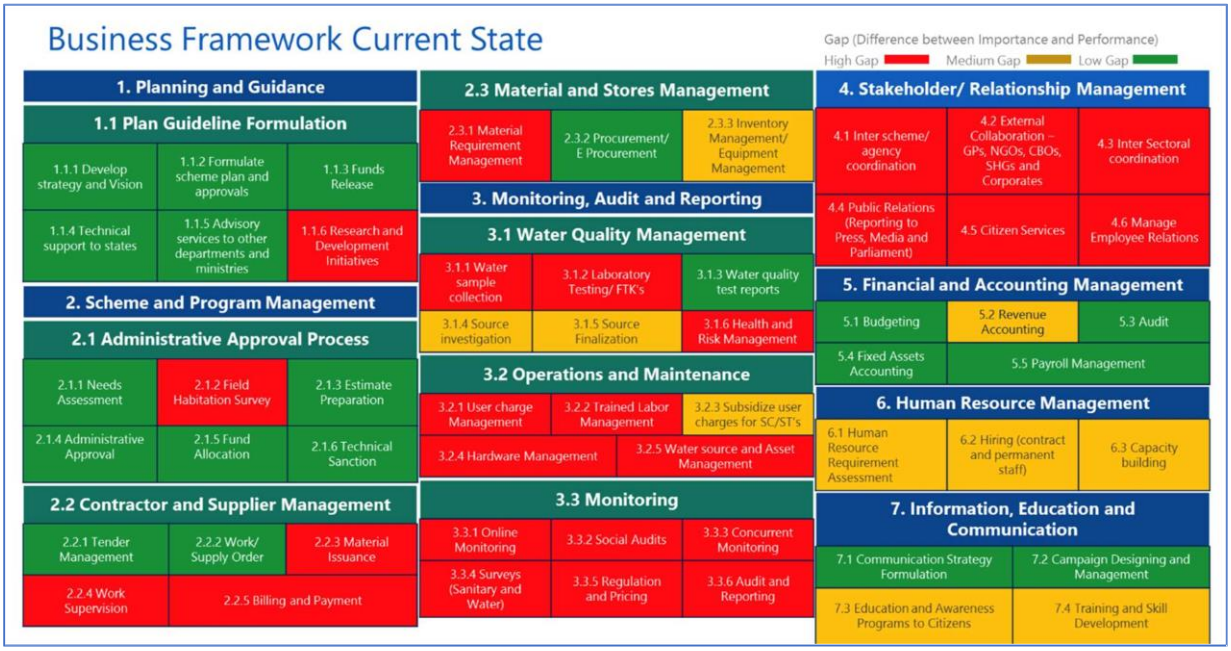


*Figure 2-5: MoDWS Current State Business Framework*

A. Application Architecture: The application architecture describes the applications supporting the business processes and functions in the business architecture and managing the data objects in the Information Architecture. In this section, all the applications present in the MDWS are listed out mapping to the business capabilities identified. A logical view of the target state of application is presented in this section and can be referred to for application development.

B. Data Architecture: This focusses on the organisational logical and physical information management assets. The goal is to identify and define the sources of information that support a given business capability to be fulfilled within the architecture. In this section, the entity relationship diagram is presented and the high-level data needs mapping to the business capabilities and actors are carved out.

C. Technology Architecture**:** This focusses on mapping application and data components to tangible hardware and software models, catalogues, and matrices.

D. Opportunities and Solutions: Based on the analysis performed in the above sections a technology roadmap was proposed. The MDWS has the ability to choose their projects and implement.

Compliance & Benefits

The Multi-tenancy based eGovernance systems for National Rural Drinking Water Programme (NRDWP[4]) and Swachh Bharat Mission - Grameen (SBM-G, Swachh Bharat Mission ) are being aligned to facilitate aims & objectives of these two national level programmes under implementation in rural areas. The development of enterprise Architecture for Ministry of Drinking Water & Sanitation (MoDWS) has enhanced understanding of overall business environment, facilitated re-architecting process for resilient online eGovernance information system to meet business requirement to a large extent and identification of gap areas to be addressed as per priority of Ministry.

For more information on this, please contact the National Informatics Centre in Delhi.

**E-PRAGATI: THE ANDHRA PRADESH STATE ENTERPRISE ARCHITECTURE [2014-15]**

**e-Pragati,** is a new paradigm. It is a mission centric approach and a framework, to galvanise the pan-government ecosystem by transcending boundaries to design and deliver services in a coordinated, integrated, efficient and equitable way that citizens and businesses demand and deserve, aimed to realize the Sunrise Andhra Vision 2029. Andhra Pradesh is the first state in India to develop a state-wide enterprise architecture. This is a pioneering development that will spur many such initiatives in the country. **e-Pragati** aims to guide and accelerate AP's journey to Government
2.0. This is characterised by an integrated operating model, which enables collaboration between departments, to deliver personalised services via multiple channels where the citizen is a participant to an outcome-driven, transparent and accountable government.

With delivering connected government as its primary goal, **e-Pragati** intends to make the Andhra Pradesh state government future-ready by transitioning from departmental stovepipes to a citizen-centred approach to public services achieved through transformation of the front, middle and back office operations. This necessitates collaborative working and information sharing between departments, forming a virtual / digital network organised around citizen services and their outcomes. Citizens, being an essential part of the ecosystem, are informed, engaged and involved to augment inclusiveness. The items of the **e-Pragati** manifesto are:

- *Single Entry, Multiple Use:* Citizen details once entered or available anywhere within the government, are propagated through e-Pragati so that citizens do not have to provide them multiple times to avail services;
- *No Wrong Door*: Citizens view the government as ONE entity, translating into citizens approaching any government service delivery channel for any government service;
- *Disintermediation and Re-intermediation:* Services requiring coordination between multiple

[4] IndiaWater

departments are taken up as a single case, and driven through to logical conclusion without the citizen having to approach the related departments individually;

- *Derive Insight, Deliver Foresight:* Predict / pre-empt services that citizens need or are eligible for and trigger service delivery proactively (i.e. without the citizen even applying or requesting); and
- *Citizen Core, Mission Focused:* Group services for categories of citizen stakeholders (e.g. farmers, students, patients, pensioners, senior citizens, civil servants, defence personnel etc.), possibly around life-cycle events and deliver them in a unified manner through government missions.

Tenets for **e-Pragati** are codified as general propositions applicable across the Government, to facilitate decision-making particularly on contentious issues, exemplifying certain degree of practical wisdom. These principles are meant to define the overall contours of the enterprise architecture and form the first level of compliance.

In order to realise the vision, it was imperative to elevate the present e-Governance initiatives to "transformation" level. With this end in view, the State Government established the Andhra Pradesh State Enterprise Architecture (APSEA). The APSEA is aimed to be a lever for transformational change in the way government services are conceived, designed, delivered and consumed. In alignment with TOGAF, the following four high-level architectures were designed:

- *Business Architecture* seeks to re-engineer, integrate and transform the business functions of the 33 departments and over 150 organisations of the State Government, along with the field offices and functionaries numbering over one hundred thousand and spread across the State;
- *Application Architecture* seeks to critically examine the existing and the new applications needed to deliver the enhanced functionality, and regroup them adopting the principle of **"Build-Once- Use-Many-Times"**;
- *Data Architecture* is the adoption of which ensures establishing data as a **"Single Source of Truth"** that is shared by all; and
- *Technology Architecture* derives the benefits the latest technologies and standards and enhances efficiency through customer-centric behaviour.

These four architectures, essentially drawn from TOGAF, form the 4 pillars of e-Pragati, and rest on the strong foundation of enterprise architecture governance.

**Target application architecture** realises government functionalities as required by various users such as citizens, employees and businesses. These applications are standardised and configured on a unified delivery mechanism, and are accessible through multiple end user devices. The applications are categorised into common, group, cross-cutting and department applications.

The **target data architecture** addresses the concerns related to data such as types of databases that should be operational across the system, how they are integrated, overarching data management framework that includes data delivery, data services, core architecture components such as data security, data access, lifecycle, migration and various data models such as conceptual, logical and physical.

The **target technology architecture** is a collection of technology building blocks, positioned and/or sourced in such a manner so as to enable the state government to achieve the government vision. These building blocks provide and support the systems used by the government, both

software and hardware. The technology architecture is based on three building blocks - technology architecture vision, principles and standards with a layered architecture of access, distribution and core layer. Access layer provides for end user computing and management of desktops, laptops, smart phones, tablets, etc. Distribution layer takes care of how users get access to services and provide a service based architecture. Core layer manages the physical components of technology architecture like compute, storage, network and data centre.

e-Pragati is not merely about modernisation of state's ICT infrastructure. It is designed to propel the state to the next level of Digital Economy. An important aspect of governments is that they are part of larger ecosystems. This is because governments exist at different levels, which despite belonging to potentially different political parties must come together to form a coherent whole. This is a real showstopper, as many architecture initiatives are plagued by political differences, contention for visibility and impact, and competition for resources and attention, all of which are disruptive and tiring. As part of visioning, state governments are recommended to factor these in and understand the overall ecosystem the architecture will be designed for and operate in. Government services transcend all levels and usually require close coordination between different parts of the ecosystem. By taking an ecosystem view, state governments would be able to envision the complexities involved, and therefore design appropriate strategies and interventions to address any emergent issues and constraints.

Architecture analysis has been used to derive the programmes and initiatives. Figure 2-6 shows the seventy-two architecture derived initiatives that form the implementation aspect of e- Pragati. These initiatives are prioritised and grouped into progressive waves. Initiatives associated with one another through dependency or shared outcomes were grouped into waves, and the waves were further prioritised based on business and operational inputs. Through the seventy-two initiatives the following goals are being aimed:

- *Citizen centricity:* This refers to viewing governments with an outside-in perspective, i.e. understanding the requirements and expectations of citizens to become the pre-eminent guiding principle for all government policies, programmes and services. In short, this represents the service-dominant logic which requires governments to operate as one enterprise and organise themselves around citizen demands and requirements;
- *Common infrastructure and interoperability*: This refers to the use of standards and best practices across governments to encourage and enable the sharing of information in a seamless manner. Interoperability is the ability of enterprises to share information and knowledge within and across enterprise boundaries. The underlying foundation for effective interoperability comes from standardised common infrastructure;

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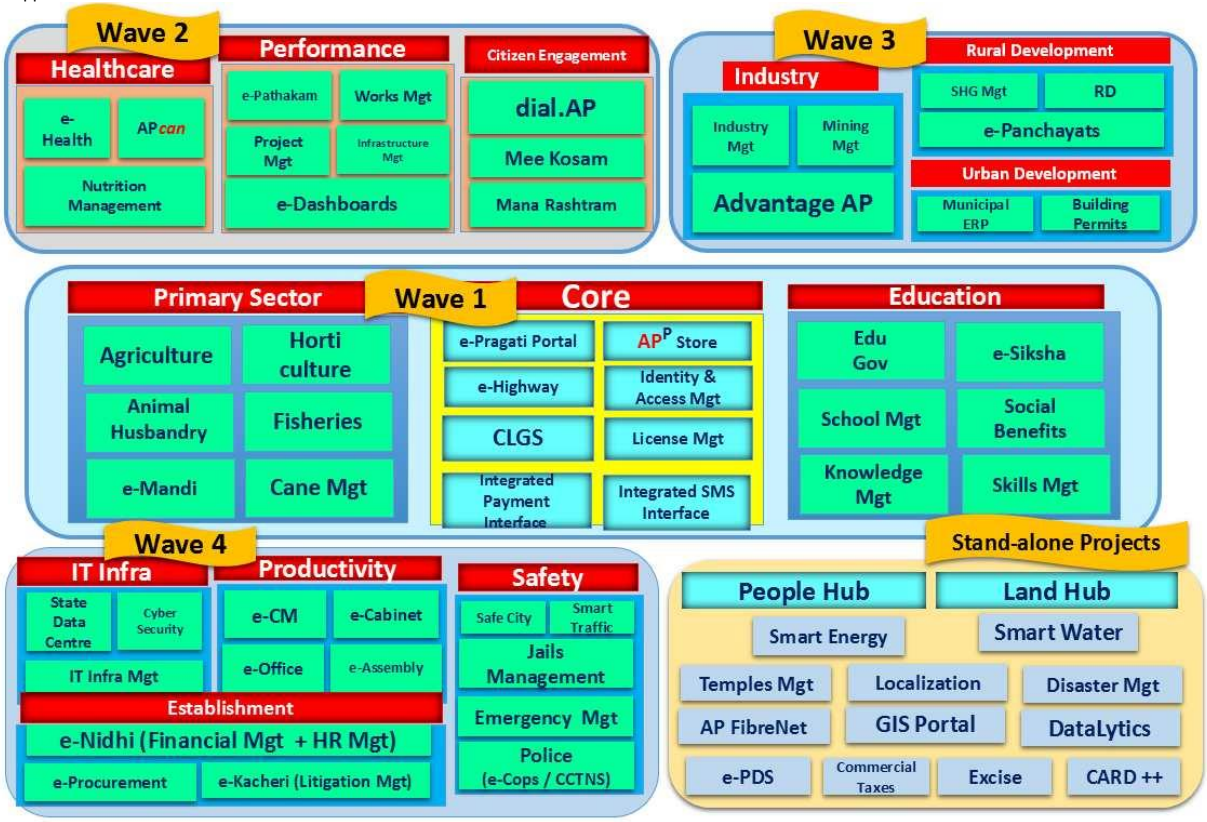



*Figure 2-6: Architecture Derived Initiatives from e-Pragati at a Glance*

- *Collaborative services and business operations:* Connected government requires departments to collaborate. It is not difficult to uncover success stories about integration and interoperability at the technology level. However, to collaborate at the level of business services and functions requires political will. This is because collaboration at this level is disruptive leading to shallower stovepipes, elimination of redundant or overlapping services and discovery of common and shared services, which in turn result in redistribution of authority and control for some segments of the government;

- *Public sector (networked) governance:* This refers to the decision rights, and the accountability framework required for implementing all other strategies for connected government. Good governance is a non-negotiable factor in the success of connected government, more so in countries that have multiple levels of governments (i.e. federal / central; state / provincial; and town / city) where various levels could be administered by different political parties;

- *Networked organisational model:* This refers to the need to accommodate new organisational models wherein the enterprise (in the context of the WOG) is a network of relatively autonomous ministries and departments working in a coherent manner to deliver value to both citizens and businesses. This makes the government a networked virtual organisation (NVO) that operates seamlessly toward a common mission;

- *Social inclusion:* This refers to the ability of governments to move beyond horizontal and vertical integration of government service delivery to engaging the citizens and businesses at relevant points in the policy and decision-making processes. E-democracy and social inclusion ensure that

delivery of government services is not a one-way exchange. Innovative ways of using technology to facilitate constituent participation and building a consultative approach are imperative for the success of connected government; and

- *Transparency and open government:* This refers to the political doctrine which holds that the business of government and state administration should be opened at all levels to effective public scrutiny and oversight. In its broader construction, it opposes reason of state and national- security considerations, which have tended to legitimise extensive state secrecy.

# 3. A Primer to IndEA

IndEA is a set of building blocks that State Governments can use to describe their future state of their e-Governance processes and systems. IndEA is a collection of architecture reference models. Broadly, reference models are documented best practices that help solutions delivery teams make effective design and technology choices. The purpose of the reference models is to increase standards adoption, speed up service design and delivery, and advance towards the target state architecture.

## a. IndEA as an Architectural Construct

Many stakeholders are involved when considering complex systems such as those expected in governments. These stakeholders have many intertwining concerns pertinent to the system of interest. Their concerns cover the full lifecycle of the system, and their complexity calls for a framework to identify and classify the concerns into appropriate categories to enable systematic evaluation and resolution to architect and build such systems.

An architecture framework contains information identifying the fundamental architecture constructs and specifies concerns, stakeholders, viewpoints, model kinds, correspondence rules and conditions of applicability. Enterprise architects can use an architecture framework to discover, describe and organise topics of interest (concerns) about the system at hand; they can further use architecture representation to clarify, analyse and resolve these concerns. The architecture description enables the enterprise architect to express an architecture.

At the core of the ISO/IEC/IEEE Architecture Description Standard are viewpoints. A viewpoint comprises of conventions framing the description and analysis of specific system concerns. A viewpoint frames one or more concerns. The term concern refers to any topic of interest pertaining to the system. IndEA covers eight viewpoints, represented as reference models designed to enable government enterprises to build their own enterprise architectures. Key considerations that went into the development of IndEA include:

i. The imperative for state governments and other government enterprises to regularly define and reconfirm their vision, mission, goals and objectives with a medium to longer term perspective, and as far as possible within the constitutional framework, embrace the practice of master- planning and execution. This is a significant factor, as many a times, governments tend to be overly focused on operational fire-fighting. In other words, with IndEA the consideration is to balance reactive behaviours with proactive planning;

ii. Proliferation of transactional services and more-than-needed focus on quantum of transactions rather than actual outcomes and impact on citizens and other stakeholders. There is a tendency among government enterprises to highlight quantity over quality, and extra-ordinary amounts of efforts expended to demonstrate that the government machinery is busy, further exacerbated by the high degree of overlaps and redundancies that exist (or are growing) due to fragmented thinking;

iii. A review of eTAAL[5] reveals that services across the states tend to be very similar. This is deliberate given that all states in India operate under a single Union / Central Government, with a constitutionally guaranteed federated form of governance. Nearly 30 – 40% of services tend to be same or similar across states, yet there is little exchange of information or willingness to take

[5] Electronic Transaction

benefits of economies of scale by combining, rationalising and organising the services. There is a significant scope for identification of common business capabilities, processes, streamlining, reduction in duplications leading to overall efficiency and effectiveness;

iv. The Open Group's philosophy of Boundaryless Information Flow™ can only be achieved when end-to-end business flows with straight-through processing is supported by data standards and shared data hubs. A standard way of describing data, common taxonomy, data exchange framework, seamless sharing of data across government enterprises, and publishing government data to public-at-large to encourage new services in a collaborative manner are key considerations in the data domain. The ability to analyse the data in order to derive insights and aid decision making are equally critical;

v. As with government services and their underlying business processes, there is a general preference to build applications to automate and support one or at most a few services. The stovepipe approach that initiates at the service and business process layers continues to get entrenched at the application and system layers. There a noticeable apathy towards "looking-across" and even attempting to uncover common application capabilities and reuse. This is amplified by the fact that most state governments and other government entities tend to be dictated / directed by their vendors, who, needless to mention, come with their own vested interests and proprietary solutions;

vi. The digitisation of government services depends on availability of ICT infrastructure that is reliable, ubiquitous and secure. The scope to achieve standardisation in this layer of the architecture is immense. There is a felt need, therefore, to provide a set of principles, standards and guidelines to steer state governments and government enterprises to design, procure and operate such infrastructure, and not be swayed by vendor priorities. This is a layer that can be consolidated and all benefits of standardisation accrued;

vii. The need to govern a mix of business services that in some form touch governments at different levels (e.g. a federally funded, state government administered and local government delivered service) bringing in high level of complexity, wherein there is ambuguity as to who the actual customer is, its role and accountability;

viii. With explosive growth of digital channels, devices and citizen expectations for providing services that are "anytime, anywhere, anyform" and the inter-connectedness of everything, the imperative to understand the security (and privacy) aspects cannot be overlooked. Mission critical assets need to be protected through a series of multi-layered, defence-in-depth interventions that are essential to ensure the critical services and information are available in the right form, at the right time, to the right people, for the right reason and in the right place; and

ix. The effectiveness of the above layers or perspectives is amplified only when there is an underlying framework for integration. Fulfilment of mission necessitates end-to-end business processes, that are supported by seamless access to data from multiple sources, orchestration of application capabilities across multiple applications, operating on common and shared infrastructure (both on premise and on the cloud), functioning in a secure way while still protecting privacy of the citizens-at-large and government assets. Therefore, the ecosystem that is connected government is realised only when enabled by an effective integration mechanism.

A few contemporary scenarios where state governments and other government entities can benefit from enterprise architecture include the following, but are not limited to:

i. Government transformation initiative which demands efficient coordination between strategies, policies, processes, services and organisational capacity to absorb change;

ii. Enhancement of service delivery across the government in order to create services that are citizen-centric, cross-departmental, end-to-end and outcome based;

iii. Rationalisation of data across the government to enable an integrated perspective, facilitate open data and transparency, and departmental collaboration and compatibility;

iv. Coordination of all ICT initiatives under one umbrella to get a better holistic perspective, boost IT planning effectiveness and optimise costs and investments for better returns;

v. Implementation and ICT enablement of government process reengineering to provide multi-channel service delivery in a manner that increases digital take-up and completion rates;

vi. Ensuring that government applications and systems provide end-users with information they need to make decisions and influence government operations;

vii. Improving the execution capability of policies and other interventions to achieve better planning and anticipate budgetary impacts on the government and enabling ICT systems;

viii. Adopting new and emerging technologies to augment government efficiency and thereby attract investments; and

ix. Building an ecosystem for the digital economy to boost shared prosperity, by leveraging ICT for employment and growth.

Active endorsement by the political leadership, cabinet and bureaucracy are imperatives for success. In the context of e-government, India is on the cusp of growth with Digital India stimulating further initiatives and advancements. The adoption of enterprise architecture in the government is a complex and eclectic mix of enabling factors, challenges, impediments which are political, environmental, social, technological, legal and operational in nature. The implementation IndEA, therefore, has to address these challenges. This guide seeks to do the same precisely.

## b. IndEA Reference Models

The primary objectives of IndEA RMs are to:

i. Capture and codify current knowledge and experience in a consolidated form for ready reference to anyone who is interested to understand this subject;

ii. Kick start enterprise architecture initiatives across India, covering entire state governments and other government / public sector entities;

iii. Enrich the procurement process and provide greater leverage to government enterprises in managing their vendors;

iv. Document issues and concerns contextual to India, in a manner such that the finer nuances of governance are captured and factored in;

v. Support India's transition towards digital governance and knowledge economy as envisaged in the Digital India initiative.

With these objectives, the eight reference models have been developed as shown in Figure 3-1 (*see IndEA Framework for details*).

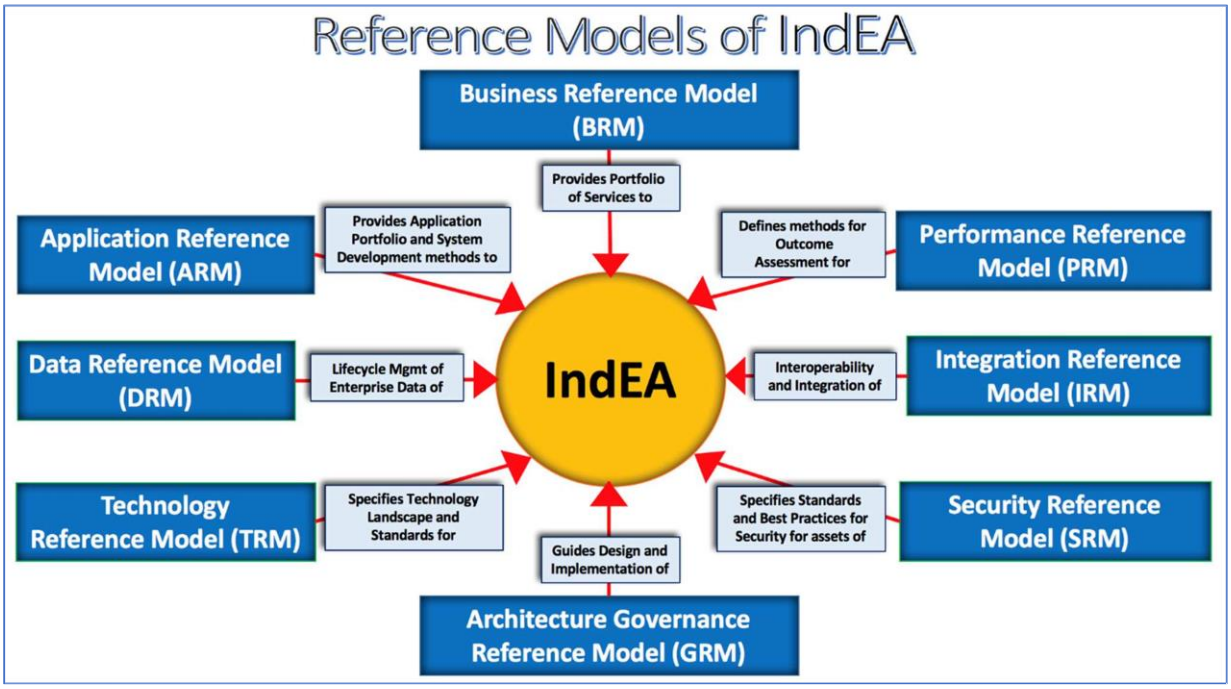


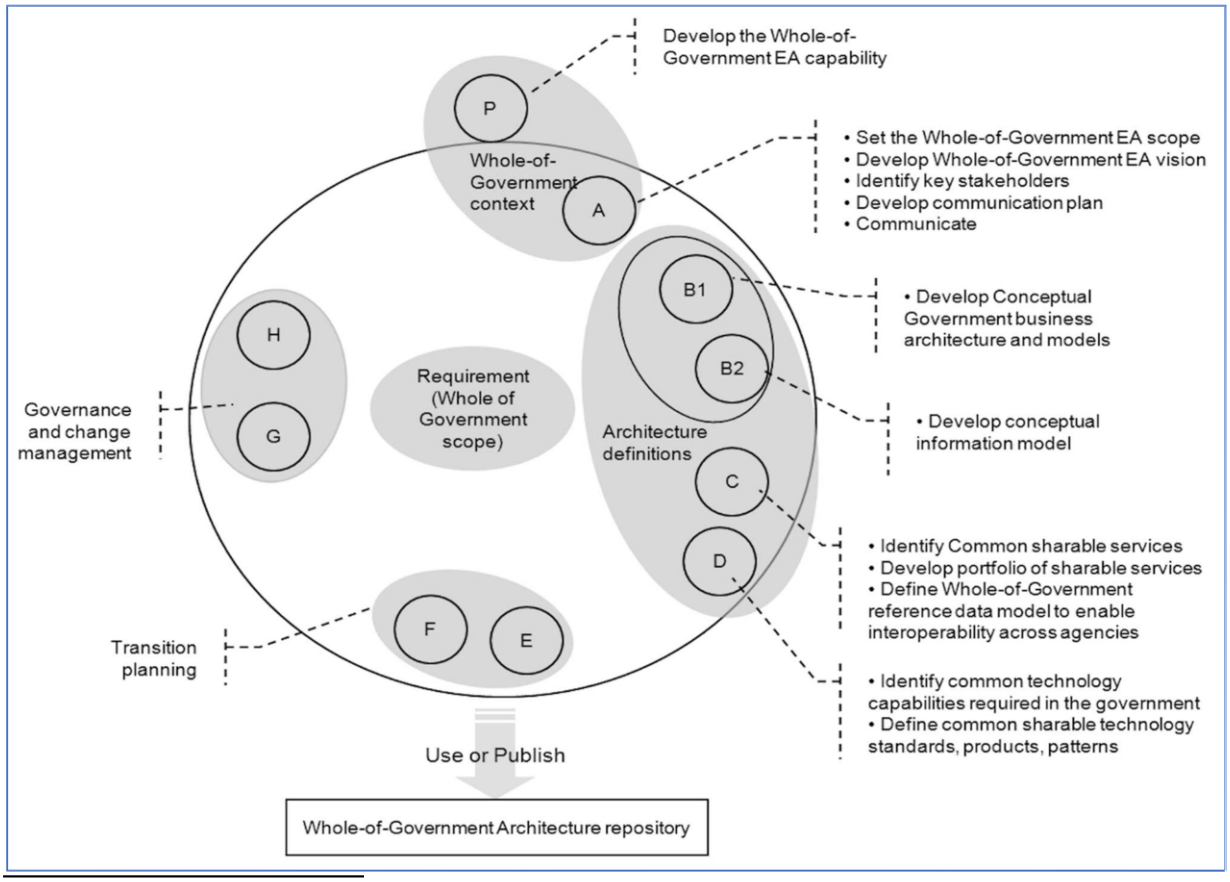

*Figure 3-1: The IndEA Reference Models Normative View*

# 4. Using the IndEA Framework

This section elaborates on how the reference models can be used. Taking the TOGAF® Architecture Development Methodology (ADM) as the base, each phase is summarised and the use of relevant Reference Models is described. Readers are referred to the detailed objectives, steps, inputs and outputs of the TOGAF ADM in the main TOGAF standard. They are not repeated here to maintain brevity.

## a. Architecture Development in a Multi-level Enterprise

Government enterprise architecture follows a multi-level approach to account for different layers of government bodies. Business services should be analysed for inter-departmental linkages, and automation/digitisation and infrastructure requirements. Different viewpoints should be linked to ensure provision of integrated services to the citizens and businesses. Service design must be citizen centred (i.e. services are anchored around key stakeholders–citizen, farmer, student, land owner, senior citizen, beneficiary). Service delivery is to be supported by deep collaboration between departments in terms of information flow, application interaction and common infrastructures. State governments and other government entities are advised to traverse the phases of the ADM in a structured manner. The use of the IndEA across the phases has been elaborated. The following figures[6] depict the key activities across the ADM phases. Figure 4-1 shows the activities when the state government is aiming to build a state government wide enterprise architecture, i.e. at the WOG level.




[6] Enterprise Architecture for Connected E-Government

*Figure 4-1: TOGAF ADM Phase-wise Activities for Government-Wide EA*

When the state government has its own government-wide enterprise architecture, that then forms an input to individual departmental enterprise architectures. This approach ensures that the departments while conforming to the overall state enterprise architecture are still able to retain their autonomy and operational independence, thereby reflecting the governance structure. This approach also encourages certain forward-thinking departments to develop their own enterprise architectures even before the state enterprise architecture is developed.

Figure 4-2 shows the ADM activities for an individual government agency to develop its enterprise architecture, which is in conformance with the WOG enterprise architecture shown in Figure 4-1. The ADM cycle in Figure 4-2 should be seen as triggered by and subsequent to the ADM cycle shown in Figure 4-1.

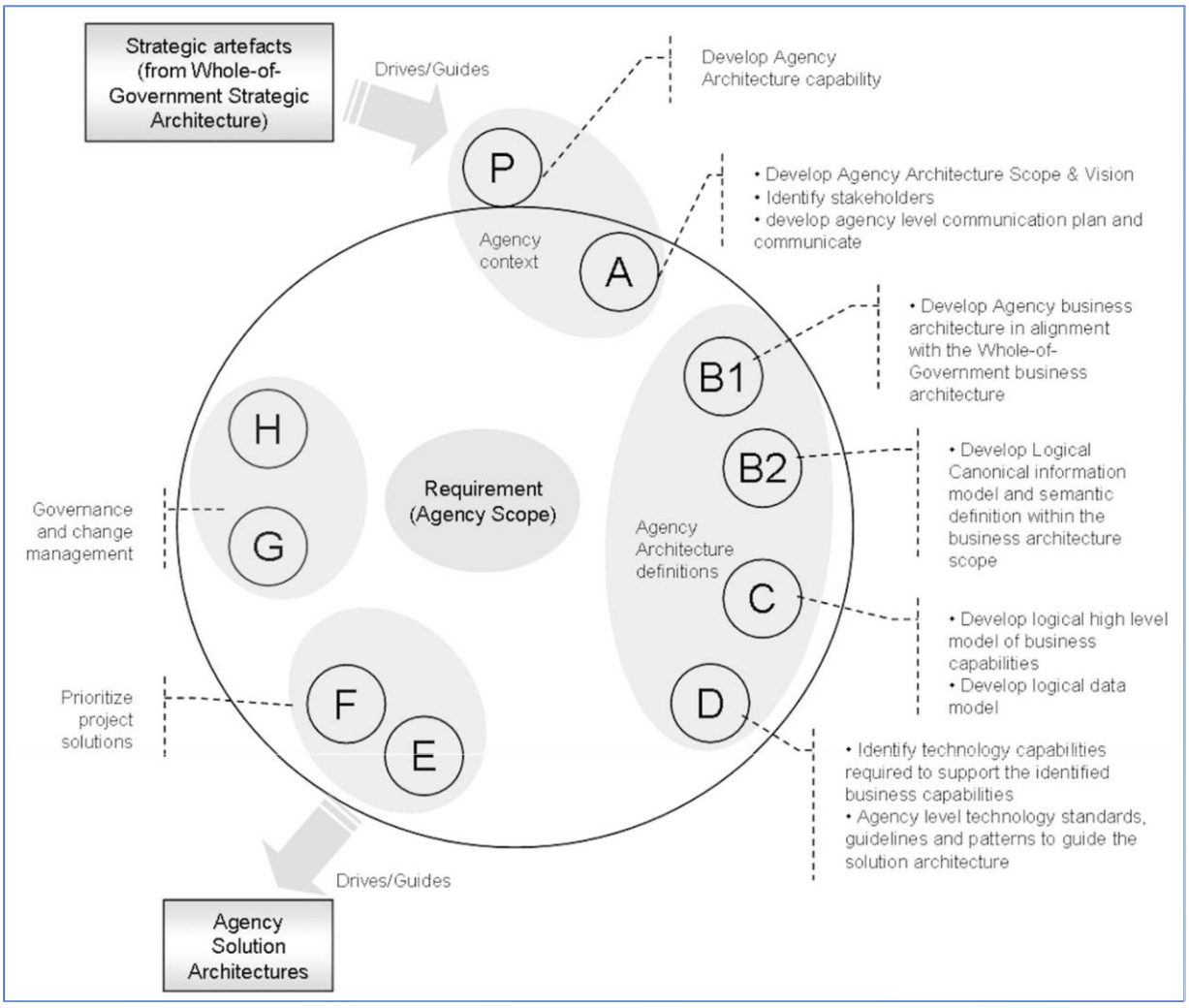



*Figure 4-2: TOGAF ADM Phase-wise Activities for Agency EA*

The architecture-derived initiatives and programmes will need to be consolidated to build solutions. These form the third level of ADM cycle, representing implementation. This is depicted in Figure 4-3. It is most likely that state governments may engage external implementation partners to perform this cycle, e.g. system integrators. Therefore, the specifications derived from earlier two

Page Upper Bordercycles (Figures 4-1 and 4-2) should form a critical part of the procurement process. The significant portions of the architecture description should be incorporated in the tender / RFP specifications.

The use of IndEA is essential at all the three levels (shown in Figures 4-1, 4-2 and 4-3). Overtime, it is expected that the state governments may enrich the reference models, by incorporating portions that may be relevant to their specific contexts. This retains the vitality for the reference models, keeping them fresh and relevant, by regularly including changes.

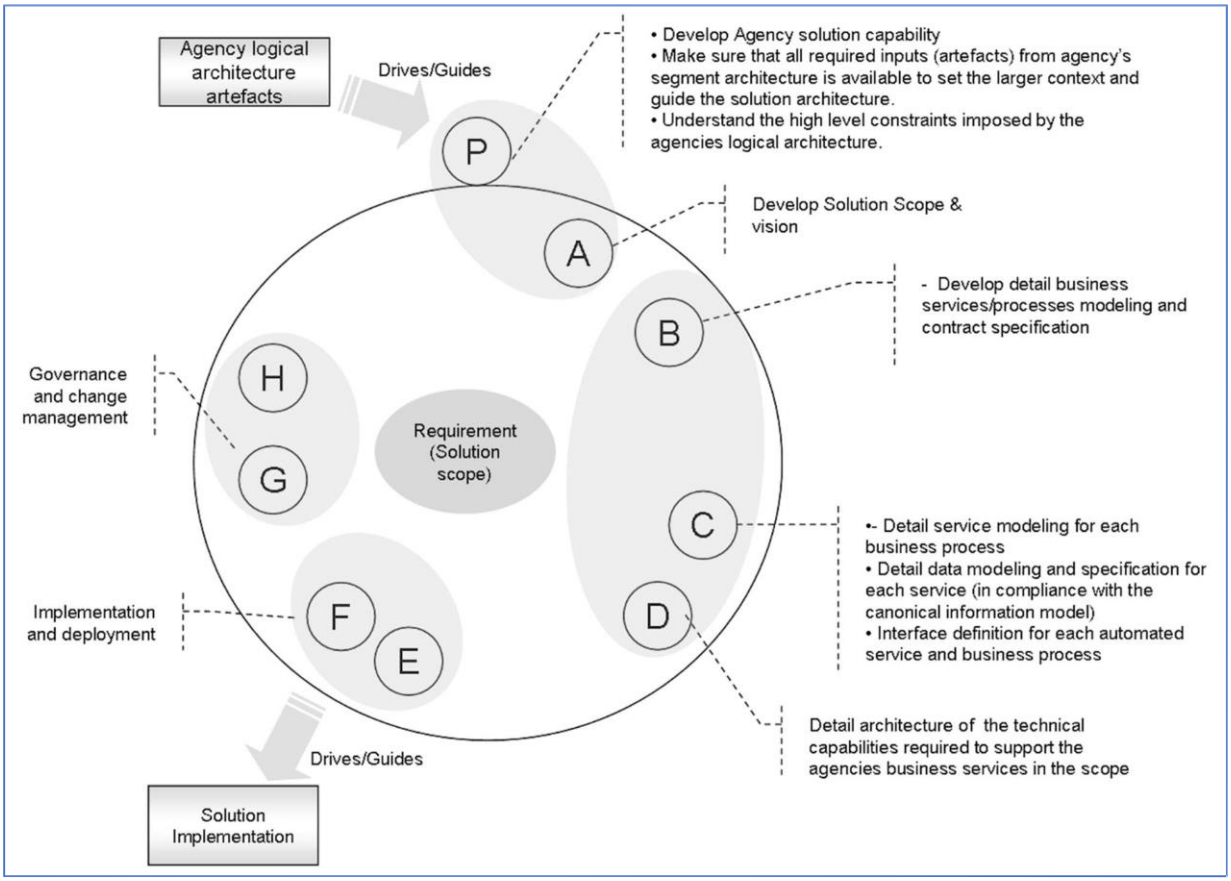



*Figure 4-3: TOGAF ADM Phase-wise Activities for Solution Architecture*

Figure 4-4[7] shows how IndEA Reference Models are positioned along with state enterprise architectures in the overall national context. The subsequent sections describe the use of IndEA in the various phases of the ADM, along with one phase on Conceptual Solution Architecture (covering Figure 4-3) which is an extension of the standard ADM.

[7] Enterprise Architecture for Connected E-Governmen

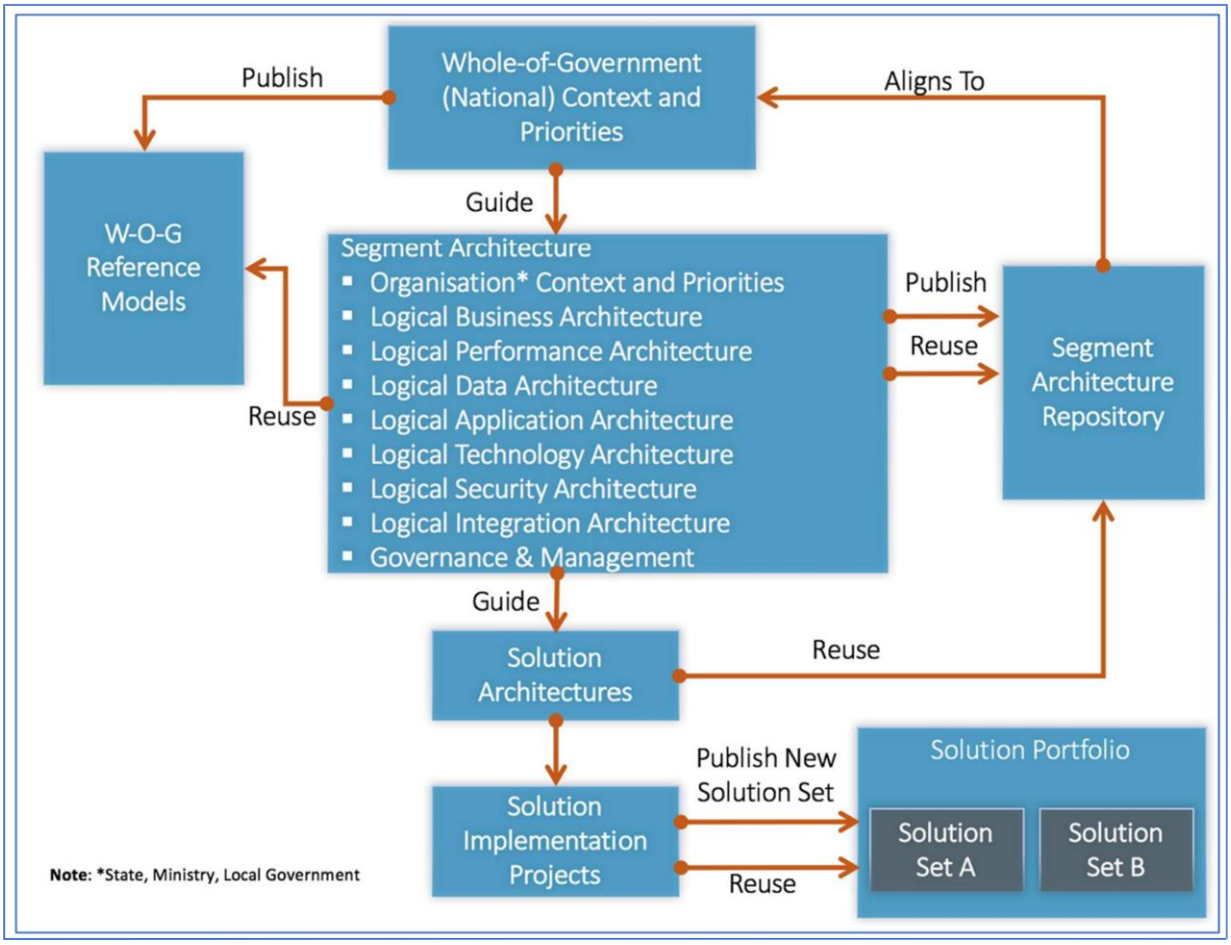



*Figure 4-4: IndEA vis-à-vis State Enterprise Architecture in the National Context*

**PRELIMINARY PHASE**

The purpose of this phase is for state governments and other government entities desirous of embarking on enterprise architecture to prepare and get the entire ecosystem ready. As part of this phase, organisations are recommended to study and understand the Reference Models, their purpose, and implications. It is important to **study all the eight reference models** and the preparation and information needed to demonstrate conformance. If an external vendor is being used for purposes of building the enterprise architecture, then they too need to be fully apprised of the reference models. In such a scenario, it is strongly advised that state governments and other government entities direct the vendors to tailor their respective approaches and methods to weave- in the Reference Models and prepare to demonstrate conformance at an appropriate juncture. Furthermore, if a **commercial EA tool** is being used then it would be prudent and timely to check and reconfirm how and to what extent is the tool a support for IndEA. Any configuration of the tool, including relabeling terms, should be done at this stage. The core team should attend tool familiarisation sessions.

The Reference models also include architecture principles. This is a good time to revisit the standard principles, and check for their adequacy and make any revision required. See Figure 5-1 for activity-wise mapping.

The key questions to be addressed in this phase include:

1. What is your organisation's strategic situation?
2. What are the most fundamental triggers to embark on the enterprise architecture initiative?
3. How is this going to impact the state's overall governance, that is visible to the citizens? What difference will this make to the citizens' quality of life?
4. What level of internal capacity and knowledge is needed? In what areas is this required to be augmented by external expertise / consultants?
5. What is the scope of the enterprise in this context? **What is scope of enterprise architecture**?
6. What is being aimed to achieve through this journey? Is there executive agreement and sponsorship?
7. What body of knowledge is accessible that will be of utility?

   What resources and tools will be needed? Are they accessible?
8. Have awareness and familiarisation sessions been conducted? Who have participated in these?
9. What governance and legal frameworks (if any) are useful during this endeavour?
10. Have the governance committee, core team, working teams been constituted, along with their terms of reference?
11. What are the acceptance criteria? Who is the signing authority?
12. Is there a clear common understanding on how enterprise architecture is going to be used and **maintained** once it is in place?

The suggested outputs from the preliminary phase include:

1. Business Vision and Mission
2. Organisation Diagnostic Report
3. Architecture Principles
4. Architecture Scope and Programme Plan (Outline)
5. Architecture Governance Strategy (Outline)
6. List of Security Policies and Standards
7. Security Vulnerability Analysis Report
8. Security Assumptions and Boundary Conditions Report

**PHASE A: ARCHITECTURE VISION**

In this phase the architecture project scope, initiation of the architecture development cycle, identification of stakeholders, their concerns, business requirements, business goals, evaluation of business capabilities, target architecture value propositions, architecture principles are performed or established. Within the scope of activities and recommended outputs for this phase, the **Performance Reference Model** is the primary one to be used. Additionally, certain aspects from the Business Reference Model and Governance Reference Model should be used in this phase. IndEA does not prescribe the overall vision and mission for the states or any government entities. This is deliberate as it is expected that every organisation building its enterprise architecture will define its own business vision and mission to suit its priority and direction. The top leadership of the state

governments (comprising of the lawmakers and bureaucrats) are critical to define the state vision and mission. For these to be realised, the states are guided to define their goals and objectives. The PRM recommends the use of UN's Sustainable Development Goals (SDG)[8] as the basis of defining state / organisation specific goals and objectives. It is to be noted that all of the 170+ goals in SDG may not be suitable for a state or a government entity. The process of establishing goals with SDG as the basis, and deriving objectives and KPIs is described in the PRM. One of the key outputs of this phase is to define the key performance indicators (KPI). The PRM explains the process to define KPIs, provides the most fundamental performance principles and critical measurement dimensions like KPI type, frequency of measurement, actions to be taken in case of deviations. Suggested KPIs, organised by domains and departments are provided as guidance. The state governments and other entities are expected to use them as reference and define their own ones. The critical part of PRM is to define and differentiate **outputs and outcomes**, as the fundamental approach of PRM is to demonstrate that KPIs do positively influence goals and fulfillment of objectives, leading to achievement of vision and mission. See **Figure 5-1** for activity-wise mapping.

The key questions to be addressed in this phase include:

1. Is there a clear and accepted **vision and mission** in place, that is both aspirational and transformational?
2. Is there a formal architecture project plan? Does this identify the core outputs, critical milestones and important timelines?
3. Which organisational entity is tasked with this initiative? What is their level of authority to implement?
4. Have the vision and mission been translated into actionable goals and objectives?
5. Which other departments should be involved? Have the SPOCs been identified? What is the expected interaction mechanism?
6. Are the business goals, business drivers and business constraints defined and implications understood?
7. Have the performance outcomes been established and agreed upon?
8. Have the architecture principles been established and agreed upon?
9. What are the potential risks, and have the mitigating activities been elaborated?
10. Is there a formal statement of work that is accessible to all relevant parties, including external consultants (if any)?

The suggested outputs from this phase (Phase A) are:

1. Architecture Scope and Programme Plan (Detailed)
2. Business Goals and Objectives
3. Key Performance Indicators and Outcomes
4. Environment Analysis Report (Current Business and IT Landscape)
5. High-Level Architecture Requirements
6. Security Environment (Physical, Business, Regulatory) Analysis Report

[8] https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf

7. Security Conformance Action Plan
8. Disaster Recovery and Business Continuity Action Plan
9. Risk Management Strategy and Mitigating Activities
10. Communication Plan

**PHASE B: BUSINESS ARCHITECTURE**

This phase primarily covers the approach to realise the vision and mission, through the development of business architecture, which in essence is a set of business services, abstracted to extract commonility and re-use and integrated across departments and sectors. The validated business principles, business goals and business drivers are critical components of this phase. The business principles are elaborated. The current and target business architectures are developed and documented, gaps between the two perspectives are analysed for identification of opportunities. These opportunities are then utilised to create high level technical requirements, and the first cut of the architecture roadmap. The BRM is the primary reference in this phase, while the PRM forms the secondary reference. Broad reference to the other reference models are more to understand the impact of business architecture to the technical domains, so that the high level technical requirements can be identified.

The BRM captures the "business of government" through the **business services** states and other government organisations provide to citizens, businesses and other stakeholders in the ecosystem. Business services (G2C, G2G, G2B and G2E) are critical, as they are the means by which governments interact with citizens and businesses. Development of current service catalogue, the process of service prioritisation, service rationalisation and simplification of service portfolio leading to the **creation of target service catalogue** is guided by the BRM. The recipients of the services (service beneficiaries) and service outcomes are also covered in the BRM. These form critical components of the target business architecture. The target business architecture is linked to the PRM through the service outcomes impacting the KPIs. The target business architecture is elaborated through the underlying business processes that realise the services, and identify any need for process reengineering. The processes provide input to identify the supporting data requirements and governing business rules, linked to the DRM and other reference models.

A key deliverable from Phase B is the **Architecture Definition Document** which takes input from the BRM, to a lesser extent from the PRM and GRM, and covering the linkages to the technical domains captured in the other reference models. See **Figure 5-1** for activity-wise mapping.

The key questions that should be addressed in this phase are:

1. How many services does the state offer / deliver to various stakeholders?
2. In the cumulative service list, how many belong to the following types:
    a. Government to Citizen (G2C)
    b. Government to Business (G2B)
    c. Government to Employee (G2E)
    d. Government to Government (G2G)
3. What proportion of services are direct, indirect (general) and obligations:
    a. Direct (for direct benefit of an individual based on need).

b. Indirect (general, for general benefit of all in the community).

c. Obligations (placed on certain individuals for the indirect benefit of all the community).

4. What proportion of services are currently automated / digitised as e-services?
5. What channels are used to deliver the services?
    a. Face-to-face aggregate (i.e. services centres / one stop shop)
    b. Face-to-face in respective departments
    c. Automated aggregate (i.e. centralized pan-government portal)
    d. Automated departmental (i.e. departmental portals)
    e. Mobile / handheld devices (i.e. m-services)
    f. Outsourced service provider (service brokers)
6. Have the services been subjected to any form of prioritisation, specifically to identify the important and critical services?
    a. If yes, what is the prioritisation approach / method adopted?
7. Have the services been rationalised (i.e. overlaps and redundancies identified and eliminated as needed)?
8. What supporting documentation is available pertaining to the services?
    a. If yes, are they adequately granular?
    b. If yes, are they appropriately recent / latest?
9. What is the approach used to identify, launch and refresh services?
    a. In past five years how many services have been abolished or discontinued?
    b. In past five years how many new services have been initiated / launched?
10. How is service performance measured?
11. Is the service performance linked to citizen feedback / satisfaction?
12. Are there services that are:
    a. Department specific (i.e. all aspects of the service are fulfilled by one department in totality, with no dependency on any other department).
    b. Common to the entire state government (i.e. services consumed by all departments of the state, requiring inter-departmental interaction).
    c. Group / cluster specific (i.e. all aspects of the service are fulfilled by collaborating departments belonging to a logical group / cluster – e.g. health cluster, education cluster, social welfare cluster etc.).
    d. Cross-cutting (i.e. which have a lead department triggering the service, but need various levels of involvement by other departments in an orchestrated manner for fulfilment).
13. In the past five years, how many services have been reengineered?
14. How does the government view its role pertaining to services?

a. As an end-to-end service provider.

b. As a partial service provider (i.e. some activities within the service flow are performed by external entities).

c. As a service assurance manager (i.e. entire delivery is outsourced, and the government uses SLAs to manage vendors).

15. Does the government have an integrated service delivery approach in place?

    a. How are the digital and non-digital interactions integrated?

16. Do the services have a common look, feel, tone, language and function?

17. Are there services that are not attributable to any mission and goal, but still active for legacy reasons?

The suggested outputs from this phase (Phase B) include:

1. Current Business Architecture
2. Target Business Architecture
3. Gaps and Opportunities Analysis Report
4. Business Service Catalogue
5. Business Process Analysis Report
6. Current Security Process Analysis Report
7. Target Security Process Analysis Report
8. Detailed Architecture Requirements

**PHASE C-1: DATA ARCHITECTURE**

This first sub-phase within Phase C of TOGAF ADM covers data and information aspects. Data is the new currency in the digital world. For governments to encourage and support the concept of "one government", the underlying data is a critical success factor. Through this sub-phase the target is to **enable data standards, data definition and data exchange**. The first and foremost activity in this phase is to find / discover data that are required and needed and the second is to find a common agreed way to describe the data. Data discovery and description is deeply influenced by business and operations, therefore context is essential for data to be meaningful and usable. As part of defining the data architecture, organisations are advised to build on the architecture principles provided in the DRM. Usually, current data architecture should consist of identifying the core applications and systems and subject them to reverse engineering to identify the underlying data entities. These current data entities should be captured together to understand the relationships and interactions. The usual shortcomings with regard to current data include – (a) incomplete data; (b) inconsistent data integrity; (c) overlaps and repeated data; (d) missing data context; (e) isolated data (no sharing); (f) missing links to business services; (g) weak or missing data governance: and (h) no clear data ownership and accountability. In defining the target architecture, the DRM should be used to build meta-data standards, data definition, data sharing and data context. The core entities that the DRM lists should be the first port of call. Only state and organisation specific data should be defined new. Available data dictionaries in various domains (e.g. Health, local government) should be closely followed and adopted, to avoid reinventing same data definitions again.

Data architecture analysis should also categorise certain common data across the government. These include data pertaining to people, businesses, land, things. They are candidates to be become **"data hubs"**. Data should be a reusable asset, that is mission-critical. This should be augmented with strong and effective data governance. The architecture definition document in this sub-phase should cover issues like – who / which process creates the data, how does the data flow, where does it get used, in what format does it get created, who owns the data, who is allowed to modify the data and under what circumstances, which is the single definitive source for this data. Governance of data must factor in the organisation's structure, roles, responsibilities and administration. See **Figure 5-2** for activity-wise mapping.

The key questions that should be addressed during this phase include:

1. Currently, where does the data reside?
    a. Entirely in respective applications and systems
    b. Partly in respective applications and systems, partly in common data repositories
    c. Entirely in common data repositories
2. Are there services wherein there are requirements to share and exchange data between departments? If yes, what is the mechanism used for data sharing and exchange?
3. Have any common and shared data been identified?
4. Have any kind of data standards been defined and adopted (i.e. standards pertaining to data definition, data sharing, meta-data)?
5. Are any industry level data standards being used?
6. How many applications have their **database schemas** readily available? Are these schemas used in managing data?
7. What is nature of data that currently exists?
    a. Parliamentary and legal data
    b. Public expenditure and budgeting data
    c. Environmental data
    d. Demographic data
    e. Socio-economic data
    f. Health and well-being data
    g. Geographical data
    h. Transportation data
    i. Agriculture and aquaculture data
    j. Industries and business data
    k. Government assets data
    l. Resources and revenue data
    m. Education and skills data
    n. Employment, labour and opportunities data
    o. Procurement data
    p. Works, contracts and vendor data
    q. Feedback and grievance data
    r. Security data
    s. Governance and administration data
    t. Housing data
    u. Rural development data
    v. Tourism, sports and entertainment data

8. Are there any requirements to combine data of different kinds and from different sources, and use them for decision making?

The suggested ouputs from this phase (Phase C-1) include:

1. Current Data Architecture
2. Target Data Architecture
3. Gaps and Opportunities Analysis Report
4. Data Dictionary / Catalogue
5. Data Governance Strategy and Action Plan
6. Data Asset and Access Privilege Report
7. Data Flow and Lifecycle Report
8. Information Classification Report

**PHASE C-2: APPLICATION ARCHITECTURE**

The second sub-phase within Phase C of TOGAF ADM covers the **IT systems and applications** used to automate business services and their underlying business processes. The systems and applications are the most visible and utilized portion of the enterprise architecture, as they manifest how interactions take place. The ARM provides specific inputs by way of suggested application architecture principles. The current application architecture is developed and analysed. The most important observable characteristic in the context is that applications in the government machinery usually reflect the fragmented and stovepipe thinking that exists in the business operations. The most important part of using the ARM to build the target application architecture is to analyse the application catalogue and identify application capabilities. The **ARM classifies applications as core, common, group and departmental applications**. Reorganising applications through a process of decomposing, understanding, rationalizing and consolidating is a critical part of the developing the target application architecture. The critical idea is to ensure that individual ministries and departments are able to maintain their required autonomy while also taking advantage of economies of scale in an ascending manner. The use of ARM will therefore get all states and other government entities to have the core set of applications at the minimum. This means certain critical services will be automated through this common core. On top of the common core, the other common, group and departmental applications (based on business priorities and availability of data) are to be built and commissioned in a structured manner. To aid adoption, the ARM provides list of common, core, group and departmental applications.

The development of application architecture in this phase also requires elaboration and clarity with regards to non-functional (or quality) requirements, and adoption of relevant standards for the various layers in the application architecture. This phase is a critical success factor as these underlying applications are how the concept of a federated and integrated government is achieved. This is what is physically visible. The organised catalogue of applications in the target application architecture should be able to support usage scenarios such as:

- *Publish* usage scenarios, which represent publishing document or data in a way that allows for electronic access over internet, typically using a web site or a web portal;
- *Interact* usage scenarios, which allow consumers of the services to interact with the government, but not in a way that involves transactional processing; for example, ability to exchange emails or to fill out feedback forms fall into this category;

- *Transact* usage scenarios, which represent interactions containing transactional component, such as on-line data entry or purchases; and
- *Integrate* usage scenarios, which involve integration of services made available by eGov with other services or data (typically, from other sources) to produce new services. These scenarios involve publishing of eGov services (typically, as Web Services) and mashups of services with other services or data sources.

In order to support these usage scenarios, it is imperative that the applications integrate and interact with one another, in an orchestrated manner so that the service interactions become seamless. This is covered in the IRM. As a consequence of "organic" and gradual proliferation of applications in government entities, the most prevalent current way of integration is point-to-point. This is a workable solution if the number of applications is less than ten. Anything over and above ten, makes point-to-point integration a spaghetti. As the way forward, the states are encouraged to adopt middleware based and hybrid integration approaches. See **Figure 5-2** for activity-wise mapping.

Some of the indicative scenarios for integration, along with recommendations are mentioned below:

*Scenario 1:* A small number of legacy applications, designed and developed independently with diverse technologies, largely operating in silos reflecting business operations, within the confines of single ministry or department, and little need for external interactions.

Recommendation: Use P2P integration for specific needs.

*Scenario 2:* A large number of a mix of legacy and new applications, designed and developed independently, requiring high degree of business and operational integration, within the confines of a single ministry or department or organisation, and little need for external interactions.

Recommendation: Use ESB / hub-and spoke approach to accommodate high degree of intra-organisational integration.

*Scenario 3:* A large number of a mix of legacy and new applications, designed and developed independently, requiring high degree of business and operational integration, requiring extensive interactions with other ministries or departments or external stakeholders in the ecosystem.

Recommendation: Adopt a hybrid approach. i.e. ESB for interactions within the ministry or department, and specific application capabilities exposed as APIs for all interactions with external entities.

The key questions that should be addressed in this phase using the ARM and IRM are:

1. How many applications are in the current portfolio?
2. How many applications are in active use?
3. How many applications are standalone (i.e. applications that require no interaction with any other application in the portfolio)?
4. Are applications evaluated for performance? If yes, how is this information used?
5. Are there applications that need interaction amongst themselves?
    a. If yes, what interaction mechanism is used?
        i. Manual / data entry

ii. Simple data transfer

iii. Screen scraping[9]

iv. Point-to-point

v. Middleware integration

vi. Integration using APIs

6. What are the primary reasons for applications to interact?
7. What is the pre-dominant application development policy – build or buy?
8. Where are the applications hosted?
9. Are there application principles established and enforced across?
10. What is the approach used to categorise or group applications?
11. Has there been any concerted effort to modernise the applications? If yes, what the most prevalent modernisation strategy?
    a. Refactor[10]
    b. Re-host
    c. Replace
    d. Re-architect
    e. Re-interface

The suggested ouputs from this phase (Phase C-2) are:

1. Current Application Architecture
2. Target Application Architecture
3. Gaps and Opportunities Analysis Report
4. Application Catalogue / Portfolio
5. Application Development Strategy
6. Application Integration Architecture
7. Application Classification Report

[9] Screen scraping is the process of collecting screen display data from one application and translating it so that another application can display it. This is normally done to capture data from a legacy application in order to display it using a more modern user interface.

[10] A disciplined technique for restructuring an existing body of code, altering its internal structure without changing its external behaviour.

## PHASE D: TECHNOLOGY ARCHITECTURE

In this phase, the technology infrastructure aspects are covered. The role of TRM in this phase is crucial, and this is the architecture layer that benefits the most from **standardisation**. Given the current technology landscape that is covered with a plethora of vendor products, the need for standardisation cannot be overstated. For most governments, technology modernisation and standardisation is a low-hanging fruit, usually vendor-influenced. The use of IndEA TRM can be augmented with the knowledge of TOGAF TRM.

The IndEA TRM identifies the technology categories, domains and relevant applicable standards. Usually, the process of procurement and adoption of ICT at different times and by different people results in technology diversity. For state governments and other government entities ICT is not the core business. Therefore, it is not an area where governments need to experiment and explore with new technologies. Their primary job is governance. Given this scenario, the two priority areas that state governments are advised to consider in this phase of ADM are **technology modernisation and technology standardisation**. When analysing the current technology architecture and developing the target technology architecture, state governments should refer to the TRM which describes ways to structure the technology layer, provides guidance on technology standards and their applicability, factoring in Government of India's priorities and preferences (e.g. use of Open Source, Open APIs and Cloud First).

**IT4IT™** is a reference architecture for the business of IT, and technology infrastructure is a major component of this framework. IT4IT covers the entire IT Value Chain including **Plan, Build, Deliver and Run** through four value streams, namely: **strategy to portfolio, requirement to deploy, request to fulfil and detect to correct**. See **Figure 5-2** for activity-wise mapping.

Major questions that need to be addressed in this phase include:

1. What is the extent of technology standardisation? Is technology diversity an issue to be addressed?
2. Is there a list of technologies currently in use within the government? If yes, when was this last updated / revised?
3. What steps are in place to ensure that the technology used within the government remains relevant and future-ready?
4. Is the current technology in use within the government, adequate to meet current and future needs? When and where are the constraints?
5. Has technology audit been conducted to ascertain the technology debt? Is this hurting, both operationally and financially?
6. Are technology assets located in-house and in-sourced? What portion is out-sourced?
7. Is there a technology service catalogue? Is this extensively used to plan, design and deliver technology capability to the line departments?
8. How well is the network topology understood and used as an input for decision making?
9. Is the link between technology and application layers documented and understood? Is this mapping used to identify gaps, overlaps and opportunities

The suggested outputs from this phase (Phase D) are:

1. Current Technology Architecture
2. Target Technology Architecture
3. Gaps and Opportunities Analysis Report
4. Technology Portfolio
5. Technology Modernisation Strategy
6. Security Technologies Catalogue

**ADDITIONAL PHASE: SECURITY ARCHITECTURE**

This is not a separate phase in TOGAF ADM, the security aspects being implicit and subsumed within Phases B, C and D. However, given the emerging criticality of cybersecurity in the digital paradigm, IndEA has made security architecture a separate domain, thus reflecting its importance in the new normal. In order to show its close relationship with the other architecture domains, Figures 5-1, 5-2, 5-3 and 5-4 map security architecture to ADM activities in Phases B, C, D and extensions.

The two major drivers for security are **Risk and CIA** (Confidentiality, Integrity, Availability). IndEA SRM covers these factors comprehensively. Keeping in view of this additional phase, state governments should use the layers identified in the SRM, and as part of current state analysis build a portfolio of security controls in place. Such controls are most likely scattered over the different architecture layers of data, application, integration and technology. The business drivers should ideally be covered as part of Phase B, business architecture. In general, in the current scenario security aspects tend to be – reactive, vendor driven, product centric and technology focussed.

Developing the security architecture (the target view) should start with defining security architecture principles. The IndEA SRM provides principles covering Risk and CIA. The impact of Cloud and SOA on security also needs to be covered. From a senior management perspective, the following are key to defining good security architecture:

- What would a serious cyber security incident cost our organisation?
- Who would benefit from having access to our information?
- What makes us secure against threats?
- Is the behaviour of employees enabling a strong security culture?
- What is our readiness to respond to a cybersecurity incident?

In defining the target security architecture, the following need to be considered and factored in:

- Assets that need to be secured and protected;
- Goals and objectives of securing and protecting the assets;
- Risks and opportunities involved;
- Processes required to achieve the level of security desired;
- People and organisational aspects of security;
- Locations where the security interventions need to be taken; and
- Time aspects that will impact the security interventions.

A critical aspect of security architecture is the ability to pre-empt and deal with insider threats. The focus, if at all, is to secure and protect against external threats. Figure 4-5 (*Source: Understanding Insider Threats; Nurse, J.R.C et al in Workshop on Research for Insider Threats [WIRT] 2014*[11]) models the framework for characterizing insider attacks.

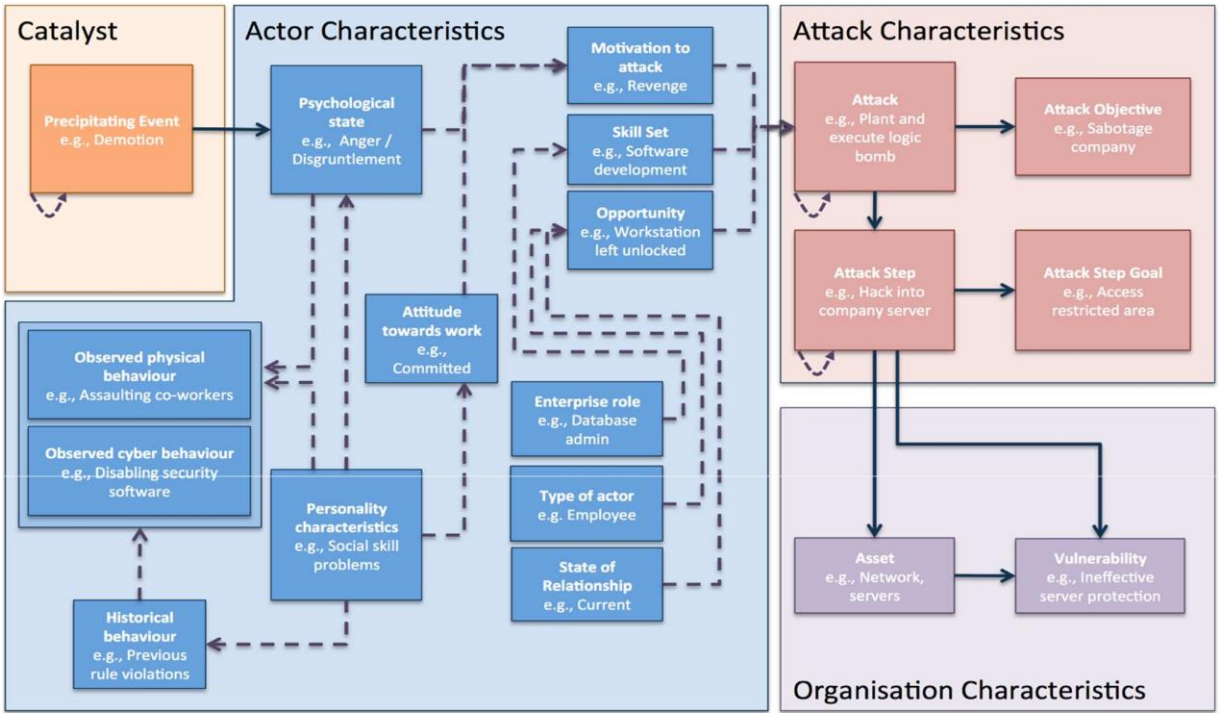



*Figure 4-5: Framework to Characterise Insider Threats*

The following security controls and interventions should be considered by state governments and other government entities:

1. Application whitelisting of permitted / trusted programs.
2. Periodic patching of applications, with the latest versions.
3. Periodic patching of operating system vulnerabilities.
4. Provide administrative privileges to a select few, purely based on roles and accountabilities.
5. Automated dynamic analysis of email and web content.
6. Host-based intrusion detection and prevention system to identify anomalous behaviours.
7. Network segmentation and segregation, to isolate portions in case of incidents.
8. Multi-factor authentication, especially for remote access (e.g. via VPN).
9. Software-based application firewall to block both incoming and outgoing network traffic.
10. Centralised logging of successful and failed computer events.
11. Centralised logging of allowed and blocked network activity.
12. Email and web-content filtering.

[11] https://www.cs.ox.ac.uk/files/6576/writ2014_nurse_et_al.PDF

13. Web-domain whitelisting for all domains.
14. Workstation and server configuration management based on standard operating environment, and disabling unneeded / undesired functionalities.
15. Heuristics based anti-virus software.
16. Denial of direct internet access for workstations, with clear process for exceptions.
17. Enforce a strong password policy covering complexity, length and validity aspects.
18. Continuous user awareness and education.
19. Restrict use of removable media, external storage and other devices from workstations.
20. User application configuration hardening to disable running of internet based code, untrusted macros etc.

The suggested outputs from this phase are:

1. Security Policies and Regulations
2. Security Stakeholders / Actors and Priveleges
3. Threats Analysis Report
4. Security Incident Impact Analysis Report
5. Security Metrics and Monitoring Plan
6. List of Applicable Security Controls
7. User Authorisation Policies

**PHASES E & F: OPPORTUNITIES & SOLUTIONS AND MIGRATION PLANNING**

There is very little direct use of the reference models. Indirect use of the reference models is covered by the Preliminary Phase and Phases A through D. This is attributable to the fact that, in general, reference models are extensively used during architecture conceptualisation, architecture elaboration and architecture governance. It is also useful for architecture evaluation.

The suggested outputs from these phases (Phases E&F) are:

1. Consolidated Gaps and Opportunities Analysis Report
2. Consolidated Target Architecture Description
3. Architecture Scope and Programme Plan (Updated, if needed)
4. Architecture Implementation Roadmap
5. Communication, Advocacy and Training Material

**PHASES G, H & REQUIREMENTS MANAGEMENT:**

After the creation of the implementation roadmap, Phase G of ADM identifies the activities required for implementation programme governance. The GRM is the primary reference to be used in this phase. The GRM provides guidance on the mode of governance, and mechanisms to ensure that the decision rights and accountablities are clear and assigned to the right stakeholders. These should be part of the architecture governance strategy. Success of the enterprise architecture stems from the fact that the blueprint is adopted. Typically, EA can be used for strategy execution, programme management, IT investment decisions etc. The details of how EA can used, should be

elaborated in the architecture adoption plan. Phase H, **architecture change management** is where steps are taken to ensure that – (a) changes are managed in a structured manner during implementation; and (b) the reference models and EA blueprints are kept updated by incorporating a process of periodic refresh. While there is no specific reference model supporting this activity, and general knowledge of all is advised. As state governments and other "consuming" entities start building and implementing their enterprise architectures, these provide inputs to add to and enrich the reference models. This feedback process (see Figure 4-4) should be formalised and internalised, in order to close the loop. Development of the compliance process and items are informed by all the reference models. Similarly, reference models should be built into a commercially available EA tool, if the government entities so desire to automate the administration and management of architecture activities.

Major issues that need to addressed in these phases include:

1. What mechanisms and processes are in place to ensure that the architecture is adopted and used?
2. Which organisational activities should be using enterprise architecture? How?
3. How do we ensure that the reference models are kept updated and fresh? What institutional mechanisms are in place?
4. What portions of the architecture specifications should be made public to enrich and steer the procurement process? How can these be used to evaluate vendors?
5. When and how should the architecture implementation be assessed for compliance? What are the action items resulting from such assessments?
6. To what extent is tool support needed to accelerate the development and use of enterprise architecture? What formal notations should be supported?
7. Is there a need for an independent review of architecture capability and maturity?
8. What steps have been taken to educate the relevant stakeholders? How are we evaluating the effectiveness of such activities?
9. Have we established a metrics and measurement programme? Is this aligned to the PRM?
10. When do we know we have done enough? What is the cycle exit / completion criteria?
11. Is there a success criteria? Who should these be reported to – citizens, lawmakers, auditors?

The suggested outputs from these phases (Phases G & H) include:

1. Architecture Governance Strategy (Detailed)
2. Architecture Adoption Plan
3. Architecture Management Plan
4. Implementation Specifications (RFP or Tendering Process)
5. Architecture Compliance Checklist and Process
6. Architecture Management System Implementation Report
7. Requirements Management Approach and Plan

## ADDITIONAL PHASE: CONCEPTUAL SOLUTION ARCHITECTURE

This is an additional phase which extends the standard ADM. From a state government perspective the need for this is driven by four factors:

1. Depicting the link from enterprise architecture to the downstream activity of solution architecture;
2. Building the capability to realise the target architecture;
3. Providing an integrated view of the services, systems and technology architectures in a visible way; and
4. Enabling and enriching the procurement process by getting a better understanding of constraints, risks, possibilities and users.

Guided by the priorities elaborated in the target enterprise architecture and the overall business vision and mission, the development of the conceptual solution architecture initiates with the assessment of current systems and services to determine the business value and overall alignment to business goals and objectives. Based on the analysis of the current systems and services, the requirements for the target systems and services are derived in a way that conforms to the target enterprise architecture. In developing target solution architecture, the reusable components (from the various reference models) should be used. This should also include understanding the dependencies, constraints, risks and issues in getting the architecture components to work together coherently. Capabilities that are not covered in the reference models, should be defined as reusable components and as part of the institutional governance mechanism these can becomes candidates to be included in the next update of the IndEA (see Figure 4-4). To the extent possible, the outputs from this phase should be vendor and technology agnostic. Refer to Figure 5-4 for activity-wise mapping.

Critical factors that need to be addressed in this phase include:

1. How are systems and services in the selected area / domain / unit / function performing to deliver business value for costs associated in operating and maintaining them?
2. How are the current systems and services linked? What data sources do they use?
3. What risks are associated with existing systems and services? Do these risks affect business continuity?
4. What systems and services should be retired / decommissioned? What should be retained for the target state? Are the reasons retention clear and understood?
5. What security and privacy monitoring activities should be considered for the target state?
6. What is the prefered solution development model? Is the implementation in-sourced or out-sourced?
7. Have the target systems and services been consolidated, rationalized and combined as a portfolio (representing a group of similar or highly dependent systems and services)?
8. Is the portfolio reflected in the transition roadmap?
9. Are there reusable components identified that can potentially be included in the next cycle of the IndEA reference models?

The suggested outputs from this phase are:

1. Current Systems and Services Analysis Report
2. Current Conceptual Solution Architecture
3. Target Conceptual Solution Architecture
4. Target Service Component Architecture
5. Target Deployment Strategy and Architecture
6. Solution Transition Roadmap
7. Conceptual Solution Architecture Presentation

# 5. Mapping ADM Phase Activities to IndEA

For ease of reference, this section maps the phase-wise activities of the TOGAF ADM to the use of IndEA Reference Models with the following colour-codes.

| Legend | Broad General Reference | Secondary Reference | Primary Reference | No Direct Reference |
|---|---|---|---|---|

| TOGAF ADM Phases | Phase Activities | Performance Reference Model | Business Reference Model | Data Reference Model | Application Reference Model | Technology Reference Model | Security Reference Model | | Governance Reference Model |
|---|---|---|---|---|---|---|---|---|---|
| Preliminary Phase | Scope the enterprise organisations impacted | | | | | | | | |
| | Confirm governance and support frameworks | | | | | | | | |
| | Define and establish enterprise architecture team and organisation | | | | | | | | |
| | Identify and establish enterprise architecture principles | | | | | | | | |
| | Tailor TOGAF, and, if any, other selected architecture frameworks | | | | | | | | |
| | Implement architecture tools | | | | | | | | |
| Phase A: Architecture Vision | Establish architecture project | | | | | | | | |
| | Identify stakeholders, concerns and business requirements | | | | | | | | |
| | Confirm and elaborate business goals, business drivers and constraints | | | | | | | | |
| | Evaluate business capabilities | | | | | | | | |
| | Assess readiness for business transformation | | | | | | | | |
| | Define scope | | | | | | | | |
| | Confirm and elaborate architecture principles, including business principles | | | | | | | | |
| | Develop architecture vision | | | | | | | | |
| | Define the target architecture value propositions and KPIs | | | | | | | | |
| | Identify business transformation risks and mitigation activities | | | | | | | | |
| | Develop statement of architecture work | | | | | | | | |
| Phase B: Business Architecture | Select reference models, viewpoints, tools | | | | | | | | |
| | Develop baseline business architecture description | | | | | | | | |
| | Develop target business architecture description | | | | | | | | |
| | Perform gap analysis | | | | | | | | |
| | Define candidate roadmap components | | | | | | | | |
| | Resolve impacts across the architecture landscape | | | | | | | | |
| | Conduct formal stakeholder review | | | | | | | | |
| | Finalize the business architecture | | | | | | | | |
| | Create architecture definition document | | | | | | | | |

*Figure 5-1: Mapping of ADM Preliminary, A and B Phase Activities to IndEA Reference Models*

| Legend | Broad General Reference | Secondary Reference | Primary Reference | No Direct Reference |
|---|---|---|---|---|

| TOGAF ADM Phases | Phase Activities | Performance Reference Model | Business Reference Model | Data Reference Model | Application Reference Model | Technology Reference Model | Security Reference Model | | Governance Reference Model |
|---|---|---|---|---|---|---|---|---|---|
| Phase C-1: Data Architecture | Select reference models, viewpoints and tools | | | | | | | | |
| | Develop baseline data architecture description | | | | | | | | |
| | Develop target data architecture description | | | | | | | | |
| | Perform gap analysis | | | | | | | | |
| | Define candidate roadmap components | | | | | | | | |
| | Resolve impacts across the architecture landscape | | | | | | | | |
| | Conduct formal stakeholder review | | | | | | | | |
| | Finalize the data architecture | | | | | | | | |
| | Create architecture definition document | | | | | | | | |
| Phase C-2: Application Architecture | Select reference models, viewpoints and tools | | | | | | | | |
| | Develop baseline application architecture description | | | | | | | | |
| | Develop target application architecture description | | | | | | | | |
| | Perform gap analysis | | | | | | | | |
| | Define candidate roadmap components | | | | | | | | |
| | Resolve impacts across the architecture landscape | | | | | | | | |
| | Conduct formal stakeholder review | | | | | | | | |
| | Finalize the application architecture | | | | | | | | |
| | Create architecture definition document | | | | | | | | |
| Phase D: Technology Architecture | Select reference models, viewpoints and tools | | | | | | | | |
| | Develop baseline technology architecture description | | | | | | | | |
| | Develop target technology architecture description | | | | | | | | |
| | Perform gap analysis | | | | | | | | |
| | Define candidate roadmap components | | | | | | | | |
| | Resolve impacts across the architecture landscape | | | | | | | | |
| | Conduct formal stakeholder review | | | | | | | | |
| | Finalize the technology architecture | | | | | | | | |
| | Create architecture definition document | | | | | | | | |

*Figure 5-2: Mapping of ADM C and D Phase Activities to IndEA Reference Models*

| Legend | Broad General Reference | Secondary Reference | Primary Reference | No Direct Reference |
|---|---|---|---|---|

| TOGAF ADM Phases | Phase Activities | Performance Reference Model | Business Reference Model | Data Reference Model | Application Reference Model | Technology Reference Model | Security Reference Model | | Governance Reference Model |
|---|---|---|---|---|---|---|---|---|---|
| Phase G: Implementation Governance | Confirm scope and priorities for deployment and development | | | | | | | | |
| | Identify deployment resources and skills | | | | | | | | |
| | Guide development of solutions deployment | | | | | | | | |
| | Perform enterprise architecture compliance reviews | | | | | | | | |
| | Implement business and IT operations | | | | | | | | |
| | Perform post implementation review and close implementation | | | | | | | | |
| Phase H: Architecture Change Management | Establish value realisation | | | | | | | | |
| | Deploy monitoring tools | | | | | | | | |
| | Manage risks | | | | | | | | |
| | Provide analysis for architecture change management | | | | | | | | |
| | Develop change requirements to meet performance targets | | | | | | | | |
| | Manage governance process | | | | | | | | |
| | Activate the process to implement change | | | | | | | | |
| Requirements Management | Identify / document (architecture) requirements | | | | | | | | |
| | Baseline requirements | | | | | | | | |
| | Monitor baseline requirements | | | | | | | | |
| | Identify changed requirements, and re-assess priorities | | | | | | | | |
| | Assess impact of changed requirements on ADM Phases | | | | | | | | |
| | Implement requirements arising from Phase H | | | | | | | | |
| | Update requirement repository | | | | | | | | |
| | Implement change in the current phase | | | | | | | | |
| | Assess and revise gap analysis in the previous phases | | | | | | | | |

*Figure 5-3: Mapping of ADM G and H Phase Activities to IndEA Reference Models*

| Legend | Broad General Reference | Secondary Reference | Primary Reference | No Direct Reference |
|---|---|---|---|---|

| TOGAF ADM Phases | Phase Activities | Performance Reference Model | Business Reference Model | Data Reference Model | Application Reference Model | Technology Reference Model | Security Reference Model | | Governance Reference Model |
|---|---|---|---|---|---|---|---|---|---|
| Additional Phase: Conceptual Solution Architecture | Collect information on existing systems and services | | | | | | | | |
| | Evaluate business value and performance of existing systems | | | | | | | | |
| | Develop current conceptual solution architecture | | | | | | | | |
| | Identify service and solution component reuse opportunities | | | | | | | | |
| | Identify target system and service components | | | | | | | | |
| | Define relationships between target systems and services | | | | | | | | |
| | Identify and analyse alternatives for transition | | | | | | | | |
| | Develop recommendations outlining selected alternatives | | | | | | | | |
| | Develop and validate target conceptual solution architecture | | | | | | | | |
| | Publish / disseminate target conceptual solution architecture | | | | | | | | |

*Figure 5-4: Mapping of Additional Phase (Solution Architecture) to IndEA Reference Models*

# 6. Getting Started and Path to Fruition

Mere availability of the reference models is not enough for government enterprises to adopt enterprise architecture. Government entities have to deal with many practical on-ground issues that are critical to address. This section lists such issues and addresses them. It is a done in a question and answer format for ease of understanding and greater receptivity to follow. While some of the answers may appear subjective and may require fine tuning at the time of adoption, an attempt is made to lead the government enterprises towards a preferred approach and direction.

## a. Frequently Asked Questions on Adoption

***I. As IndEA recommends a holistic and integrated planning and structured approach, what happens to the currently ongoing programmes and initiatives?***

Enterprise architecture is seldom done on a clean slate. Current ongoing programmes should be analysed for relevance and alignment to the organisation's mission and architecture conformance. Programmes that are found conforming should be kept and continued, while those not fulfilling the requirements either have to be reworked or discontinued in a planned manner, without disrupting current operations.

***II. How does IndEA help in aligning closer to Digital India programme?***

In order to transform the entire ecosystem of public services through the use of information technology, the Government of India has launched the **Digital India programme** with the vision to transform India into a digitally empowered society and knowledge economy. Therefore, states and other government enterprises are strongly urged to leverage on the approach and methodology formalized as part of Digital India. IndEA based enterprise architecture directly impacts eight of the nine pillars[12] of Digital India, namely – 1, 2, 3, 4, 5, 6, 8 and 9 in different ways.

***III. Which departments and functions should be involved in the development and adoption?***

Ideally, enterprise architecture should be a joint effort of the Planning and IT departments. In general, IT departments provide support functions, and therefore may find it challenging to enforce certain standards in the line departments, which have much larger mandates and priorities. The important success factor would be to set up a Council of Ministers empowered to implement enterprise architecture across the state and other government enterprises, the critical point being any entity set up or involved should have adequate authority to get things done.

***IV. What are some areas of likely policy level changes needed to enable enterprise architecture adoption?***

There are several areas where policy level changes may be necessitated to implement enterprise architecture. Some of these areas could be, but are not limited to:

- Changes of business processes, requiring changes to business rules;
- Consolidation of services, therefore impacting the departments and divisions providing such services;
- Security and privacy issues;

[12] Pillars of Digital India

- Digitisation of documents, elimination of approvals;
- Procurement and vendor management;
- Data exchange and sharing of data across government enterprises;
- Shared services and other shared infrastructure;
- Regulatory issues pertaining to Cloud ecosystem;

***V. How long and how much effort does it take to do this?***

The two major segments, i.e. planning and design should be done in less than 12 months; while the implementation / execution can span 3 – 4 years. More than these suggested durations, the critical success factor is sustaining the interest, funding, and ability to make mid- course corrections in a planned manner. Given that multiple initiatives emerge out of the architecture, it is advisable, therefore, to have a **strong programme management** capability, which is able to manage the collection of initiatives as a portfolio. The advantage of bringing in the portfolio approach is the ability to distribute risks, and therefore enhance the chances of success.

***VI. Aside from the reference models, what other help is available and where does this start?***

Please see Section 7 (References and Further Reading) of this document.

The need and importance of enterprise architecture has to be communicated to all the government agency staff, in particular to the key stakeholders and decision makers. Awareness campaigns such as presentations, workshops and seminars should be conducted. It is recommended that the EA Core team and working teams find the most effective ways to create awareness, understanding and interest.

***VII. How can existing organisational structures be leveraged to enable enterprise architecture?***

State governments or government enterprises already have apex committees to make critical decisions in the area of e-Governance. Attempt should be made to leverage such readily available structures, rather than creating new ones for enterprise architecture matters. Existing structures that are already part of the organisations are more likely to sustain and be effective, as the channels of communication and influence are already in place. The aim should be to include enterprise architecture as part of the TOR of the such existing structures.

***VIII. Can enterprise architecture be done for one or a few departments / functions, and then extended to entire enterprise?***

Yes, this is very much an approach that can be adopted should there be a need to demonstrate success and effectiveness of enterprise architecture on a smaller scale, before committing to the larger canvas. For instance, within a state, the first cycle of enterprise architecture could be done for a single department or a geographical entity like a city or a municipality. Nevertheless, the key is to eventually start and sustain a culture of holistic integrated planning, coupled with phased implementation to suit business direction and state priorities.

**IX. If vendors insist on bringing their own proprietary approaches and methods, what is the mechanism to make them conform?**

The aim of developing IndEA is not to discourage vendors and service providers to innovate and bring best practices to state governments and other government entities. As a collection of reference models, the aim is to encourage and enable adoption of standards. The approach and the methodology to fulfill the requirements of standards is not prescribed. This gives vendors and service providers more than adequate elbow room to differentiate their services. The process of conformance to standards as described in the RMs should ideally start at the procurement stage itself. IndEA is meant to be a document that is easily available and readily shared, so that it is used to shape the ecosystem around it.

**X. What is the role of NIC in this? How can state governments tap into their expertise?**

The National Informatics Centre (NIC) is the designated nodal agency for enterprise architecture in the country. An IndEA-Centre of Excellence is envisaged to be set up with the aim to provide first level support to state governments and government entities in building and implementation of enterprise architecture. At the time of writing, this is an area that is still fluid and the support system will continue to be strengthened over time.

**XI. What is the role of SeMT and existing e-Government functions in the context of IndEA?**

The State e-Mission Teams (SeMT) would need to be upgraded in skills to build proficiency in enterprise architecture. Members of the SeMT have the natural advantage of having on-ground knowledge about the state, its governance and connect at the grassroots level. This can be of great benefit to enterprise architecture initiatives. Understanding of and experience in e-governance projects for capacity building, awareness and advocacy, data collection and validation, architecture documentation, vendor and programme management, procurement are some critical areas where SeMT can be directly involved. Ideally, all members of SeMT should be certified in TOGAF.

**XII. What is the role of academia? How can their expertise be taken advantage of?**

The academia can and should play an important role in the adoption of enterprise architecture. One of the key impediments that confronts the industry, both government and private sectors alike, is the difficulty in finding experienced enterprise architects. By incorporating contemporary topics like enterprise architecture in their regular post-graduate and executive curriculum, the academia is in an unenviable position to influence the thinking, create interest in the topic and over time build a critical mass of qualified architects in the country. The aspect where the academia is in a good position to influence is through their regular interactions with the industry. The academia-industry collaboration provides the ability to even study and document case studies and use such material to enrich the pedagogy and reinforce interest. The Open Group India Academic Initiative[13] aims to achieve all of the above.

[13] https://www2.opengroup.org/ogsys/catalog/Q170

**XIII. What can be done to provide a level playing field to small and medium businesses to participate in the derived implementation initiatives?**

There is a general perception in the industry that stringent requirements pertaining to revenue, previous experience, size, credentials greatly favour larger service providers and consulting firms. This, for all practical purposes, shuts out small and medium enterprises as they find it difficult to conform to the requirements needed to qualify for any government work. One of the key derivatives from enterprise architecture in the government sector is to use this as a lever to further the digital economy (and therefore SMEs). One practical way to get SMEs into the implementation projects is to mandate large services providers and consulting firms to collaborate with SMEs and even form consortiums (with a substantial portion of the overall revenue earmarked for SMEs) in the tender / RFP processes. This allows larger service providers and consulting firms to be the primary contractor, with a certain portion of the implementation given to partner SMEs, and revenue pass-through. Another way suggested in the IndEA Framework is the publication of Open APIs in different sectors that enables an eco-system of startups and SMEs to develop applications & apps useful to the stakeholders.

## b. Architecture Assurance with Maturity Model

The path of building enterprise architecture is a long term endeavour. One of the key success factors in continuing on this journey is to institutionalise an evaluation mindset in order to assess the maturity of the enterprise architecture at regular frequency. Maturity describes the extent of formality and optimisation of a capability. A maturity model:

- Defines a starting point of low maturity and a target state of high maturity;
- Demonstrates reasonable next steps at each point of development – how to succeed one step at a time;
- Educates and trains stakeholders about an area of concern; and
- Evaluates the level of maturity in the organisation, pinpointing the need for resources and skills.

The maturity of enterprise architecture is to be measured on two dimensions. First, is the maturity of the enterprise architecture itself; second, the maturity of the enterprise architecture programme. The two-dimensional approach is needed to ensure a coherent and comprehensive evaluation of enterprise architecture that contributes to business success, the very essence of architecture assurance.

The aim of this guide is not to provide a detailed elaboration of EA maturity model. For the purposes of IndEA's primary audience (ministries, state governments and local governments) the two dimensions of maturity model are as follows:

**Enterprise Architecture Programme**

This dimension primarily covers the programme / function / process that is established and followed in order to develop and implement the enterprise architecture. The maturity stages are:

1. *Initial:* The architecture programme is non-existent or ad-hoc at best.
2. *Repeatable:* The architecture programme is localised, limited to slivers of activities (like projects or teams).

3. *Defined:* The architecture programme is generalised and formalised around a set of policies, process, procedures and work approaches. There is some discipline established.
4. *Managed:* The architecture programme is controlled and administered using a system of metrics: core philosophy being (if you cannot measure it, you cannot manage it).
5. *Optimised:* The enterprise is taken to be a complex adaptive system (CAS), where the aim is to understand the entire enterprise as a system, and transition from straight-line to closed loop thinking.

**Enterprise Architecture**

This dimension covers the architecture itself, i.e. product of the process. The aim is to analyse and design organisational systems so that strategy, structure, operating models, and skill bases fit together effectively and efficiently, and harness this understanding to make needed transformation. The maturity stages are:

A. *Fractional:* An informal architecture that is fragmented and disjointed.
B. *Standardised:* The overarching goal is to derive economies of scale benefits by standardising, usually ending up with the lowest common denominator to gain highest extent of compliance.
C. *Rationalised:* The primary goal is to eliminate redundancies and overlaps in order to optimise operations. This leads to operational efficiencies.
D. *Connected:* The primary goal is to amplify the linkages between various aspects of the enterprise and its architectural components. Such linkages are multi-dimensional to gain new insights and perspectives, by analysing behaviuors over time.
E. *Coherent:* The central goal here is to understand the systemic structures from where the patterns emerge, and synthesise them to modify mental models, an essential ingredient to achieve transformation on enterprise scale and intensity.

Figure 6-1 combines the two dimensions and respective maturity stages into a single unified model. The model is designed to be used to identify the maturity stage along each dimension and assign a composite score (e.g. B4). As is evident, this can be expanded to use the model to even assign a target composite score and plan a transition (e.g. moving from B2 to D4) as part of the overall mission. In other words, this can be used for both assessment and improvement.

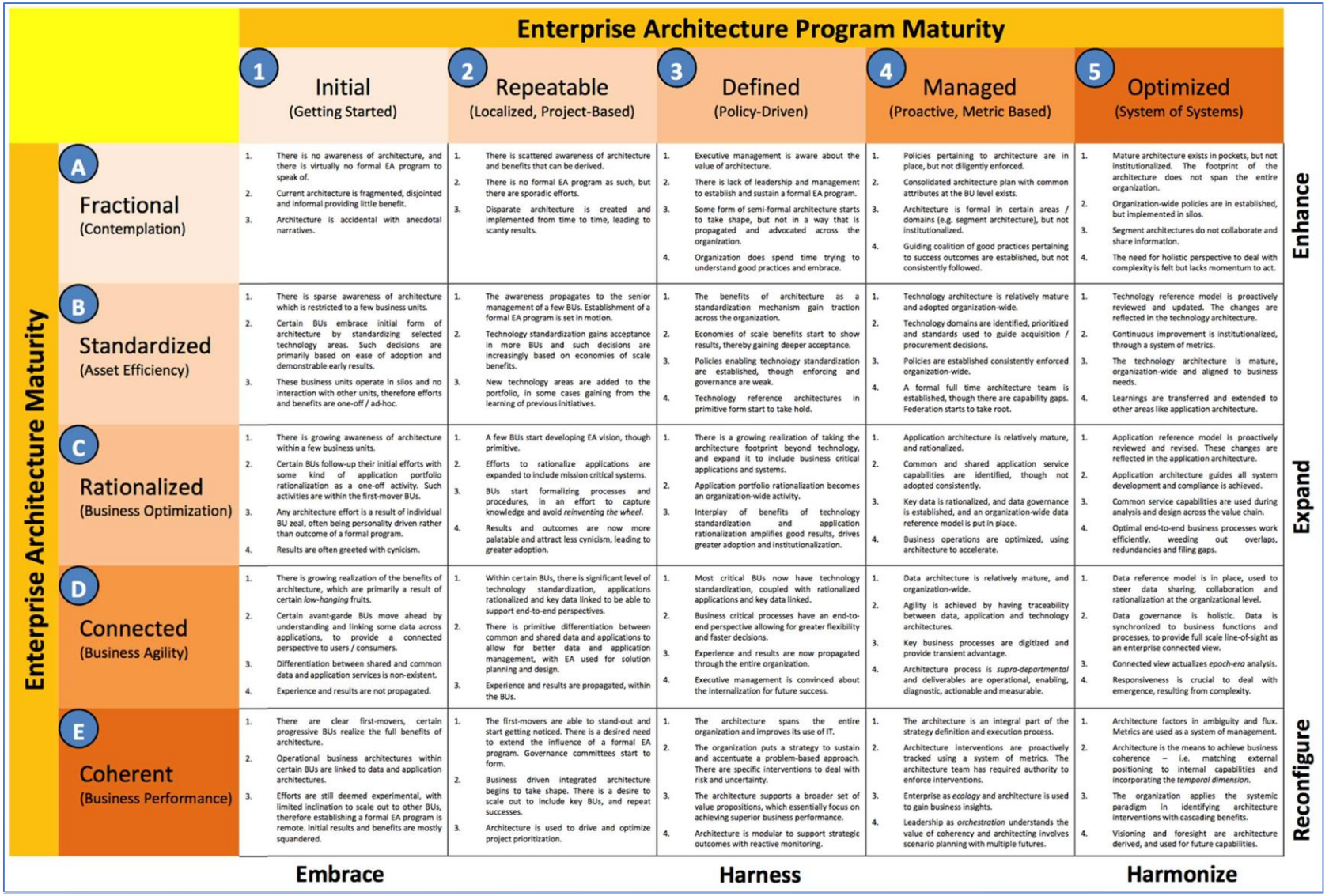



*Figure 6-1: Maturity Model for Architecture Assurance with IndEA*

# 7. References and Further Reading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