Nigeria e-Government Interoperability Framework (Ne-GIF)

National Information Technology Development Agency (NITDA)

August, 2019

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Foreword

Approach to e-Government

Deriving expected value from Information Technology (IT) requires carefully orchestrated plan, research and practically proven approaches. It has been proven that one of the strategic directions for e-government is to adopt a Whole-of-Government (WoG) approach.

Governments are moving away from structural devolution, disaggregation and single-purpose organisations to more integrated approach of public service delivery. It is a paradigm shift toward the vision of a connected, networked, citizen-centered government. However, in practice, the new trend has been increasingly difficult to achieve. WoG involves back-end offices reengineering, consolidation and integration of business processes across government agencies to deliver effective and consolidated services, through front-end offices, at affordable cost.

Advanced phases of service innovation cannot be achieved without integrating many back-office functions. For instance, citizen-centered service delivery involves breaking up silos, integrating across agencies, innovating new ways of doing business, and creating a service-focused culture.

Example of National e-Government Systems

Effective deployment of information technology is critical to achieving WoG, which is an advanced e-Government concept leading to Government Digital Transformation (GDT). The Federal Government of Nigeria (FGN) has successfully deployed a few silo e-Government solutions to implement her policies and programs. Some of the successful policies and e-Government solutions include in Treasury Single Account (TSA), Integrated Personnel and Payroll Information System (IPPIS), Government Integrated Financial Management Information System (GIFMIS), Bank Verification Number (BVN) among others. However, in spite of these laudable government initiatives, the difficulty of integration with other relevant e-government solutions vis-à-vis citizens' increased demand for better and efficient service delivery, has clearly amplified the challenges of operating silos systems.

Necessity for Cross-Portfolio Service

The legitimacy of a government, in this age of knowledge economy and information society, requires full-scale inclusion, participation and co-creation of customised and personalised services for citizens. Moreover, our national peculiarities in terms of multi-tribal society, population, huge demand for accessible public services, new challenges of agitations, security and terrorism etc. demand digitally transformed governance.

All these have called for cross-portfolio service delivery by Ministries, Departments and Agencies (MDAs) which necessitates integrated policies and programs, collaborative and collective responses to social problems, promotion of shared infrastructure and applications, leveraging on comparative advantages of various agencies and maximising value from investments in e-government.

To achieve the needed integration, there is need for a framework that guarantees interoperability of IT infrastructure and applications. Regrettably, Nigeria, with all her efforts at deploying IT infrastructure and/or e-Government systems, is yet to develop one.

Therefore, the National Information Technology Development Agency (NITDA) whose primary mandate is to regulate and develop IT in the country as stipulated in the NITDA Act of 2007, has developed the Nigeria e-Government Interoperability Framework (Ne-GIF) to close the identified gap.

The Ne-GIF provides tools, specifications and guidelines for supporting MDAs in undertaking interoperability of e-government systems for the provision of cross-portfolio services.

Dr Isa Ali Ibrahim (Pantami), PhD, FNCS, FBCS, FIIM
Director General/CEO,
National Information Technology Development Agency (NITDA)
August, 2019

INTRODCUTION

Steps towards Government Digital Transformation

National Information Technology Development Agency is currently focusing on creating an enabling IT environment for Government Digital Transformation (GDT) in Nigeria. Ne-GIF is one of the critical steps taken by NITDA to achieve the GDT. The framework specifies concepts, principles, policies, recommendations, standards and practices for MDAs to work together, towards the joint delivery of cross-portfolio services. The goal of the Ne-GIF is to ensure that services that require two or more MDAs' business processes are delivered seamlessly and at an affordable cost, using Information and Communication Technology.

1.1 Authority

In exercise of the powers conferred on NITDA, specifically by section 6 (a) and (c) of the NITDA Act of 2007, the Nigerian e-Government Interoperability Framework (Ne-GIF) is hereby issued.

1.2 Purpose

The Purpose of Ne-GIF includes:

1. To set the baseline framework for e-Government/IT systems interoperability across MDAs;
2. To provide a set of standard specifications and best practices for deploying e-Government/IT systems by MDAs in order to ensure seamless information exchange; and
3. To encourage deployment of e-Government/IT systems that promote cross-portfolio service provision by MDAs and ensure seamless interactions between government, businesses and citizens while using ICT tools for service delivery.

1.3 Scope and Applicability

The Ne-GIF is to provide guidelines and specifications that enable cross-portfolio service provision by MDAs. It details the principles upon which interoperability will be based, levels and steps for achieving interoperability, challenges of adoption as well as compliance measures and review processes.

The Ne-GIF is applicable to interaction between Government to Government (G2G), Government to Businesses (G2B) and Government to Citizens (G2C).

1.4 Stakeholder

The stakeholders include:

1. Government Organizations (including Local, State and Federal Government);
2. ICT Industry/ Providers of e-Services;
3. Citizens/General Public; and
4. Professional Bodies.

1.5 Outcome

It is expected that the compliance/implementation with the provision of Ne-GIF will enable the Nigerian Government achieve the following:

1. Improve synergy between government organisations by promoting easy communication and exchange of data;
2. Fully integrated public sector e-Government/IT systems for the provision of efficient cross-portfolio services;
3. Affordable and accessible e-Government services;
4. Seamless and smooth online interaction between government organisations, businesses and citizens;
5. Increase citizens' participation in governance; and
6. Promote and ensure the actualization of government policies on the ease of doing business.

[1]

1.6 Ownership

In view of the fact that the successful integration of all government sector and services will be beneficial to outlined stakeholders, all stakeholders are regarded as co-owners of the framework while NITDA coordinates. Hence, stakeholders are encouraged to work together to ensure/promote its smooth and swift implementation at all times in their respective organizations.

1 The benefits of interoperability is in appendix A.2
Practical examples of interoperability is in appendix A.3

CONCEPT OF INTEROPERABILITY

Definition of interoperability

2:1 Interoperability

Interoperability is the ability of different e-Government/IT systems from various MDAs to interact by communicating, interpreting and exchanging information in a meaningful way to deliver public services that require two or more MDAs in an integrated manner.

Requirements needed to achieve interoperability

Achieving interoperability needed to deliver integrated services across MDAs requires:

1. Identifying and agreeing on required processes;
2. Presentation of data through IT infrastructure/applications in a standardized and meaningful manner; and
3. Ability of cooperating IT infrastructure/applications to use the exchanged data understandably for service provision & delivery.

Thus, MDAs that work together towards the joint delivery of public services using ICT must understand the above concepts and ensure that mechanisms are put in place to meet them.

To achieve the above goal, MDAs are required to agree on sets of IT specifications to ensure technology standardization and process integration necessary for e-Government/IT systems interoperability.

Since interoperability of e-Government/IT systems is a multi-agency affair, it is necessary to establish shared principles upon which Ne-GIF will be operationalised. Thus, the following section itemizes the underlying principles of Ne-GIF.

2:2 Underlying Principles of Ne-GIF

Core Principles of Ne-GIF

The three (3) core underlying principles of Ne-GIF are:

1. Information Technology Standardization;
2. Process Integration; and
3. Efficient Public Service Delivery.

***1. Information Technology Standardization*:** Leads to IT acquisition efficiency across MDAs, and helps government build relevant capacities to support resource sharing and future innovations. Achieving technology standardization across board will ultimately decrease the number of platforms deployed by the Government and reduce the cost of IT systems.

2. ***Process Integration****:* Data standardization is a pre-condition for effective process integration. It makes provision of services easier and seamless through a standardized data/information sharing and exchange mechanism. The objective is to make extraction of transaction data from disparate government applications easy and available to business processes necessary for public service delivery. It enables common view of public data and information by ensuring transparency of silo systems.
3. ***Efficient Public Service Delivery*****:** One of the ultimate objectives of Ne-GIF is to guarantee efficient public service delivery across Government Agencies. The inherent Government digital transformation entails ability of ICT to effectively digitize government processes to deliver excellent public service to citizens at affordable cost.

Note: The sub-principles of Ne-GIF is in appendix A.10

There is need to subject all e-Government/IT systems of MDAs to these principles.

2.3 Major Technical Requirements for Achieving Interoperability

To ensure interoperability across MDAs, there is need to ensure the following two things are observed and defined at various interoperability requirement levels. These are:

Technical Requirements

1. Adoption of Open Standards; and
2. Metadata Standards Definition.

Internet and WWW standards for Interoperability

The main thrust of interoperability is to adopt open standards, including the Internet and World Wide Web specifications, for all government systems.

The following section describes Open Standards and Metadata Standards at high level and how they help government organizations achieve interoperability.

2.3.1 Open Standards

There is no globally accepted definition of open standards. However, the following are essential characteristics of Open Standards:

1. Transparent evolution and management process open to all interested parties;
2. Approved through due process by consensus among participants;

[2]
[3]

2. The list of Open Standards Organizations is in Appendix A.4
   Advantage of Open Standards is in Appendix A.5
3 Metadata and Metadata Standards are Explained in Appendix A.6 and A.7

3. Platform-independent, vendor-neutral and usable by unrestricted number of competing implementations;
4. Openly published including specifications and documentation; and
5. Accessible to everyone without user discrimination

Recommendation

The Ne-GIF recommends that MDAs greatly adopt open standards and specifically, use web and internet technologies for the development of e-services applications and platforms.

Recommendation

Ne-GIF recommends that Web Resources should be presented in XML/JSON formats

2.3.2 Metadata and Metadata Standards

Metadata standard is a requirement which is intended to establish a common understanding of the meaning or semantics of the data, to ensure correct and proper use and interpretation of the data by its owners and users. To achieve this common understanding, a number of characteristics, or attributes of the data have to be defined, also known as metadata. The purpose of this standard is to support interoperability across all MDAs for online data discovery, use and management.

Recommendation

The Ne-GIF recommends that the international Open Standards in table 1.0 (Appendix A.7) for metadata standards be adopted in specific focus areas of e-Services implementation to ensure both machine interoperability (information exchange) and web resource discovery.

Technology and Human Factors requirement

2.4 General Requirements for e-Government/IT Interoperability

Achieving a significant result from interoperability requires considering both **Technological and Human factors**. This is evident from the requirement of delivering integrated service across MDAs. That is, identifying and agreeing on required processes (human), seamless exchange of data through IT infrastructure (technology) and ability of cooperating IT infrastructure to understand meaning of exchanged data the same way (technology) at both ends.

Focus Areas of Interoperability

Hence, interoperability can be categorised into three (3) focus areas leading to efficient digitisation of public service:

1. Processes definition within and across MDA(s) to deliver integrated service;
2. Presentation of data between disparate e-Government/IT systems in a standardised and meaningful manner; and
3. Ability of cooperating e-Government/IT systems to communicate seamlessly and use the exchanged data understandably for efficient public service provision and delivery.

These can be further categorised into three levels as follows:

1. **Organizational Interoperability**: Ability of MDAs to define, implement and manage processes and other organisational barriers for delivering cross-portfolio services;
2. **Semantic Interoperability**: Ability to present data in a standardized, shared and meaningful way to cooperating e-Government/IT systems and infrastructure while exchanging data; and
3. **Technical Interoperability**: Ability of cooperating e-Government/IT Infrastructure/applications to communicate seamlessly and use the exchanged data understandably for public service provision and delivery.

Therefore, achieving e-Governance interoperability requires human and technological factors. For the technological factor, the different technologies should be based on open standards and metadata definition.

2.5 e-Governance Interoperability Framework

In order to develop a practical e-Governance interoperability framework, above two major factors of interoperability for delivering integrated services across MDAs must be considered holistically.

Approaches to public administration

Academic literature has established that there are three competing approaches to public administration (Rosenbloom, 1983), namely, Managerial, Political and Legal approaches. At the center of these approaches lies the Public Administration, as shown in fig. 1.0.

Therefore, to ensure success of e-Government projects, these three approaches must be balanced. That is, political interests and structure, the positions of laws and regulatory frameworks governing public services and the government in general as well as the managerial skills and tools required to bring efficiency in governance must be adequately managed.

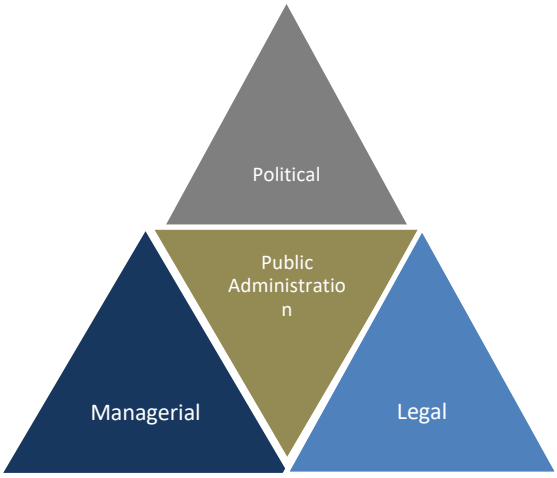

Figure 1.0: Competing Approaches to Public Administration

Considering the human and technology factors in building interoperability framework makes it practical and sustainable. The human and technology factors cut across the interoperability levels from organizational to semantic and technical. This is shown in figure 2.0.

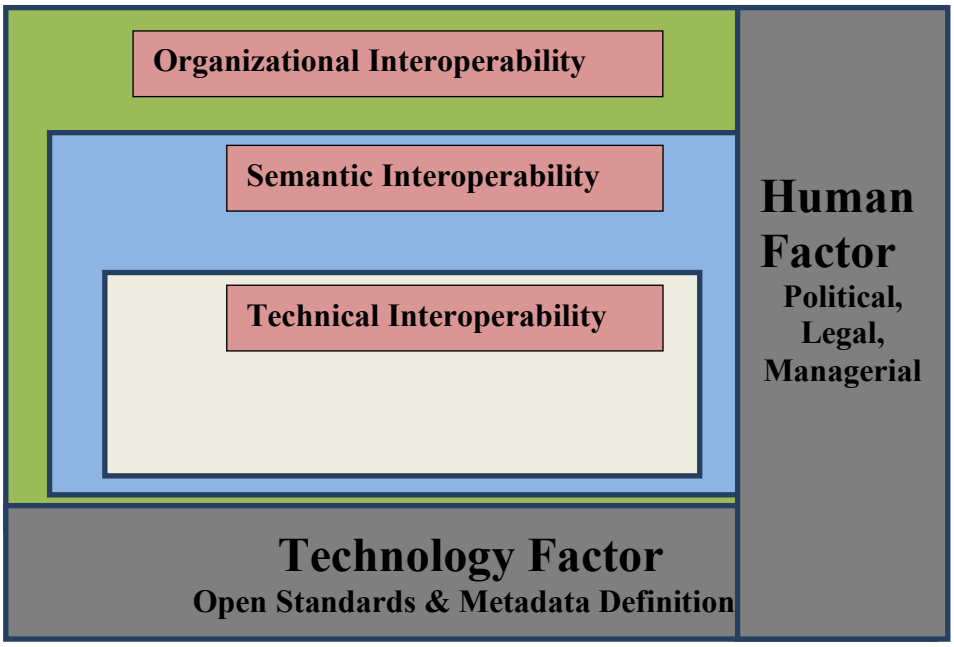

Figure 2.0: Nigerian e-Governance Interoperability Framework

LEVELS OF INTEROPERABILITY

Ne-GIF Drivers

Ne-GIF is driven by the Government Enterprise Architecture (GEA), e-Government Master Plan and e-Government Strategy. These are high level documents and guides articulating how IT projects should be implemented in MDAs to record successes and achieve government digital transformation. Ne-GIF is one of the "how" of implementing these plans for achieving the objectives.

Practical example of integrated service is discussed in the Appendix A.3. Such service necessitates interactions between different MDAs and stakeholders. Therefore, digitising such service also requires interoperability of cooperating IT infrastructure and systems. These facts guide the implementation of interoperability at different levels. The three levels of interoperability is discussed below.

3.1 Organizational Interoperability

Organizational interoperability ensures effective management and implementation of the processes required for the provision of cross-portfolio services. It identifies and addresses any possible barriers including data ownership issues, public service structure, information technology requirements and processes management etc.

3.1.1 Steps for the Provision of Cross-Portfolio Service

Provisioning of cross-agency service at a minimum requires the following steps:

1. ***Cross Agencies Service Identification/Discovery***
   This step identifies or discovers services in which their provisions require two or more government agencies. These services might have been provided manually or digitally but separately by two or more MDAs. However, such services should be digitized and provided in an integrated manner.

   On the other hand, sub-service of Agency 'A' required to provide integrated service by Agency 'B' can be accessed by Agency 'B' through a **web service/ open API** of Agency 'A'.

Initiating Cross-Agency Services

   An interested MDA or any stakeholder can initiate cross Agency service if such service is going to benefit citizens, businesses (promoting ease of doing business) and the Country at large.

2. ***Identification of Service provisioning MDAs***

Providing integrated service requires identification of MDAs and/or third party(ies) involved. Cooperation and buy-in among MDAs is critical to the success of other steps. Knowing the MDAs involved and their responsibilities is very germane to cross-agency service provision.

3. ***Cross Processes Identification and Definition***

This step identifies and defines cross processes required by disparate MDAs to provide the cross-agency service. Each MDA involved must specifically spell out processes to be digitised from its end. These processes are sub-processes to be integrated with other sub-processes by the cooperating MDAs. The processes can be described in narrative terms and/or as a graphic flow.

4. ***Process Agreement***

This step facilitates cooperation between the participating MDAs and defines the role of each participating stakeholders.

The issue around process agreement is that it is human in nature. It involves active engagement of participating MDAs to agree on how to carry out the process automation of the sub-processes from individual MDAs. The engagement could happen through the governance structure discussed in chapter four (4).

Issues to be resolved in Process Agreement

Basically, the following issues should be resolved in the process agreement:

a. Data Ownership
b. Users Identification
c. Legal issues
d. Needed IT infrastructure/Applications
e. Standard Operating Procedures
f. Service Level Agreements
g. Process hand-over mechanisms
h. Compliance guideline and check-list
i. Change Management (Change Management plan should be developed)

5. ***Process Standardization***

This step identifies Open Standards required to aid sub-processes integration and interoperability between disparate MDAs.

This calls for the use of Business Process Management (BPM) concepts and standards. The goal of BPM Standards is to ensure reusability, definitional clarity, interoperability and portability.

Open Standards for Process Standardization

Process standardisation also aims at unifying process procedures for a common service across MDAs that use different steps/methods to accomplish. This makes it easier to integrate data across systems. Mainly, it relies on **Business Process Modeling Language Notation (BPMN)** as the open standard for coordinating the sequence of processes and the messages that flow between different processes across various MDAs in a related set of activities.

BPMN maps directly to **Business Process Execution Language (BPEL)** which is a standard/formal method of computation for dynamic processes. It ensures that business processes can be directly mapped to any business modeling executable languages for immediate execution. BPEL is XML-based language used to define enterprise business processes within Web services.

6. *Process Digitisation and Automation*

Process Automation steps

The identification of Open Standards required for process standardisation makes automation/digitisation of related processes easier as outlined below:

a. ***Process Design:*** Process Design encompasses both the identification of existing as-is processes, business process re-engineering and the design of "to-be" processes. This includes identifying processes that can be candidate for automation, outlining the different activities that constitute each of the processes, identifying areas of improvement if any, redesigning how the work is accomplished to reduce costs and better meet the MDA's vision, document the "to-be" design in Open Standards models and tools to ensure proper process management.

   This should appropriately indicate process flow and the actors within it. Where the internal sub-process involves sub-process from other MDA(s), this should be indicated in the design of the process flow.

Prototyping Business Modelling

b. ***Process Modeling*****:** This stage includes selection of Open Standard tools and implementation of a prototype business process. Prototyping also helps to identify the different roles that will be involved in the process, specific milestones and most importantly, any sub-processes that may be candidate for re-usability.

c. ***Process Automation:*** At this stage, the development of end-to-end automated process will commence alongside any other functionality(ies) that may be required for visibility and automation. Process automation entails complete visualisation and simulation of

the sub-processes which can be replicated at the software/application design and development stage.

d. ***Process Execution****:* This stage includes process integration and quality assurance. It involves integration of the cooperating sub-processes to provide integrated service(s) and assurance(s).

   This stage entails connecting cooperating MDAs databases, applications or systems including legacy systems, Enterprise Resource Planning (ERP) systems and Customer Relationship Management (CRM) software etc. At this stage the integrated process shall be ready for deployment in the production environment.

e. ***Business Process Monitoring:*** This stage focuses on monitoring the behavior of the automated business process between the cooperating MDAs in order to identify areas where there are bottlenecks and to delineate a remediation of performance issues, bug fixes, alongside the identification of future enhancements.

f. ***Business Process Optimization****:* This stage refers to ensuring that remediation of issues identified during the monitoring stage are addressed; and that any area(s) of improvement in the process are modified in order to meet integrated service provision needs.

Responsibilities of cooperating MDAs

Note: The first three stages are performed by each cooperating MDA to automate its sub-processes needed to deliver the integrated services. The cooperating MDAs jointly implement the rest of the stages having followed Open Standards at each stage.

Recommendation

Ne-GIF recommends the above automation stages based on BPM lifecycle, the use of ***Business Process Modeling Language Notation (BPMN)*** *and* ***Business Process Execution Language (BPEL)*** *at each stage.*

7. ***Service Provision***

Service provision is the last step for provision of cross-agency service. At this stage, the integrated process is ready to be deployed in the production environment.

Recommendation

Ne-GIF recommends the use of ***Service-Oriented Architecture (SOA) and Web Service*** *approaches.*

3.1.2 Challenges of Organisational Interoperability

Organisational level interoperability involves much more human element than technology. The issues around public service institutions structure and culture, territories and the claim of overlapping functions must be addressed properly in order to achieve meaningful interoperability.

Addressing Organizational Interoperability Challenges

At organisational level, the following challenges should be addressed:

1. Data Ownership: who owns, secures, utilises data should be defined and agreed to by the cooperating MDAs. In addition, the challenges around who pays for service, payment sharing formula and infrastructure requirements etc. should be resolved at the organisational level;
2. Additional budget for interoperability compliance must be taken into consideration;
3. Non-transparent processes and resistance to change to new process and data from existing process should be managed properly through a change management process;
4. Political and legal matters should be resolved around provision of particular integrated service; and
5. Skills and expertise required should be provided through capacity building and awareness creation on the importance of interoperability.

3.2 Semantic Interoperability

Semantic interoperability is perceived as a key aspect on the road to e-government integration and improved service quality. It takes advantage of both the **structuring** and the **codification** of the data exchange including vocabulary so that the receiving systems can interpret the data the same way.

Semantic integration of e-government services means all relevant information processed or shared is based on successful **mediation and/or translation of the end-to-end meaning to** service providers or users (citizens, businesses, the Government service providers) as well as e-Government/IT applications.

According to the **part two** of **Data Interoperability Standards**, [4] Semantic interoperability includes:

1. The ability of organisations to understand exchanged data in a similar way;
2. The ability of software systems to make adequate use of data received from other software systems;
3. How the elements of the data structures exchanged are related to real world objects, relations and events;

4 http://nitda.gov.ng/wp-content/uploads/2018/05/data-interoperability-standards.pdf

4. Exchange of information about the context of data i.e. relations, operations and functioning in general; and
5. Exchange of metadata between organisations/agencies

It also states that Semantic Interoperability is achieved when:

1. Data exchange partners have a shared understanding of the meaning of shared data;
2. Data exchanges adhere to the shared understanding; and
3. Data is exchanged without misinterpretations.

Data Ownership and Maintenance

Federal MDAs that wish to provide cross portfolio service aimed at integrating different web resources containing service information from legacy systems and making it accessible via a single platform should leave the data and its maintenance with the owner organisations.

The following steps articulate how MDAs can achieve semantic interoperability for cross-agency service provision and e-Government integration.

3.2.1 Semantic Interoperability Assets

Data Structure and Interpretation

Broadly, Semantic Interoperability assets focus on packaging of data (syntax) and the transmission of the meaning with the data (semantics). It deals with the structure of data while semantic interoperability asset explains how data should be interpreted.

Schema Building Blocks

1. ***Syntactic assets*** relate to the Schemas building block and their main role is to **define data structures** in a formal fashion. This includes schemas (XML compatible format) and metadata schemas. The syntactic level of interoperability is the first stage in achieving semantic interoperability because it provides a level of formalization around known data subjects.

   This is usually achieved by creating **asset repositories for common schemas** and establishing a public sector wide policy for their use. This is addressed at the data layer of the technical interoperability.

2. ***Semantic assets*** relate to the Data Standards Catalogue building block and their main role is to provide a central terminology to ensure that data elements are interpreted in the same way by communicating parties. These assets denote information resources that have been created in order to ensure the interoperability of information systems. Semantic assets for semantic interoperability are divided as follows:
   a. Dictionaries
   b. Thesauri
   c. Nomenclatures

d. Taxonomies
e. Mapping tables
f. Ontologies
g. Service registers.

Note: The semantic interoperability in this chapter focuses more on the semantic assets while the data layer in technical interoperability section addresses syntax assets.

3.2.2 Steps to follow by MDAs for Semantic Interoperability Assets

1. ***Cross-Agency Service Information Analysis***: In this step, related information about the integrated service to be provided by two or more MDAs are collected and analysed. It details the collection and analysis of what, who, where (MDAs locations), time, channels, nature, requirements, specifications, processes and law/regulations etc. of the service.

   This step can be accomplished by the specification of scenario and use cases, describing in a free-text form. The free-text should be transformed into a more **structured table format** containing identified information needs and the corresponding service(s) as well as what the service users need to do in order to obtain the service.

   Generating Structured Data

   The table containing service entities should be modelled using **Unified Modelling Language (UML)** to produce workflow modeling schemas having also considered the BPMN.

   Modelling Service Entities & Recommendation

2. ***Create Glossary of Topics & Terminologies:*** This step creates a glossary that contains all relevant topics and terms needed for describing the services in question. Each entry should provide a short description of the topic, how it relates to other terms and the corresponding informational needs.

   Ne-GIF recommends ***Metadata standards specified in interoperability concept*** *(in Appendix A.7: table 1.0) as standards for service topic & terminologies descriptions.*

   Recommendation

3. ***Create Controlled Vocabulary and Group Related Terms****:* Based on the glossary, a controlled vocabulary should be created. Each service and general topic to be described should be represented by a **main term** and possibly additional related terms. All items of the controlled vocabulary should be grouped through defined relations into hierarchical subgroups. This is a form of classification for related elements called **Taxonomy**.

National ICT-enabled vocabulary

Note: Establishing control vocabulary for each cross-agency service will gradually help develop national standard vocabulary. This is a bottom up approach for populating **Standard National ICT-enabled service vocabulary**.

4. ***Design an Ontology***: Ontology fixes the meaning of the terms and their relations in a formal way. Informal description in the glossary should be verified to ascertain its reflection of the formal meaning (and vice versa).

Recommendation

*Ne-GIF recommends **Web Service Modeling Ontology (WSMO)** as standards to provide an ontology based framework, which supports the deployment and interoperability of Semantic Web Services.*

5. ***Implement Semantics**:* The implementation of the ontology is the use of the above constructs for service description and operation (e.g. creating **service profiles** in WSMO). Web Service Modelling Language (**WSML)** provides syntax and semantics for Web Service Modeling Ontology (WSMO). [5]

Recommendation

Ne-GIF recommends WSML to provide syntax and semantics for WSMO

3.3 Technical Interoperability

Technical Interoperability examines the technological pieces linking information systems. It includes interface specifications, secure communication protocols; interconnection services, data presentation and exchange, application and data integration for integrated public service provision.

The purpose of technical interoperability is to utilise series of technical standards and specifications to combine a variety of infrastructure, applications and services to achieve interoperability in e-Governance systems and platforms.

3.3.1 Conceptual Model for Integrated Public Service Delivery

The conceptual model for integrated public service provision is necessary for specifying a **clear view** of the components constituting the integrated environment, supported by interoperability requirements and procedures. The conceptual model promotes the idea of interoperability by design. The model is depicted at figure 3:

5 A formalized WSML representation of the ontology, containing all the definitions (concepts, classes) of services, goals, and life events, can be produced as a result of the 5-step procedure. Then, service(s) can be meaningfully implemented using applications built on Open Standard technologies such as Java, C++, Python, Ruby, PHP etc. using the ontology developed. Implemented services can be collated to form national service register in which its services can be reused.

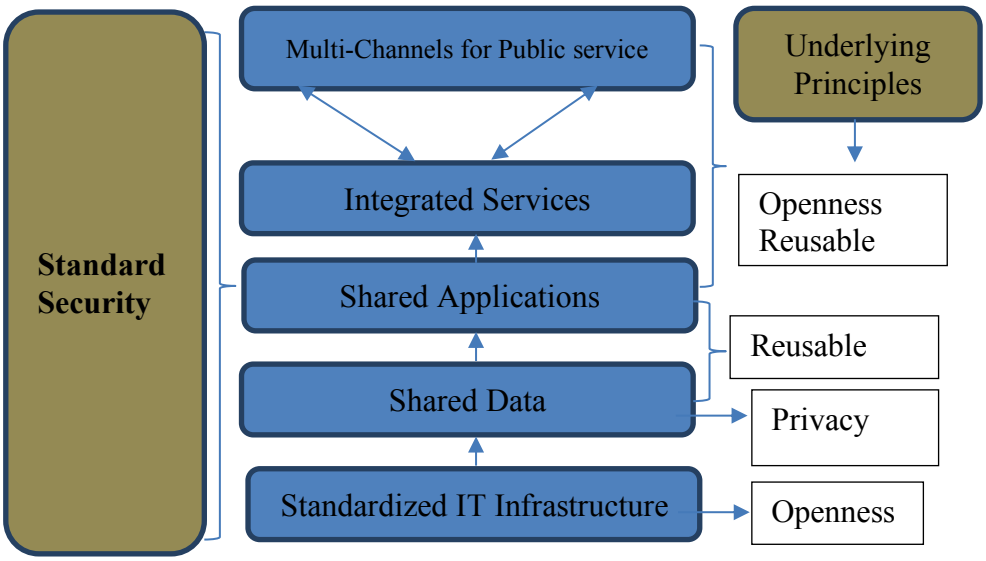

Figure 3.0: Conceptual Model for Integrated Public Service Delivery

Recommendation

For Federal MDAs services to be interoperable, they should be designed in accordance with the above model and in line with the Ne-GIF underlying principles.

The following technical interoperability architecture domains should be observed in order to ensure cooperating e-Government/IT infrastructure/applications communicate seamlessly. It will also ensure that the exchanged data is used understandably for public service provision following the organisational and semantic interoperability requirements and specifications. The technical interoperability architecture domains to be observed are discussed in the following section.

3.3.2 Technical Interoperability Architecture Domains

The technical interoperability architecture domains build organising logic for data, applications and infrastructure captured in a set of relationships, technical standards and choices to achieve desired technical standardisation and integration.
The critical interoperability architecture domains considered for effective interoperability of e-Government/IT systems are: **channel, service, application, data, infrastructure and security**. These to some extent are captured and aligned with The Open Group Architecture Framework (TOGAF), a widely accepted architecture domains for enterprise architecture. It covers Business, Data, Application and Technology Architecture excluding **channel and security**.

The business layer is likened to the organisation interoperability domain which has already been described in the organisational interoperability section of the document.

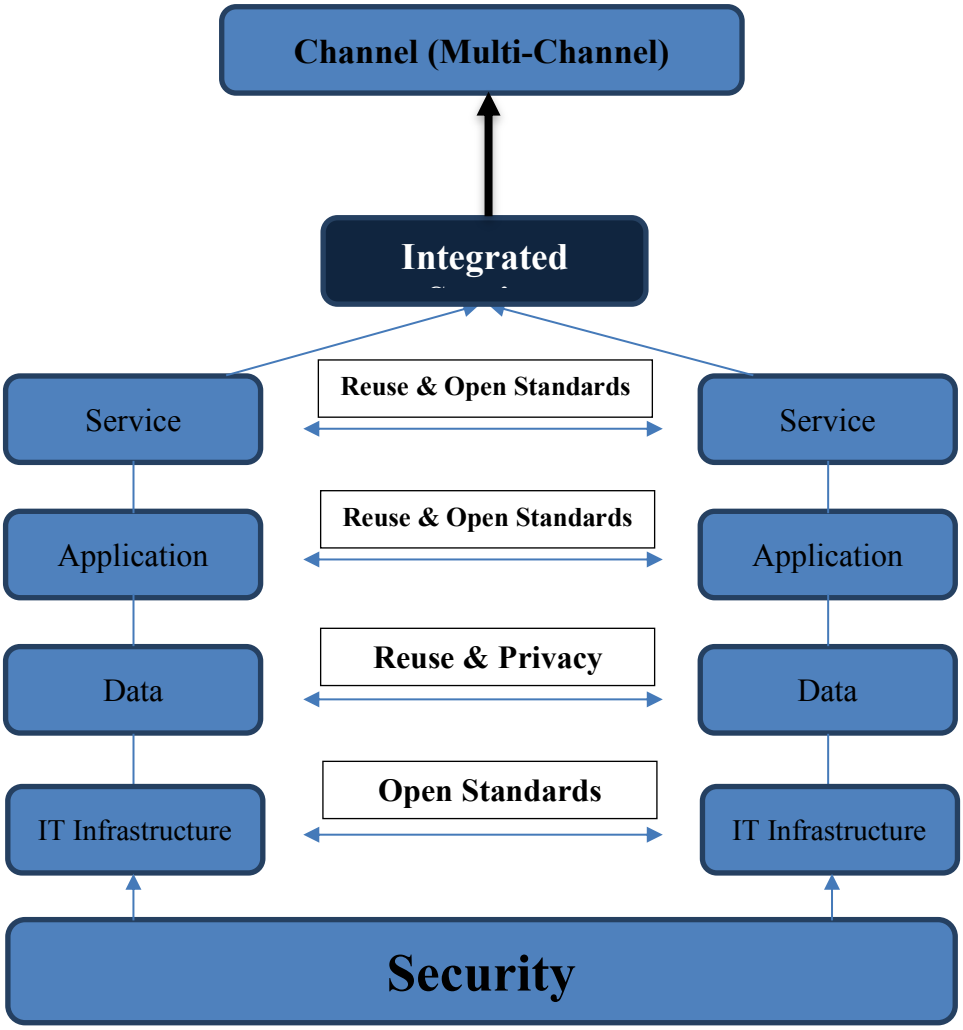

Figure 40: Interoperability Architectural Domains

In this context, the Government Enterprise Architecture (GEA) represents the WoG architecture while technical interoperability architecture represents a ‘‘solution-specific’’ architecture that deals with the necessary building blocks required to offer the integrated service in question. The five major architectural domains are being specified to meet technology interoperability requirements for providing integrated services by two or more MDAs.

3.3.2.1 Channel

Channels are interface through which integrated public services are delivered. They are critical to the success of e-Governance and multi-channel service delivery should be a design consideration. The adoption of multi-channel for integrated service is a prerequisite to service accessibility, convenience and delivery at

affordable cost. All the channels are expected to be interoperable with one another and with whatever devices being used by the service takers.

Recommendations

Ne-GIF recommends the following channels: Common Service Centers, Website/Portal, Mobile Platform and Government Contact/Call Centre to form part of the integrated service. [6]

Ne-GIF recommends the following for channels:

MDAs should adhere to Standard and Guidelines for Government Websites by NITDA. In addition, adherence to Open Web Platform by W3C is recommended; and

MDAs should adhere to **Standards for Web Applications on Mobile** by W3C

3.3.2.2 Service

The service architectural domain is very crucial to **integrated service** provision.

Recommendation

It is recommended that most integrated services should be provided through the **Web** using the **Internet** as a communication medium because of its openness, advancement and wide adoption. Making services available over the web using internet as a communicating medium brought the concept of **Service-Oriented Architecture (SOA)** and **Web Services**. [7]

Recommendation

Every MDA should adopt Open Standard for the development of APIs for accessing its infrastructure/applications/services.

Recommendation

The Ne-GIF recommends the adoption of **REST Approach** for implementing web services because of the flexibility the approach.

Recommendation

Ne-GIF recommends that the message from service consumer to provider and vice versa should be presented in **XML**. [8] [9]

3.3.2.3 Application

Middleware

In addition to SOA and Web Services for web-based integrated service provision, integration of standalone enterprise applications software and legacy systems can be achieved through **Middleware.** Example of Middleware services include **enterprise application integration** (EAI), data integration, message oriented

6. Explanation on e-Services Channels are in Appendix A.8
7 Explanation on SOA, Web Services and APIs is in Appendix A.9
8 SOAP and REST are explained in Appendix A.9
9 XML and JSON are explained in Appendix A.9

middleware (MOM), object request brokers (ORBs), and the enterprise service bus (ESB).

Recommendation

The table 2.0 in the Appendix A.9 provides category of middleware services that could be used by MDAs for applications interoperability.

Furthermore, Middleware facilitates and manages the interaction between applications across heterogeneous computing platforms and acts as an abstraction layer that hides complexities of building distributed applications. It supplies services facilitating data exchange in a standardised format.

Types of Middleware

The table 3.0 in the Appendix lists the types of middleware with examples and brief description of each. Any of these identified middleware can be adopted depending on the need and requirements. The overall framework is the same but architecture and deployment varies.

3.3.2.4 Data

Data is the only component of interoperability architecture that passes through the fabric of ICT, powers the applications and enables the provision of services. It is the most important component of the interoperability architecture.

To provide a cross portfolio service, data is exchanged between cooperating MDAs' e-Government/IT infrastructure and applications.

Recommendation

The data from each MDA should be structured based on standards to guarantee seamless exchange of information. This implies that uniform data schemas should be followed.

Recommendation

Majorly, these schemas are **standard XML and metadata schemas**. They determine the data attributes for "core" data assets such as a "Person" (Name, NIN, Date of Birth, Phone Numbers etc.) or an "Organization" (Name, Sector, Address etc.). The common schemas are the syntactic requirements of data interoperability.

Syntactic Requirements

The syntactic level of interoperability is the first stage in achieving semantic interoperability because it provides a level of formalisation around known data subjects. This is usually achieved by creating **asset repositories for common schemas** and establishing a public sector wide policy for their use.

Recommendation

For syntactic interoperability to be achieved, Ne-GIF recommends adherence to related areas of **PART three (3) to six (6) of Data Interoperability Standards, 2016.** [10]

10 http://nitda.gov.ng/wp-content/uploads/2018/05/data-interoperability-standards.pdf

3.3.2.4 IT Infrastructure

The IT infrastructure layer of interoperability architecture includes the combination of **Hardware, Operating System, Network and Database** components. The figure 5.0 presents the components of IT infrastructure as defined by Ne-GIF.

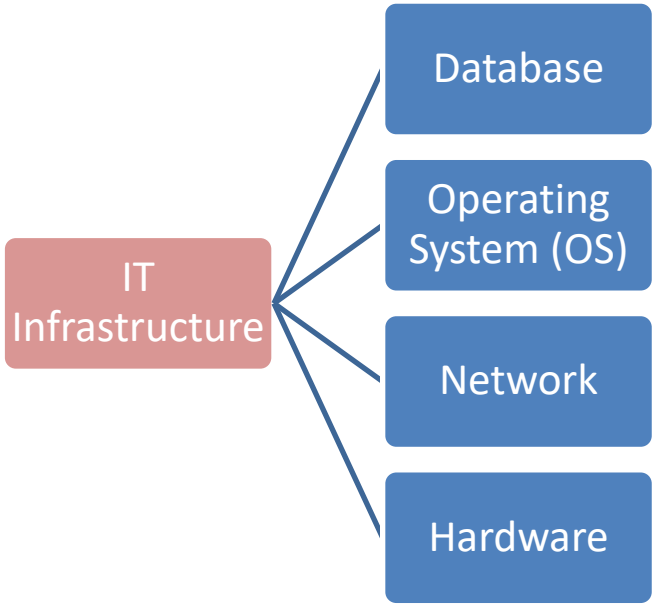

Figure 5.0: IT Infrastructure Layers

IT Infrastructure Goal

The goal of the IT infrastructure interoperability architecture is to ensure that cooperating IT infrastructure deployment from participating MDAs use exchanged data understandably for the provision of integrated or cross portfolio services.

To achieve the goal, IT infrastructure deployment must be based on certain specifications. The specifications for IT infrastructure are stated in the figure 7.0.

Database Specifications

Recommendation

Ne-GIF recommends adoption of:

1. Any Relational Database Management System (RDBMS) that supports ANSI standard Structured Query Language (SQL) as a standard language for access;
2. Any Non-Relational Database Management System (Non-RDBMS), based on specific requirement(s), that supports Structured Query Language (SQL) and other Not-Only SQL (NoSql) query languages;
3. The deployed Database Management System by MDAs should support standard Application Programming Interface (API) for database access. e.g. Open Database Connectivity (ODBC)

Operating System Specifications

Recommendation

Ne-GIF recommends MDAs should use Operating Systems (OS) that is compliant with Portable Operating System Interface (POSIX) standards. Examples of such OS are Unix, Linux, Windows, MacOS and Android etc.

Network Specifications

Recommendation

Ne-GIF recommends that MDAs should ensure:

1. Communication networks (LAN, WLAN, WAN etc.) are built based on TCP/IP Model & Protocols;
2. Networks support open standards (e.g. wired, wireless and security standards) and open standard protocols; and
3. Network equipment supports configuration with open standard protocols.

Hardware Specifications

Recommendation

Ne-GIF recommends that MDAs should ensure that hardware to be deployed:

1. is compatible with the POSIX compliant Operating Systems;
2. is compliant with Standards Interfaces (e.g. USB, SATA, Ethernet etc.);
3. is upgradable to support future requirements; and
4. supports installation of Open Standards Software (e.g. Middleware)

3.3.2.5 Security

Security Layer

Security domain defines the security services that are required at each domain of interoperability architecture model. Security layer cuts across all technical interoperability layers. It includes standards, protocols and technologies needed to secure exchange of information as well as secure access to public sector information and services.

Security Services

Majorly, security measures must guarantee **confidentiality, integrity and availability** of information and information systems. These are fundamental security services and interoperability efforts must not compromise them. The services entail encryption of data, public key infrastructure standards supporting the use of public and private encryption and decryption keys, digital signatures, and secure transmission protocols. It also includes storing, using, and safekeeping identity information for users, citizens, employees, and resources.

Recommendation

To achieve minimum interoperability security standards, Ne-GIF recommends that MDAs should adhere to the following specifications:

1. Security equipment deployed for e-Government systems support open security protocols and standards;
2. Security is designed into IT/e-Government systems with interoperability as a key consideration;

3. Adherence to the National Information Systems and Network Security Standards and Guidelines;
4. Observe NITDA's Data Protection Guidelines; and
5. Comply with international Public Key Infrastructure (PKI) standards.

3.4 Governance Structure

To properly govern the three levels of interoperability, there is need to adopt Ne-GIF governance structure.

Recommendation

Ne-GIF recommends the following governance structure:

1. **Ne-GIF Governing Committee (NGC)**: The Committee is responsible for overseeing and supervising the entire process of cross-agency/cross-portfolio e-Service delivery. The Committee will work to ensure all standards are complied with.
2. **Technical Working Group (TWG)**: The group is responsible for actual implementation of the Ne-GIF and report to the NGC as and when required.

COMPLIANCE

The development and acceptance of the Ne-GIF by all stakeholders, without adequate compliance, cannot on its own achieve its purpose. Thus, it is crucial that the Ne-GIF be backed up with adequate compliance by stakeholders.

The Need for Compliance

Achieving interoperability in line with the Ne-GIF simply connotes stakeholders' compliance with the provisions of the Ne-GIF.

4.1 Compliance Officers

As co-owners of the Ne-GIF, all stakeholders are expected to work towards and ensure the effective implementation of the framework. Thus, each stakeholder in carrying out their respective mandates, responsibilities and duties are urged to monitor, encourage and ensure compliance with the provisions.

Core compliance officers

In view of the above, the following officers in stakeholders' organizations shall be the core compliance officers:

1. **IT Heads and IT Systems Managers of MDAs** should be primarily responsible for ensuring compliance with the provisions of the Ne-GIF since they are responsible for the actual implementation of the technical provisions. Thus, they are required to critically study, understand and ensure that their respective organizations comply with the technical provisions.

   This will enable them to adequately recommend specifications for IT systems procurements and installations as well as for the upgrade of old systems in line with the provisions of the Ne-GIF. Also, it will enable them effectively implement all approved IT projects in accordance with approved specifications.

2. **Heads of MDAs and Heads of e-Government Units/Departments** are responsible for the approval of IT projects on behalf of their MDAs and Departments/Units. Hence, they should be responsible for ensuring compliance with the provisions of the framework. Thus, they are expected to carefully study and understand the Ne-GIF as well as ensure that all projects are in conformity with the provisions of the framework before approval.

3. **Government IT Projects Approving Bodies** such as IT Clearance body of NITDA, all government procurement departments/units, Bureau of

Public Procurement and Federal Executive Council etc., as gate keepers to government projects, are similarly responsible for ensuring compliance with the provisions of the Ne-GIF because of their strategic positions. They are urged to therefore study, understand and ensure compliance with the technical provisions of the framework.

Where it is discovered by these approving bodies that a proposed project is likely to contravene the provisions of the Ne-GIF, approval should be withheld/denied and the applicant should be advised to comply.

Aside the above compliance officers/bodies, the following can also assist with ensuring compliance with the Ne-GIF:

1. **E-Government/e-Business Strategists** who work with and for government are urged to study, understand and comply with the provisions of the Ne-GIF. Failure to ensure that e-government/e-business strategies developed are in conformity with the framework will result in the refusal of such initiative as well as non-committal of government funds in support of such strategy.
2. **Applications developers'** who are keen on working with or for any government organization in the development of their systems, should also study, understand and comply with the provisions of the Ne-GIF. An application which does not comply with the technical provisions of the framework will not be accepted or sponsored by the government.
3. **All ICT Providers** who intend to transact business with government or assist government organizations with the implementation of its projects should ensure that all systems solutions proposed to government are in conformity with Ne-GIF.

Ne-GIF Compliance Assessment

4.2 Assessment of Compliance

To ascertain the status of stakeholders' compliance with the provisions of the Ne-GIF, there is need to regularly carry out MDAs system assessment to determine conformity with the provisions of the framework as well as ascertain if it violates any of its specifications.

It is recommended that this assessment should be carried out annually by stakeholders in their various organizations and a status report of compliance be submitted to the Ne-GIF Governing Committee on or before the 31st of January following the year of assessment. This will enable them measure and assess overall stakeholders' compliance with the framework.

Establishment of Ne-GIF Governing Structure

4.3 Ne-GIF Governing Committee

To ensure the proper monitoring of implementation and compliance with the provisions of the framework, there shall be:

1. Established a Working Committee which shall be known as 'Ne-GIF Governing Committee'.

Ne-GIF Governance Structure Members

2. The Ne-GIF Governing Committee shall consist of the following:
   a. A Coordinator
   b. The Head of IT or e-Government Department/Unit from each of the following organizations:

a. A Coordinator

b. The Head of IT or e-Government Department/Unit from each of the following organizations:

I. Federal Ministry of Communication
II. National Information Technology Development Agency
III. Office of the Secretary General of the Federation
IV. Federal Ministry Finance
V. Nigeria Communications Commission
VI. National Identity Management Commission
VII. National Population Commission
VIII. Nigerian Immigration Services
IX. Central Bank of Nigeria
X. Federal Mortgage Bank
XI. Nigeria Social Insurance Trust Fund
XII. National Bureau of Statistics
XIII. Independent National Electoral Commission
XIV. Federal Inland Revenue Services
XV. Joint Tax Board
XVI. Corporate Affairs Commission
XVII. National Health Insurance Scheme
XVIII. Office of the Security Adviser
XIX. Federal Road Safety Corps
XX. Pension Commission
XXI. Nigerian Police Force

XXII. Nigerian Prison Service

XXIII. Galaxy Backbone

XXIV. Budget office of the Federation

XXV. National Lottery Regulatory Commission

XXVI. Nigeria Communication Satellite

XXVII. Bureau of Public Procurement

XXVIII. Presidential Enabling Business Environment Council (PEBEC)

XXIX. Chairman, Committee of ICT Directors of Tertiary Institutions

c. However, where an organization has the Head of IT department/unit and Head of e-Government Department/unit, the Head of e-Government Department/Unit alone shall be a member of the Ne-GIF Governing Committee.
d. One IT professional in the Governing board from each of the following Professional Bodies:
    i. Computer Professional (Registration Council) of Nigeria (CPN)
    ii. Nigeria Computer Society (NCS)
e. One IT professional in the Management Cadre from each of the following:
    i. Nigeria Inter-Bank Settlement System (NIBSS)
    ii. Organized Private Sector

f. Three IT professional to be drawn from the Private Sector

Coordinating Ne-GIF Governing Structure

3. Considering the strategic mandate of NITDA in developing framework, standards, guidelines and policy for the '*development of electronic governance and monitoring the use of electronic data interchange and other forms of electronic communications transactions*'[11] as well as for the '*standardization, application, coordination, monitoring and evaluation of information technology practices, activities and systems in Nigeria'*[12], NITDA (through a representative from its e-Government Development and Regulation Department) shall be the Coordinator of the Committee.
4. A third of the members of Ne-GIF Governing Committee and the Coordinator or his/her representatives shall constitute a quorum.
5. The Committee shall amongst other related things:

[11] Section 6(c) of the NITDA Act 2007.
[12] Section 6(a) of the NITDA Act 2007.

Monitor stakeholders' compliance with the provisions of the framework.

a. Meet annually to assess the compliance level of stakeholders with the provision of the framework.
b. Coordinate (where necessary) or assist in the development, promotion and adoption of standards, guidelines and policies that will help ensure the actualization of the purpose of this framework.
c. Coordinate the review and update of the framework in line with the provision the Ne-GIF.

4.4 Technical Working Group (TWG)

Setting up MDAs' TWG

1. All MDAs are encouraged to set up in-house TWG that will:
   a. Ensure that all IT projects and initiatives are in compliance with the provisions of the Ne-GIF;
   b. Provide timely advise to their Management on the need to carry out Ne-GIF compliance assessments annually;
   c. Initiate and implement cross-agency services as the need arises;
   d. Submit to Ne-GIF Governing Committee, a report on the status of Ne-GIF compliance assessment carried out within their organization, on or before the stipulated 31st of January date through the Head of IT or e-Government; and
   e. Escalate challenges, suggestions, innovations and ambiguities etc. encountered in the process of implementing the Ne-GIF to the Ne-GIF Governing Committee through the Head of IT or e-Government.
2. The TWG should be made up of at least 5 persons to be drawn from both the IT and/or e-Government departments/units.
3. The TWG should be headed by either the Head of e-Government or IT department/unit.
4. However, where an organization has both the Head of IT department/unit and Head of e-Government Department/unit, the TWG should be headed by the Head of e-Government department/Unit while the Head of IT department should be made a member of the TWG.
5. Upon the creation of the TWG, the details of its members should be communicated to the Ne-GIF Governing Committee.
6. All communications from the TWG to the Ne-GIF Governing Committee should be through the Head of the TWG.

4.5 Challenges to Compliance

1. This framework is subject to the willingness of stakeholders to comply with laid down specifications, policies and standards. Therefore, compliance by stakeholders cannot be compelled but can be merely encouraged. In view

of the above, there is a need to develop an **enforceable** guidelines and standards to ensure compliance to the provision of this framework.

2. Similar to the above challenge, the assessment of stakeholders' compliance is dependent on their ability to carry out the required annual assessment and their willingness to submit a report to the TWG. The TWG cannot properly assess the level of compliance if stakeholders fail or lacks the capacity to effectively assess their level of compliance with the provisions of this framework or refuse to submit the required report or submit falsified report to the TWG.
3. No MDA is allowed to make expenditure in a fiscal year without an approved budgetary provision. In view of this, MDAs are encouraged to make appropriate budgetary provisions for projects that are initiated to ensure compliance with the provisions of Ne-GIF.

REVIEWS AND UPDATES

Ne-GIF Review

In consideration of the fast changing nature of IT, it is expedient that the Ne-GIF remains up to date and in conformity with best international requirements/standards at all time as well as have the capacity to adequately provide for new technologies and market developments. In view of the above, there is need for the framework to be reviewed and updated (where necessary) from time to time.

Ne-GIF Review Procedure

The framework will be reviewed and updated biennially (i.e. every two years) or whenever there is an urgent need for review. The following shall be considered urgent for the purpose of review before the set biennial review period:

1. Where it is observed and recommended by the Ne-GIF Governing Committee that key technical provisions of the framework should be reviewed and updated due to the fact that they are obsolete or impossible to implement by stakeholders.
2. Where any document(s) relied on for the development of this framework has been substantially reviewed such that it affects the provisions of this framework.
3. Where a more efficient and cost effective way of improving integration is developed and it is substantially different from the recommended technical specifications contained in the framework.

Where a review is requested or has become necessary in line with any of the above requirements, the Ne-GIF Governing Committee will:

1. Constitute a Sub-Committee to critically review the Framework and come up with a revised/updated draft.
2. The revised/updated draft will be presented to the Ne-GIF Governing Committee for consideration and approval for presentation to all stakeholders for further consideration and adoption.
3. The Ne-GIF Governing Committee shall organize a stakeholders meeting for the consideration, approval and adoption of the revised/updated draft.
4. Upon approval and adoption, the document shall be published as the extant framework and labeled as a higher version of the Ne-GIF i.e. 2.0, 3.0 and 4.0 etc.
5. However, where the proposed review is minor and not likely to drastically affect the implementation of the framework, there will be no need to organize a stakeholders meeting. Such minor alterations versions of the framework will upon approval by the Ne-GIF Governing Committee be labeled as sub versions of the existing version of the framework i.e. 2.1, 2.2 and 2.3 etc.

THIS INSTRUMENT IS HEREBY ISSUED ON THE 2ND DAY OF AUGUST, 2019
BY THE NATIONAL INFORMATION TECHNOLOGY DEVELOPMENT AGENCY (NITDA)

…..……

Dr Isa Ali Ibrahim (Pantami) PhD, FNCS, FBCS, FIIM
Director General/ CEO
Chief Information Technology of Nigeria.

APPENDIX

A.1 Definition of Terms

The terms used in this Framework are defined as follows:

Information Technologies refer to the use of computing technologies such as networking, hardware, software, the Internet etc. to create, process, store, secure and exchange all forms of electronic data for the providing service(s).

e-Government is the use and application of information technologies in government activities to streamline and integrate workflows and processes, effectively manage data and information, enhance public service delivery, as well as expand communication channels for engagement and empowerment of people.

Whole-of-Government (WoG) denotes public service agencies working across portfolio boundaries to achieve a shared goal and an integrated government response to particular issues through the use of ICT.

Government Digital Transformation (GDT) denotes advanced WoG. It means Nigerian Government transformation that is ICT-enabled for the purpose of citizen-driven service delivery and empowerment; transparent and efficient government with ultimate goal of a sustainable national economic, political and social transformation.

MDA means Ministries, Departments, Extra-Ministerial Departments and Agencies of Government at Federal, State and Area Council levels.

Government Enterprise Architecture is a Blueprint and Framework for efficiently re-architecting and aligning Nigerian Government's Processes, Information Technology, People and other enterprise driving factors for the purpose of achieving Government Digital Transformation Agenda.

A service is a well-defined function emanating from a set of processes provided by a government agency within its jurisdiction to stakeholders using Information and Communication Technology tools as a delivery medium.

Service-oriented architecture (SOA) references a set of principles and methodologies applied by software engineers to design and develop software in the form of interoperable services.

The Internet is the global system of interconnected computer networks that use the Internet protocol suite (TCP/IP) to link devices worldwide

The web or **World Wide Web** is a global collection of documents and other resources from Internet servers that support specially formatted documents and linked resources by hyperlinks and Uniform Resource Identifiers (URIs).

Extensible Markup Language (XML) is a universal markup language format that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable (i.e. representation and transfer of structured data on the web or between different applications)

A web service is any piece of software that makes itself available over the internet, uses a standardised XML messaging system and describes a standardized way of integrating Web-based applications using the XML, SOAP or REST, WSDL and UDDI open standards over an Internet protocol backbone.

An Application Programming Interface (API) is a programmatic and standardised interface consisting of one or more publicly exposed endpoints to a defined request–response message system, typically expressed in JSON or XML, which is exposed via the web—most commonly by means of an HTTP-based web serve.

Simple Object Access Protocol (SOAP) is a messaging protocol specification based on XML for exchanging structured information in the implementation of web services in computer networks

REpresentational State Transfer (REST) is an architectural style for developing web services or design pattern for APIs based on several web and internet standards.

The Open Group Architecture Framework (**TOGAF**) is a framework for enterprise architecture that provides an approach for designing, planning, implementing, and governing an enterprise information technology architecture.

A.2 Interoperability Benefits

It is expected that using the Ne-GIF will:

1. Increase efficiency, flexibility and the value of existing investments in e-Government/IT systems;
2. Promote seamless exchange of data between Ministries, Departments, and Agencies (MDAs);
3. Encourage transparent view in common government processes;
4. Promote shared e-Government/IT infrastructure, applications and services;
5. Ensure technology discipline in IT deployment by MDAs;
6. Ensure integrity and security of shared data and processes;
7. Promote competition among IT suppliers and encourage provision of innovative e-services by MDAs; and
8. Minimize the cost of e-Government/IT investments and prevent vendor lock-in.

A.3 Practical Examples

Procurement Process as an example of Cross-Portfolio Service

The scenario considered in this example is that of a procurement process for IT projects in which bidders are expected to submit the under listed documents to the procurement Units/Departments of MDAs as part of the requirement:

1. Certificate of incorporation with CAC
2. Proof of filing of CAC annual returns (where applicable)
3. Tax Clearance from FIRS
4. Proof of Registration by NITDA
5. Bureau of Public Procurement (BPP) Contractor registration
6. Nigeria Social Insurance Trust Fund (NSITF) Certificate
7. Industrial Training Fund (ITF) Certificate
8. Value Added Tax (VAT) Registration
9. PENCOM Certificate.

In order to comply with the above requirement, bidders spend time and resources moving from one MDA to the other to acquire the required documents in preparation for the bid.
Similarly, the procurement units/departments of MDAs follow similar cumbersome process to ascertain the veracity and authenticity of the above documents submitted by bidders'.

With proper implementation of Ne-GIF by concerned MDAs, procurement in Nigeria will be more efficient as time and cost spent by both bidders and government to obtain and verify the required documents respectively will be reduced to the barest minimum through an integrated platform. Similarly, it will help reduce the volume of paper work associated with the procurement process and eliminate cost of storage of hard copies submitted by bidders which needs to be kept safe by the procuring organization for a certain minimum duration of time. Bidders would only need to quote their various certificate numbers while MDAs verify their claims with the click of a button.

The goal of the Ne-GIF is to ensure that services that require two or more MDAs' business processes are delivered seamlessly and at an affordable cost, using ICT.

A.4 Open Standards Organization

The following are essentially identified as organizations that proffer open standards that ensure interoperability.

1. The Internet Engineering Task Force (IETF);
2. Object Management Group (OMG);
3. World Wide Web Consortium (W3C);
4. The Open Group;
5. Organization for the Advancement of Structured Information Standards (OASIS); and
6. Institute for Electronic and Electrical Engineers (IEEE)

Government IT systems should be open; open to the people and MDAs that use public services and to any service provider. The ability of MDAs to freely connect and communicate with one another through information technology is an indispensable tool for public administration modernisation and effective public service delivery around the world.

Prevalent interoperability across varying government information systems can only be achieved through reliance upon standard technology interfaces that establish clear rules for communicating and understanding of shared and exchanged information. Information/data shared appropriately across MDAs without loss of integrity, reduces the need to hold duplicate data and supports efficient service delivery.

Standard Technology Interface and Rules for Communicating

Opportunities for exploiting information significantly increase when it is made available in standardised, structured and linkable formats. ICT standardisation and interoperability are preconditions for the uptake of digital innovations. In modern ICT, the service value of a device relies on the ability to communicate with other devices.

Standardisation is the process by which specifications are set while specifications ensure that products made by different manufacturers are able to interoperate, and users are offered the chance to pick and mix products or services of different suppliers.

The exchange of information between two or more government organizations would be easier and seamless if each application is developed using web and internet technologies where information/services are exchanged/consumed through standard APIs.

Web and internet technologies are developed based on Open Standards. Realistically, most e-services should be built on web and internet technologies because of their ability to present and ensure exchange of data in a standardized and meaningful way to disparate IT infrastructure/applications. For instance, XML and JSON are languages/notation for presenting data in a standard, structured and application-specific format. In principle, data expressed in XML or JSON is portable between applications since it is self-describing and any operation on a resource can be invoked using one of the GET or POST methods. In essence, they provide programmatic interoperation and access to data on the web.

In addition, web and internet based technologies such as web services, Application programming Interface (API), Service-Oriented Architecture (SOA) etc., provide

means of meaningfully and programmatically exposing data to applications as well as consuming data for efficient e-services delivery.

A.5 Advantage of Open Standard

Implementing Open Standards principles across MDAs for E-Government/IT ensure MDAs support the delivery of:

1. An efficient and interoperable ICT environment;
2. A level playing field for open source and proprietary software providers competing for government IT contracts;
3. Improved flexibility and ability for government to collaborate with businesses, Non-governmental organizations to deliver effective public service to the citizens; and
4. A more sustainable cost in MDAs IT projects

A.6 Metadata

Metadata is a set of data that describes and gives information about other data. Metadata is information about web resources such as data and it is structured in a manner that facilitates understanding of meaning, discovery and retrieval of resources (data) on the World Wide Web etc.

A.7 Metadata Standards

Defining a common Metadata Standard will help citizens and businesses find government information and resources more easily. Metadata standards have been developed to support both machine interoperability (information exchange) and web resource discovery by human users of the Web and applications. It would greatly help at the service and application layer when information is combined and exchanged between different applications to deliver public service.

Table 1.0 describes open metadata standards for specific focus areas.

Name	Focus	Description	URL
e-GMS (UK Government)	Government	The e-Government Metadata Standard (E-GMS) defines the metadata elements for information resources to ensure maximum consistency of metadata across public sector organizations	http://www.govtalk.gov.uk:80/schemasstandards/draftschema.asp Visited last: 28 February, 2018) OR

			http://www.govtalk.gov.uk:80/rfc/default.asp Last Visited: 28 February, 2018)
Dublin Core	Networked resources	Dublin Core - interoperable online metadata standard focused on networked resources.	http://dublincore.org/ Last Visited: 28 February, 2018)
ISO/IEC 19506	Software Systems	ISO/IEC 19506 Standard called Knowledge Discovery Metamodel is an ontology for describing software systems. The standard provides both a detailed ontology and common data format for representing granular software objects and their relationships enabling the extractions such as data flows, control flows, call maps, architecture, database schemas, business rules/terms and the derivation of business processes. Used primarily for legacy and existing systems security, compliance and modernization	https://www.iso.org/standard/32625.html Last Visited: 28 February, 2018)

ISO 19115	Geographic data	The ISO 19115:2003 Geographic information. Metadata standard defines how to describe geographical information and associated services, including contents, spatial-temporal purchases, data quality, access and rights to use. It is maintained by the ISO/TC 211 committee.	https://www.iso.org/standard/53798.html Last Visited: 28 February, 2018)
RDF (W3C)	Web resources	General method for conceptual description or modeling of information that is implemented in web resources, using a variety of syntax formats.	https://www.w3.org/2001/sw/wiki/RDF OR https://www.w3.org/DesignIssues/Metadata Last Visited: 28 February, 2018)
ISO/IEC 11179	Organizations	ISO/IEC 11179 Standard that describes the metadata and activities needed to manage data elements in a registry to create a common understanding of data across organizational elements and between organizations.	https://www.iso.org/standard/35346.html Last Visited: 28 February, 2018)
NITDA	Data Structure and	Data Interoperability Standards	http://nitda.gov.ng/wp-content/uploads/2018/05/data-

	Standardization		interoperability-standards.pdf

The **WSMO** has four main components:

Goals- The MDAs customers' objectives when consulting a Web Service.
Ontologies- A Formal Semantic description of the information used by all other components.
Mediators- Connectors between components with mediation facilities. Provides interoperability between different ontologies.
Web Services- Semantic description of Web Services. It may include functional (Capability) and usage (Interface) descriptions;

A.8 e-Services Channel

1. ***Common Service Center*:** These are designated ICT centers or channels where common government services can be provided. It is a suitable service delivery model for the educational sector and rural dwellers**.**

2. ***Website/Portal***: This is online channel for providing informational and transactional e-services to the public. Web portals present an effective way to integrate applications, people, and businesses by two or more MDAs to offer a unique point of access to services for users.

3. ***Mobile Platform***: Integrated service delivery through mobile platforms in Nigeria is very efficient in terms of coverage, convenience, affordability and accessibility. To ensure interoperability, the choice of open standard approach is critical. For instance, the choice of open standard approach for mobile apps development will allow MDAs provide (a) **unique user experience** (b) **versatile support and integration** that allows mobile apps to be built and deployed to any channel and (c) **agility and innovation** through efficient government-wide mobility.

4. ***Government Contact/Call Center***: Delivery of integrated service through call centers can be a feasible model in Nigerian context. They are centers where government customers can make direct calls to request for services and information. However, the centers must be built on standards to ensure interoperability of systems between the centers and customers' choice of devices hardware and operating systems.

A.9 Service-Oriented Architecture, Web Services and Application Programming Language

The concept of SOA and web service is a major enabling technology for the provision of an integrated service. They enable two or more entirely different or similar applications from same or separate platforms to communicate with one another over the web. By this, interoperability of cooperating IT applications from two or more MDAs to provide integrated service is feasible.

SOA is a solution for making two software/applications communicate with each other to exchange information. **Web Service** is the implementation of **Service Oriented Architecture** (SOA). In web service and SOA concepts, services are exposed through **Application Programming Interfaces (APIs).** API helps to achieve seamless connectivity. An API opens up an interface through which application of an Agency A can connect to application of an Agency B or more to exchange information/data for the purpose of providing a service.

There are two methods of implementing Web Services: Simple Object Access Protocol (SOAP) and Representational State Transfer (REST). The concepts of **SOA, Web Services and API** are explained through the following diagram.

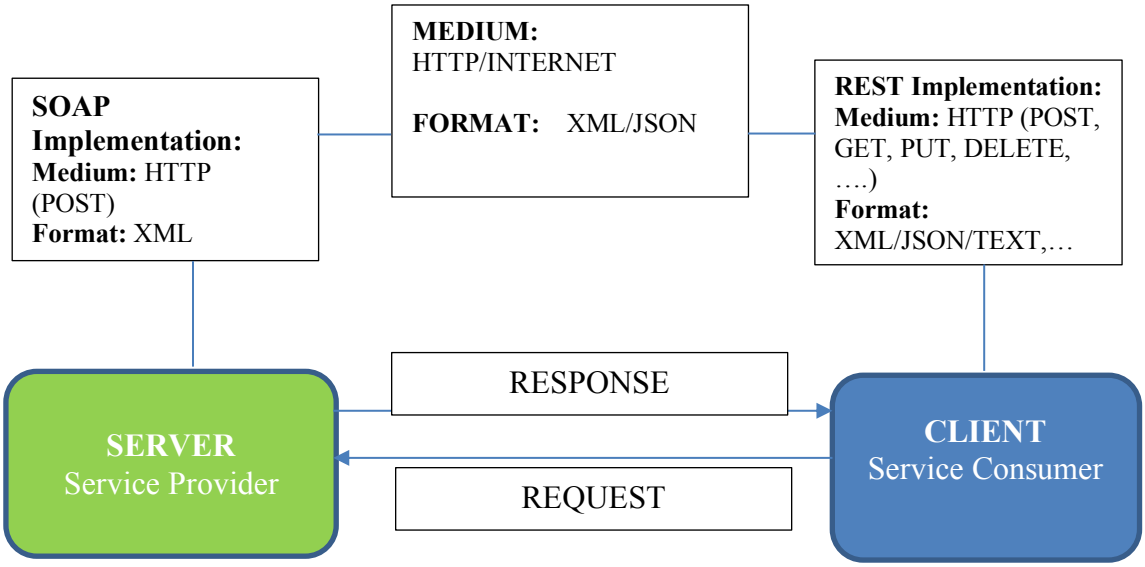

Figure 6.0: SOA concepts

Two major software enable the implementation of web service. They are **service provider** and **service consumer**. A web service provider develops/implements the application (web service) and makes it available over the internet (web) through an

API while a web service consumer uses/consumes web service provided by the service provider through the same API.

A web service provider publishes and communicates service description in a directory using **Web Service Description Language (WSDL).** The consumer queries the directory to locate a service and find out **how** to communicate with the provider. For online services, where service provider and service consumer do not know each other, web service provider (through WSDL) publishes its services in an online directory called **Universal Description, Discovery and Integration (UDDI)**

Messages are sent and received from the directory using SOAP or REST methods. Service provider and consumer talk to the directory for service and service description respectively using either SOAP or REST.

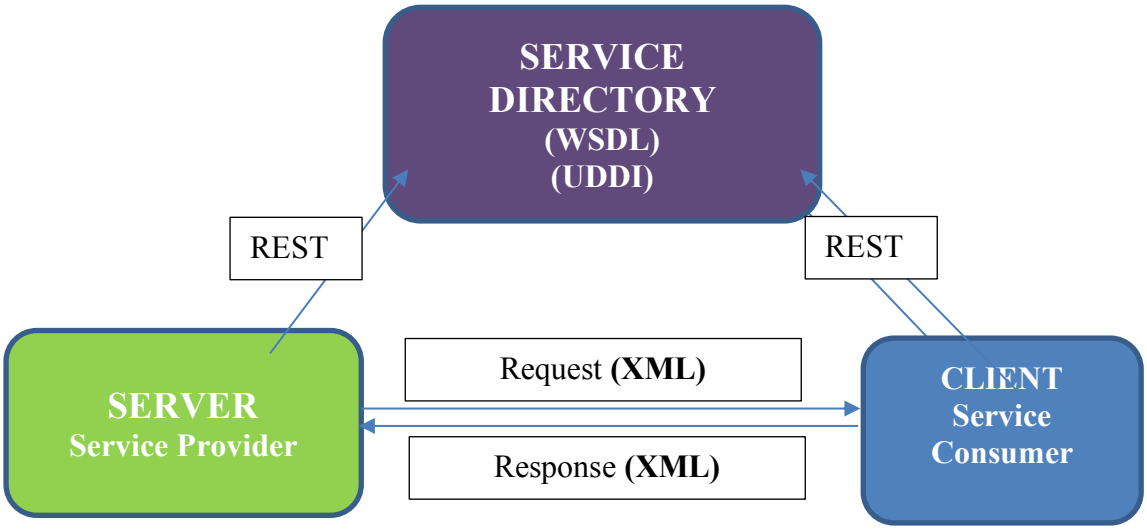

Figure 7.0: Web Services Implementation

Message communication (request and response) between service consumer and provider is carried out in XML. XML format makes the interface technology/implementation independent.

Table 2.0: Middleware Services

S/N	Services	Description	Situation/ Example	Technology Method/ Standards
1	Enterprise Application Integration (EAI)	An integration framework composed of a collection of technologies and services which form a middleware or "middleware framework" to enable integration of processes, systems and applications across an enterprise.	For integrating of silo IT/e-Government software/applications across MDAs. (Where identical data are stored in different applications); vendor independence and Common facade	**Mediation** (Intra-communication)- acts as the go-between or broker between multiple applications and **Federation** (Inter-communication)- acts as the overarching facade across multiple applications.
2	Data Integration	Data integration involves combining data residing in different sources and providing users with a unified view of them.	Databases harmonization/merger between two or more MDAs	Creation of Mediated Schema (Virtual Database). This interfaces with source databases via wrappers/adapters

3	Message-Oriented Middleware (MOM)	MOM is software or hardware infrastructure supporting sending and receiving messages between distributed systems. It provides a layer that allows software components that have been developed independently and that run on different networked platforms to interact with one another.	For interaction/integration of MDAs software components (applications, servlets etc.) that have been developed independently and that run on different networked platforms to provide integrated services. It allows distributed applications to communicate and exchange data by sending and receiving messages	It is Publish/ Subscribe based messaging exchange system e.g. Advanced Message Queuing Protocol (AMQP), MQ Telemetry Transport (MQTT), Object Management Group's Data Distribution Service (DDS), eXtensible Messaging and Presence Protocol (XMPP) etc.
4	Object Request Broker (ORB)	ORB allows program calls to be made from one computer to another via a computer	For bridging MDAs heterogeneous IT systems/platforms. It can be used in an integrated	Common Object Request Broker Architecture (CORBA), Internet Communications Engine (ICE), etc.

		network, providing location transparency through **remote procedure calls**. It provides a framework which enables remote objects to be used over the network, in the same way as if they were local and part of the same process.	service provision where applications and services installed on MDA A's server can be run on MDA B's client	
5	Enterprise Service Bus (ESB)	ESB implements a communication system between mutually interacting software applications in a service-oriented architecture (SOA) based on client-server model.	To provide reusable of common or disparate IT-enabled public services by different MDAs	**Commercial:** IBM Websphere Message Broker Integration Bus, Window Azure Service Bus etc. **Open-Source:** Apache Camel, Fuse ESB, Open ESB etc.

Table 3.0. General Standards for interoperability

Standard	Purpose/Description	URL
XML	XML is a software- and hardware-independent tool for storing and transporting data. The XML standard is a flexible way to create information formats and electronically share structured data via the public Internet, as well as via corporate networks.	https://www.w3schools.com/xml/default.asp
XSD	**XML Schema or** XML **schema** definition (**XSD)** defines the element in an XML document. It can be used to verify if the elements in the xml document adheres to the description in which the content is to be placed.	https://www.w3schools.com/xml/schema_intro.asp
WSDL	Web Service Description Language (WSDL) is specific type of XML document which describes the **web service**. It is an XML language for describing Web services. WSDL itself adheres to a **XSD**	https://www.w3.org/TR/2007/REC-wsdl20-20070626/
SA-WSDL	AWSDL defines a set of extension attributes for the Web Services Description Language (WSDL) and XML Schema definition language. Application	https://www.w3.org/TR/sawsdl/

	of the attributes shall allow for description of additional semantics of WSDL components	
RDF	RDF is a standard model for data interchange on the Web. RDF has features that facilitate data merging even if the underlying schemas differ, and it specifically supports the evolution of schemas over time without requiring all the data consumers to be changed. It allows structured and semi-structured data to be mixed, exposed, and shared across different applications.	https://www.w3.org/RDF/
OWL	The W3C Web Ontology Language (OWL) is a Semantic Web language designed to represent rich and complex knowledge about things, groups of things, and relations between things.	https://www.w3.org/OWL/
UML	Unified Modeling Language (UML), is a standardized modeling language consisting of an integrated set of diagrams, developed to help system and software developers for specifying, visualizing, constructing, and documenting the artifacts of software systems,	http://www.uml.org/what-is-uml.htm

	as well as for business modeling and other non-software systems. It was developed to forge a common visual language in the complex world of software development that would also be understandable for business users and anyone who wants to understand a system.	
XMI	Metadata Interchange (XMI) is an Object Management Group (OMG) standard for exchanging metadata information via Extensible Markup Language (XML). Specifically, XMI is intended to help programmers using the Unified Modeling Language (UML) with different languages and development tools to exchange their data models with each other. In addition, XMI can also be used to exchange information about data warehouses.	https://www.omg.org/spec/XMI/About-XMI/

A.10 Sub-Principles of Ne-GIF

Sub Principles of Ne-GIF

The following 10 sub-principles of the core underlying principles of Ne-GIF:

1. ***Openness****:* Openness is based on the use of open standards. It also entails the use of standard protocols and interface. The openness of e-Government/IT systems can be determined primarily by the degree to which new resource-sharing services can be added and be made available

for use by a variety of client programs without compromising service delivery.

2. ***Portability****:* Ability of an application developed for an e-Government System A to be executed, without modification, on a different e-Government System B that implements the same interfaces.
3. ***Transparency***: Provision of effective and consistent services by bringing together resources, processes and data that currently exists across multiple silos.
4. ***Flexibility:*** Refers to ability of information systems to adapt to current situation and needs without compromising the overall objective of interoperability. In that, it makes it easy to configure the system out of different components (possibly from different developers) and add new components or replace existing ones without affecting those components that stay in place.
5. ***Accessibility*****:** Ensures e-Government/IT resources of one Agency are reachable and useable in a secure manner by other permitted government Agencies for the purpose of public service delivery.
6. ***Reusability****:* Indicates ability of e-Government resources (e.g. Software Components, Application Programming Interfaces, Standards etc.) and common processes to be reused across MDAs.
7. ***Security*****:** Ensures reliable exchange of information between e-Government/IT systems in conformity with established Government security standards and policies.
8. ***Privacy****:* Ensures government information systems guarantee the confidentiality of information of government, businesses and citizens as stated in the appropriate data protection and privacy policies or guidelines.
9. ***Scalability***: The ability of government information systems to handle a growing amount of work in a capable manner or its capability to increase its total output under an increased load, when resources (typically hardware) are added.
10. ***Heterogeneity:*** Refers to ability of e-Government/IT systems to interoperate effectively irrespective of various types of network devices and networks, computer hardware, operating systems, programming languages and implementation by different developers.