

# Enterprise Architecture-Based E-Government Interoperability Frameworks - A Comparative Analysis

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**ABSTRACT:** *Many countries have actively engaged in the development of interoperability for electronic data and transaction exchange among government agencies to provide better joint-up public services to their citizens. National-level policy frameworks, often called Electronic Government Interoperability Frameworks (e-GIF), have been established to drive these initiatives in many of those countries. However, most of these e-GIF frameworks haven't adopted the holistic concept of Enterprise Architectures (EA), except for example in the case of Thailand, U.S.A. and Canada. This paper proposes a comparative analysis methodology with an aim to propose further improvement for the EA-based interoperability frameworks to better drive the effective development of smart and connected e-government services. In this paper, Thailand e-Government Interoperability Framework is methodically compared and analyzed with the U.S. Federal Enterprise Architecture Framework as a case study.*

**Keywords:** E-Government Interoperability, Enterprise Architecture, Collaborative E-Government

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## 1. Introduction

During the past ten years, there were several analysis studies and improvement of e-government interoperability frameworks (e-GIF) [1] around the world. For example, the national-level e-government interoperability frameworks of 30 different countries were compared and analyzed as reported in [2]. However, most of those e-GIF frameworks haven't applied the holistic concept of Enterprise Architecture (EA) [3], except, for the case of Thailand, U.S.A. and Canada. The government of the United States of America has adopted and successfully utilized the Federal Enterprise Architecture (FEA) framework since 1999 [4] for e-government development and operations. Meanwhile, Thailand had developed the e-GIF of Thailand, so called TH e-GIF, since 2005 as a national policy framework and methodology to guide the development of several interoperable and collaborative e-Government projects of the country. However, the TH e-GIF is still at the early stage for guiding enterprise architecture development for enhancing citizen-centric e-government interoperability and services in the country.

In this paper, we therefore propose to analyze and compare the TH e-GIF and US FEA to provide recommendations for further improvement of the framework and approaches for the e-Government Interoperability in general, but using the e-GIF of Thailand as a case study. We recommend a strategy, management and operation concept for comparatively analyzing the National Enterprise Architecture (NEA) frameworks as proposed also in [5]. This concept systematically analyzes enterprise architecture (EA) in a broader perspective, particularly on policy, governance, management and implementation aspects that influence the adoption and widespread implementation of EA for e-government establishment.

The paper is organized in five sections as following: the introduction in Section 1; the background information about the two national e-government development frameworks, US FEA and TH e-GIF, described in Section 2; a strategy-management-operation comparative concept provided in Section 3; a comparative analysis summarized in Section 4; conclusion and recommendations for further strengthening of the e-GIF in Section 5.

## 2. National e-Government Case Studies

There were several research studies which reported comparative analysis of several e-GIF frameworks. The purpose of those comparisons was to identify weaknesses and propose suggestions for further improvement. For example, the comparison of three e-GIF countries in Asia was analyzed in [6] [7] reporting about the cases in Singapore, South Korea and Indonesia. That study compared several aspects based on the architecture domains proposed in the TOGAF framework [12].

However, those criteria for the analysis do not provide guidelines on how to improve the e-GIF frameworks. Therefore, in this paper, we propose to use a National Enterprise Architecture (NEA) as our comparative framework. The NEA promises to fill the gap between policy, management and implementation [5]. We choose to compare with the US FEA because the United States is one of the most successful countries in adopting the complete cycle of the EA concept in planning, budgeting, implementing, monitoring and measuring the e-government development programs and its notable features which can generate ideas for future improvement. This section highlights the key characteristics of the two frameworks.

### 2.1 US Federal Enterprise Architecture Framework

The US Federal Enterprise Architecture Framework (US FEA) [4] is a conceptual model that begins by defining a documented and coordinated structure for cross-cutting businesses. FEA is designed to support collaboration in the development of structural optimization and increase economies of scale. FEA provides an organized structure and a collection of common terms by which federal segments can integrate their respective architectures.

One of the key reasons of choosing the US Federal EA framework for our comparison is that US FEA is a long-time-established and proven framework in promoting effectiveness of many government agencies by standardizing the development and use of architectures within and among Federal agencies. By adopting the US FEA, many US Federal agencies have eliminated waste and duplication, enhanced shared services, mitigated gaps and promoted engagement among government, industries and citizens. The key components within FEA consists of six reference models as shown in Figure 1.

<b>Security / Privacy SRM</b>	<b>PRM</b>	<b>Strategic Plans</b>
	<b>BRM</b>	<b>Business Activities</b>
	<b>DRM</b>	<b>Data &amp; Information</b>
	<b>ARM</b>	<b>Systems &amp; Applications</b>
	<b>IRM</b>	<b>Networks &amp; Infrastructure</b>

Figure 1. FEA Reference Models

1. Performance Reference Model (PRM) is a standard method for performance measurement and strategic planning. It suggests a common way for the Executive Branch of the federal government as mandated in the Government Performance and Results Modernization Act of 2010 [8]. PRM as aligned with the organization strategy plans is a performance-oriented reference model to support organizational vision, and evaluation and measurement performance of work process.

2. Business Reference Model (BRM) is a transaction reference model that emphasizes collaboration and services among both intra-agency and extra-agency. BRM provides a functional view of Federal Government organizations and their lines of business, including mission and support business services.

3. The Data Reference Model (DRM) supports foundation for all reference models. DRM is planned to provide a common framework for effective sharing across organization, increase integration and support semantic of interoperability. It likes a “silos” through better discovery and understanding of the meaning of the data and it provides a classification taxonomy used to describe the context for information exchange.

4. The Application Reference Model (ARM) is a component-driven taxonomy that categorizes the systems and applications. ARM integrates existing organizational applications and provides guidance to Federal Governments on standards desktop configurations and how to improve the reuse and standardization of technology and service components.

5. The Infrastructure Reference Model (IRM) is a component-driven taxonomy that identifies cloud/network related standards and technologies that support deliverable such as data, voice, video, service components and capabilities. IRM collects agency infrastructure and provide a foundation to advance the reuse and standardization of technology and service components to Federal Government.

6. The Security Reference Model (SRM) provides the roadmap which assists US agencies to combine IT security/privacy with EA, and it promotes inclusion of security and privacy in business processes and business activities. SRM integrates the National Institute of Standards and Technology (NIST) [9] “*Risk Management Framework*” and the agency’s system development life cycle processes. It assists program executives to understand how the Federal Information Processing Standard (FIPS) of confidentiality, integrity and availability and eight privacy Fair Information Practise Principle (FIPPs)[10] can be combined within the EA planning.

FEA also suggests an approach for overall development methodology called “*The Collaborative Planning Methodology (CPM)*” [4]. CPM is a process that consists of integrated, multi-disciplinary analysis that results in recommendations formed in collaboration with leaders, stakeholders, planners, and implementers. The CPM consists of two main phases: (1) Organize and Plan and (2) Implement and Measure. Although these phases may look sequential, but in fact there are frequent and important iterations within and between the phases. In the first phase, the architect serves a key role facilitating the collaboration between leadership and various stakeholders to clearly identify and prioritize needs, researches other organizations facing similar needs, and formulates the integrated set of plans to define the roadmap of changes that will address the stated needs. In the second phase, the architect shifts into a participatory role, supporting other key personnel working to implement and monitor change related activities. As part of the second phase of the methodology, the architect specifically supports investment, procurement, implementation, and performance measurement actions and decisions.

## 2.2 Thailand e-Government Interoperability Framework

Developed since 2005, the Thailand e-Government Interoperability Framework (TH e-GIF) [11] is a national policy framework and methodology for promoting collaborative e-Government development towards smart and joint-up public services for citizen and business. The TH e-GIF has been endorsed by the Cabinet such that the framework and methodology within TH e-GIF are recommended to all government agencies as the guidelines and best practices for implementing the smart collaborative e-Government development projects in Thailand.

At a policy level, the TH e-GIF suggests six critical factors that guide the development of collaborative inter-agency e-Government initiatives.

**Factor 1 - Political Will Creation:** The successful implementation of e-government interoperability depends to a large degree on political good will and commitment at the highest level. It is essential to secure political support and adequate funding for investment and operations of the programs from top executives.

**Factor 2 - Inter-Agency Collaboration and Social/Cultural Change:** The mechanisms to generate and maintain collaboration among stakeholders are vital to cope with the challenges arising from the inter-organizational nature of the project. The need to coordinate among numerous government agencies and the business community cannot be over-emphasized.

**Factor 3 - Legal Power:** The related laws and regulations must be identified, reviewed, and adjusted carefully to ensure a legally enabling environment for e-government interoperability efforts.

**Factor 4 - Process Agreement:** To achieve process agreement, all participants must participate in analysis of existing “*as-is*” business processes and mutually agree on new “*to-be*” business processes. Lack of clear and integrated process agreement often manifests as the burden for the users (citizens or business users) to provide the same information to multiple government services instead of a single event.

**Factor 5** - Meaning Exchange Agreement or Data Harmonization: The meaning exchange agreement is necessary to facilitate exchange of same meaningful data for successful data interoperability across different systems. Meaning exchange is fundamentally different from data exchange because of the aspect of misinterpretation. It is much more difficult because there is no implicit guarantee that all participants will interpret the meaning of the data in the same way.

**Factor 6** - Technical Development: To ensure effective collaborative e-government interoperability, concerned parties and stakeholders need to mutually agree on common protocols and technical standards necessarily for inter-agency collaborative systems. Open standards and technology are normally recommended because they are well supported in the marketplace.

TH e-GIF suggests a development methodology of five phases, as shown in figure 2, so called Inception Phase, Elaboration phase (Detailed EA Design), Planning phase, Implementation Phase, and Change Adoption Phase. In each phase, it is suggested that ten key components, shown in Figure 3 as similar to the TOGAF ADM (Architecture Development Cycle/ Method) [12], should be considered. These ten components are iteratively analyzed. Each of these components must be studied and analyzed to understand the “*as-is*” conditions, their gaps and improvement opportunities, and then to propose the new and better “*to-be*” conditions. All these ten critical components should be revisited during the Inception Phase, Elaboration Phase, Planning Phase, Implementation Phase and Change Adoption Phase, but of course, with different levels of depths and perspectives. The looping of the development cycle should be revisited and refined until the “*to-be*” of all these ten components are mutually accepted by key stakeholders.

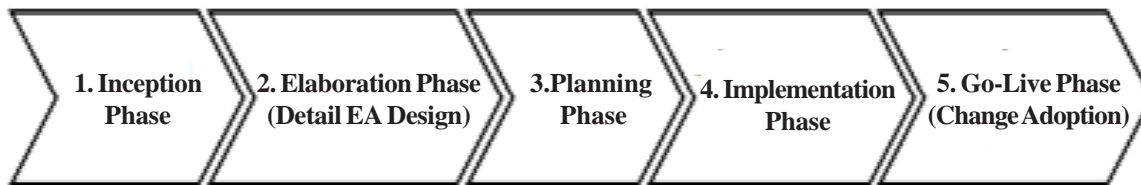


Figure 2. Five development phases

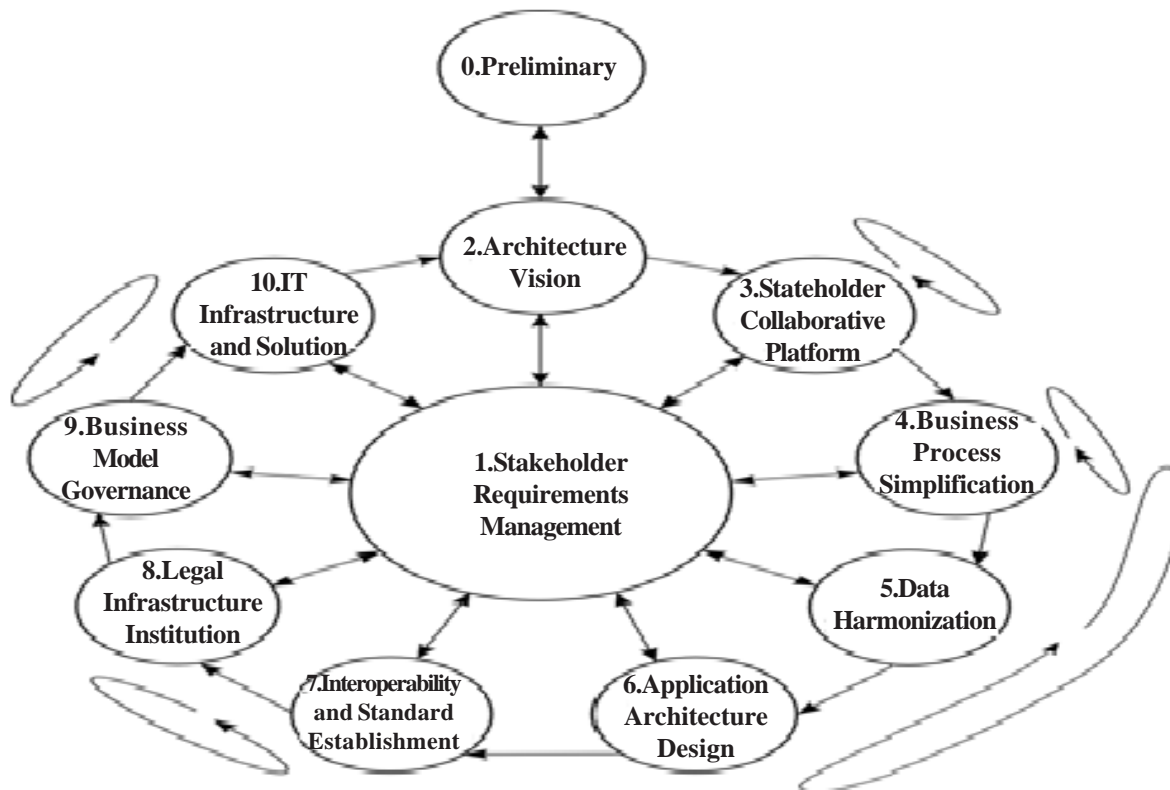


Figure 3. Ten key components (modified from TOGAF ADM)

The original TOGAF ADM components are modified here to better suit the context of collaborative and inter-agency project management. The TH e-GIF emphasizes especially on stakeholder collaborative platform establishment, process redesign and agreement, data harmonization and legal issues because these components support and drive collaborative e-government development in real cases. The ten key components are briefly explained as follows:

**Component 1:** All of the stakeholders' needs and requirements must be clearly identified and continuously managed for the development of collaborative e-government.

**Component 2:** The clear visions and objectives of any collaborative e-government projects must be articulated, considered, refined and agreed by key stakeholders and also endorsed by high-level policy decision makers.

**Component 3:** A strong lead agency, inclusive membership and participation of key stakeholders, effective inter-agency and collaborative platform of all those key stakeholders should be established, maintained and kept continuously interacting.

**Component 4:** Current (as-is) related business processes are analyzed and redesigned to reach the improvement objectives/visions, e.g. better effectiveness and efficiency. For example, the proposed future (to-be) processes should be simplified, more efficient and more secure. The proposed new processes must be reviewed, refined and accepted by key stakeholders.

**Component 5:** Analysis, simplification and standardization of involved documents and data is the aspect that should not be underestimated, especially on the data semantics including the harmonization of data definitions among different related documents. With the harmonized data elements and document simplification, the technical development teams can successfully create data models, electronic documents and messages to deliver better services to citizens and businesses.

**Component 6:** Service functions, referred to as the application architecture, must also be designed and agreed. It provides a blueprint for describing services and functions. This blueprint includes the different sub-systems and components for the software solutions, their interactions, and their relationships to the core business processes of the government agencies and business users.

**Component 7:** Open and internationally recognized technical standards, interoperability and communication protocols must be adopted and agreed among different ICT platforms involved in the specific collaborative e-government project.

**Component 8:** Enabling laws and related regulations to ensure the legitimacy, trust and confidence in electronic transactions and new business processes must be institutionalized.

**Component 9:** Financial and business models (e.g. investment and operation cost consideration, and the sustainability issues), the governance mechanism for monitoring, ensuring and enforcing the implementation and operations must be analyzed, designed and implemented.

**Component 10:** Technology infrastructure, system and hardware development, software development, deployment with security/privacy and business continuity concerns are designed, implemented and executed.

All these ten key components must be cross-checked to ensure that each component is consistent and aligned with the key stakeholder's requirements (Component 1 in the middle of Figure 3). Note that Component 0 is a preliminary or preparation stage before engaging into any new project.

### 3. Comparative Study of e-Government Interoperability Frameworks

A structured concept proposed for comparison is aimed to take a broad view on both US FEA and TH e-GIF. This structured comparative concept is based on the National Enterprise Architecture (NEA), a similar comparative concept appeared in [5]. The key contents of NEA are architecture models, principles and standards. Figure 4 illustrates the framework for analyzing NEAs categorized in a policy/strategic, design/management and implementation/operation structure. The grey circle shows that the related architectures are analyzed and designed, and the strategic decision and plans are translated into decisions and implementation. This concept applies enterprise models, standards and architectural discipline. Therefore, five criteria are used for our comparisons as shown in Figure 4.

**3.1 Policies, Actors and Structures:** This aspect contains the environment and political driver for EA. The political actors provide strategic objectives for architecture and the democratic structures define related constraints.

**3.2 Governance:** The governance structures and mechanism are considerable to guide and provide incentives for desirable behaviors in the use of IT resources. The enterprise or government agency normally provides three types of governance mechanisms. There are decision-making structures, alignment process and formal communication [13].

**3.3 Enterprise Frameworks and Methodology:** There are many methodologies that are applied in development of enterprise architecture. Each of them is different, e.g. a taxonomy framework like the Zachman framework [14], a process framework like the Open Group Enterprise Architecture (TOGAF), and the hybrid one like TH e-GIF and FEA [15].

**3.4 Architecture Principles and Standards:** The architects utilize principles, guidelines and standards to set the direction of the future and provide the suggestion for implementation.

**3.5 Implementation:** The implementation embraces the development and use for central facilities and infrastructures. Central facilities possibly are used by local agencies to support the development of their system architectures.

**4. The Result of Comparative Study of E-Government Interoperability Frameworks**

Table 1 shows our comparative analysis between US FEA and TH e-GIF based on those 5 aspects of the general NEA framework.

This comparative study of e-Government Interoperability Frameworks realizes that FEA provides several good features such as, a good business transformation strategy, design principles, and assessment and measurement framework. FEA suggests suitable laws and policies which integrate strategic drivers. Its reference models offer to standardize a categorization for strategic, business and technology models, and information harmonization. Meanwhile, TH e-GIF has not offered any specific reference models and any explicit measurement method has not been recommended yet. However, within the National Information and Communication Technology Master Plan 2020 (ICT 2020) of Thailand, its fourth strategic agenda provides the clear policies to promote services innovation of e-government to serve citizens and involved business agencies efficiently.

Furthermore, before any budget approval, large-scale e-government ICT projects in Thailand must propose their clear “Enterprise Architecture design” to the national ICT approval committee such that these blueprint designs ensure that the projects support clear implementation scope, interoperability, transparency, and less(non)-duplicative investment. However more detailed guideline on how to develop such clear EA-based program proposals still need for their development.

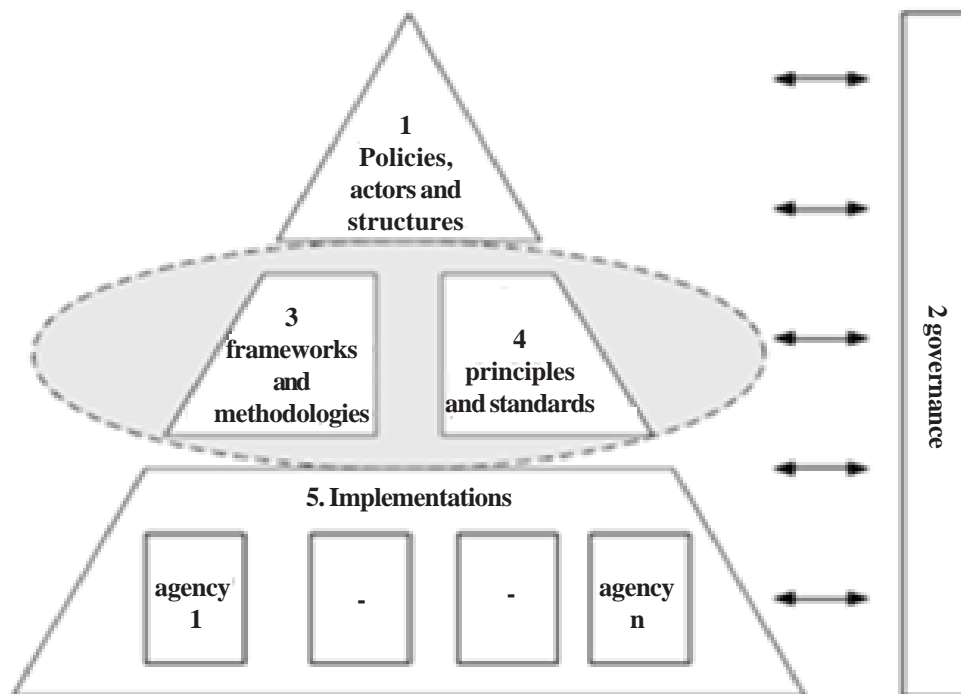


Figure 4. A framework for comparison and analysis

	<b>FEA</b>	<b>TH e-GIF</b>
1. Policy actor and structure	Executive Branch of the U.S. Federal Government, Federal laws and policy require Agency Heads to develop and maintain an agency-wide enterprise architecture that integrates strategic drivers, business requirements, and technology solutions.	The TH e-GIF concept was initiated in 2005 in response to the policy of Ministry of Information and Communication Technology (MICT) for promotion of interoperability between different public agencies and to achieve the target of one-stop electronic services by connecting several electronic business processes among different e-government information systems.
2. Governance	The United States has enacted laws and regulations that also effectively enforce the operation of FEA. The main part of FEA is the Performance Reference Model (PRM). PRM serves the goals of FEA by establishing a common language to describe the outputs and measures used to achieve strategic objectives through coupled business services.	Thailand government has established Information and Communication Technology Master Plan 2020 (ICT 2020). The fourth strategic agenda of ICT 2020 drives and promotes services innovation of e-government to better serve citizens and business efficiently. Furthermore, by regulation, any large-scale e-government ICT projects must have clear “ <i>Enterprise Architecture design</i> ” proposing to their executive board before budget approval. The blueprint design with all necessary architectural viewpoints ensures that the projects support interoperability, transparency and non-duplicated investment.
3. Architecture Framework and methodology	The US FEA suggests an approach for overall development process and methodology called “ <i>The Collaborative Planning Methodology (CPM)</i> ” [2]. CPM is a process that consists of integrated, multi-disciplinary analysis that results in recommendations formed in collaboration with leaders, stakeholders, planners, and implementers. The CPM consists of two main phases: (1) Organize and Plan and (2) Implement and Measure. The framework and management method has established strong inter-agency collaborative platform.	TH e-GIF suggests a development methodology consisting of five phases so called Inception Phase, Elaboration Phase (Detailed EA Design), Planning Phase, Implementation Phase, and Change Adoption Phase. In each phase, it is suggested that ten key components should be considered. These ten components must be iteratively analyzed as similar to the TOGAF ADM concept. Each of these key components must be studied and analyzed to understand the “ <i>as is</i> ” conditions, their gaps and improvement opportunities, and then propose the new and better “ <i>to be</i> ” conditions. All these components should be revisited iteratively during the Inception Phase, Elaboration Phase, Planning Phase, Implementation Phase and Change Adoption Phase, but of course, with different levels of depths and perspectives. The looping of the development cycle is made until the “ <i>to-be</i> ” of all these ten components are refined in more details and accepted by all key stakeholders.
4. Architecture principles and standard	Federal EA provides principles and standards in Application Reference Model (ARM) for how business, information, and technology architectures should be developed across the Federal Governments so they can be used consistently at various levels of scope within and between agencies, as well as with external stakeholders.	TH e-GIF provides a set of technical open protocols and standards of 141 items classified within 7 categories such as data exchange standards, data formats, communication and secured protocols. However, all these are provided as the recommendations, and they must be chosen and “ <i>agreed</i> ” among key stakeholders in each group of collaborative e-government projects, e.g. all stakeholders in the electronic National Single Window project for trade facilitation commonly agree to use the ebXML Messaging Service Protocol v2.0[16] as the secure messaging protocol for conducting electronic data and service exchange among different IT platforms.

	FEA	TH e-GIF
5. Implementation	<p>US FEA has eight levels of scope for implementing an architecture using the common approach. The eight levels consist of International, National, Federal, Sector, Agency, Segment, System and Application. The scope of a particular architecture ranges from high level views of one or more organizations, to detailed views of a single segment, system, or application. Due to the nature of how the U.S. Federal Government functions, multiple levels of scope are needed to develop effective architectures that support mission and support objectives within and between agencies. These architecture levels ease the alignment of the design and implementation</p>	<p>TH e-GIF has been implemented in 3 key levels as following.</p> <p><b>Level 1: Strategic Direction and Policy Guidance</b> TH e-GIF provides strategic direction and guidance with the national policy framework, methodology, and guidance on how to formulate and establish visions and goals, necessary collaborative platforms, enterprise architecture design and standards that enable interoperability among different ICT platforms.</p> <p><b>Level 2: Management Level</b> Applications of this framework in different domains have been established and supported such that relevant sector-specific architectures, “to-be” business process, common data set, technical protocols and interoperability standards have been developed, refined and agreed among different sets of collaborative stakeholders</p> <p><b>Level 3: Investment and Implementation Level</b> Funding for implementation, through MICT and other government agencies, must be secured for implementing pilot also deployed projects.</p>

Table 1. The Comparison Between US FEA and TH e-GIF

## 5. The Result of Comparative Methodology of e-Government Interoperability Frameworks

### Phase 1: Inception Phase (Preliminary Study) of TH e – GIF vs. Identify and Validation of FEA

The Inception phase is similar to the “*Identify and Validation*” phase of FEA, because it is an early stage of development. The objective of this phase is to find requirements and target, define stakeholders, leaders and operational staffs. In the inception phase, ideas and primary opinions among stakeholders, leaders and operational staffs are analyzed exchanged. Some quantitative and qualitative indicators for costs and benefits should be analyzed at least roughly for the viable of possible connected e-government projects. If the vision, possible benefits, future collaboration and at least some high-level enterprise architectures are analyzed and accepted among the initial and key stakeholders and sponsors, and they agree to work and link together, the next step should start. If they disagree, the next step should not start.

In “*Identify and Validation*” phase, it sets some necessary components to achieve such as factor and target coordination. Then they created Initial performance metrics for projects measurement. It can be seen that the FEA supports the synchronization of the units, all units are linked to the mission, So in the first step it can be a factor, and goals of the agencies involved at all and FEA aims to achieve performance in line with the goals set forth in the first step of the work.

### Phase 2: Elaboration (Detailed Architecture Design) Phase of TH e–GIF vs. Research and Leverage of FEA

The key concepts of “*Research and Leverage*” phase of FEA and Elaboration of TH e–GIF are quite similar even though the detailed suggested steps are different. The Elaboration phase focus on how to analyze the detailed “*as-to*” and design the “*to-be*” environment of each of the ten critical components of the overall collaborative e-government projects. The process starts from the analysis of “*as-is*”, identify gaps and improvement opportunities, and then design the proposed “*to-be*” to achieve the integration, electronic data and e-service exchange among government agencies.

While Research and Leverage emphasizes on the research of other organizations and service providers to assess whether they have similar needs and whether these organizations have already met these needs or are currently planning to meet these needs. The architects lead the assessment of the applicability of the other organizations’ experiences and results and



help to determine whether there are opportunities to leverage or work together to plan. Once these organizations and their needs and experiences have been identified and assessed, the architect formulates a set of findings and recommendations detailing the applicability and opportunity for leverage.

### **Phase 3: Planning Phase of TH e – GIF vs. Define and Planning of FEA**

In Phase 3 of FEA “*Define and Planning*” Phase of TH e – GIF are also very similar in concept. However, FEA provides quite clear criteria for measuring the success of the work. The detailed architecture as developed and agreed among the key stakeholders and sponsors in the Elaboration (Design) Phase will be the basis for migration plan/development roadmap, for a long-term programmes, the development projects and their detailed term-of-references will be developed and funding (investment) should be secured in this phase, such that the procurement and construction of the projects will be carried out in the next phase.

### **Phase 4: Execution/Construction Phase of TH e – GIF vs. Invest and Execute of FEA**

In step 4 of FEA “*Invest and Execute*” phase and Construction Phase of TH e – GIF are slightly different. Construction Phase is the further detailed design, development and installation of technical, software, network infrastructure software, system and application software.

While FEA Invest and Execute discusses finance, investment and construction/execution. If no investment, return to Phase 1. To modify the plan as in Step 3 and Step 4 based upon the types of changes, e.g. policy changes, organizational changes, technology changes, process changes, and skills changes.

### **Phase 5: Adoption (Change Management) Phase of TH e – GIF vs. Performance and Measurement of FEA**

In Phase 5 of the FEA “*Perform and Measure*” Phase and Adoption Phase of TH e - GIF are again similar in concept but different in details. FEA provides better detailed guidance on performance and measurement of both outputs and outcomes (impacts) of the projects. While TH e-GIF emphasizes more on the change management and adoption approached for engaging both government staffs (internal users), and citizens/business entities (external users) to adopt to the new environments, new practices, and new systems. This is quite a challenge to most government staffs and citizens.

The Adoption Phase focuses on encouraging target users and relevant parties to be familiarize and adopt to the new applications such as training for new users, and piloting adoption. Thailand still needs a better approach for this endeavor.

While FEA Perform and Measure focuses more on the measurement of outputs and outcomes as defined in first phase (FEA Identify and validate). TH e-GIF should be improved in this perspective also such that the planned outputs/outcomes and return on investment should be articulated and quantified, and can be measures and compared with the actual outputs/outcomes and return on investment.

## **6. Conclusion and Recommendations**

The above study reports a systematic assessment methodology and comparative results of the US Federal Enterprise Architecture (FEA) and Thailand e-Government Interoperability Framework (TH e-GIF). The following points summarize the improvement opportunities for the e-GIF framework, as in the case Thailand.

### **6.1 Measurement of Outputs and Outcomes**

The findings from the FEA suggest that a good assessment and measurement framework should be established and utilized for e-government projects starting from the inception phase till the adoption phase. FEA provides a good performance reference model (PRM) to suggest mechanisms to measure and monitor outputs and outcomes/impacts of the projects. PRM consists of measurement area, measurement categories, measurement groupings and measurement indicators. PRM accomplishes these goals by establishing a common language to describe the outputs and measures used to achieve strategic objectives through coupled business services. This framework is also strengthened by laws, e.g. the Government Performance and Results Modernization Act of 2010 [17].

There is no clear measurement method offered in TH e-GIF, therefore a measurement framework and methodology including risk management should be developed and utilized within the new version of TH e-GIF. The objectives of this measurement framework should include at least the followings: the method on how to measure and evaluate the results which should be

clearly the responsible goals of each agency, and how to manage and reduce the risks to increase the chances of successful implementation of the planned target.

### **6.2 Mandatory and Compliance of TH e-GIF**

For more effectiveness of TH e-GIF, the Cabinet should enact, legislate or mandate a policy or a regulation for all government agencies to adopt the Enterprise Architecture Concept and TH e-GIF for all e-government projects, also with the performance measurement as parts of mandatory conditions for budget approval, architecture design, implementation, adoption, operations, progress reporting and output/outcome measurement.

### **6.3 Security Framework and Privacy Reference Model**

The FEA security and privacy concern has been injected in all parts of the FEA models such that risk identification and management are applied throughout all phases in the development cycle. The risks should be monitored, controlled and mitigated accordingly. The detailed security framework and methodology including security policies, operational procedures, and secure infrastructures, should be developed and improved within the TH e-GIF. Data privacy policy and operational procedures and guidelines shall also be included. The SRM of US FEA could provide a starting point for this case.

### **6.4 Better Project Management and Change Adoption Mechanism**

The Change Adoption phase of TH e-GIF should be strengthened with more detailed guides on how to manage change, and people adoption of new environments. The mechanisms to establish and improve the service level agreements and business continuity of the systems in operation are very crucial, especially for critical-mission applications.

These features should be improved and included in the future version of the e-GIF framework and guidelines, especially for the case of Thailand.

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