

EXPLOITING THE FULL POTENTIAL OF INFORMATION SYSTEMS INTEROPERABILITY IN PUBLIC INSTITUTIONS: A CASE OF TANZANIA

Respickius Casmir, Senior Lecturer, Department of Mathematics and ICT, College of Business Education, Bibi Titi Mohammed Road, P. O. Box 1968, Dar es Salaam, Tanzania, Tel: +255-22-2150177, Mobile: +255 784 613198, Fax: +255-22-2150122, E-mail: rescasmir@gmail.com

ABSTRACT

Information is undoubtedly one of the most valuable resources for any progressive organisation around the world. In that case both inter- and intra-information sharing is key to the success and growth of social and economic development. Meanwhile, public organizations usually have mixed or what is sometimes referred to as heterogeneous computing environments through which information is processed. However, there are essential elements that need to be taken into account to optimally harness the full potential of information systems interoperability. These include infrastructure, methods, models, and approaches in a complex yet achievable manner. This paper attempts to explicitly unveil the untapped opportunity emanating from systems interoperability and recommending means and ways to achieve systems interoperability.

KEYWORDS: *Information Resources, Systems Interoperability, and Standards*

INTRODUCTION

Nearly all sorts of decisions made by individuals, groups of people, institutions, countries, and even by the World's decision making bodies entirely depend on information at their disposal. Tipathi (2015) argues that "the information is used as a raw material for decision making" adding that "the success of an organisation largely depends of the quality of the information it generates". Information is the only thing that helps us to better understand the past, effectively manage the present and predict the future with the highest degree of certainty. For the purpose of this paper, information is defined as known fact with explicit meaning. Meanwhile the real value of information cannot be visible if the information in question is not accessible, reliable, relevant and consistent (DCSF, 2008). Reliability of information in this context includes its security. According to Morgan and Waring (2004) data or information is considered reliable if and only if it is *Complete, Accurate and Unaltered*. The latter implies integrity which is a fundamental element of information security goals.

The Need for Systems Interoperability in Tanzania

Countries and organisations around the World are increasingly acquiring, implementing and deploying IT based information systems to facilitate their core and support functions. Tanzania is no exception. Presently Ministries, Departments and Agencies in Tanzania have acquired, implemented and deployed various mission critical information systems to support government operations in delivery of essential services to citizens. Notably are the following:

i) Biometric Voters Register (BVR) at the National Electoral Commission (NEC);

- ii) Passport Management System at the Immigration Services Department (MOHA);
- iii) Tax Identification Number (TIN) at Tanzania Revenue Authority (TRA)
- iv) Driving License Management System at Tanzania Revenue Authority (TRA)
- v) Births and Deaths Registration System at Registration, Insolvency and Trusteeship Agency (RITA)
- vi) National Identity Management System at National Identification Authority (NIDA)

In each of these information systems the same individual provides personal particulars six times independently. In such scenario chances are quite high that inconsistency, duplications, and errors of omission are likely to occur intentionally or inadvertently. In either case wrong decisions are likely to be made based on misinformation from one or more of these systems since they are operating independently and gets inputs from different sources at different time. This calls for development and implementation of a comprehensive framework for achieving interoperability at both the data and schema levels. The proposed systems interoperability framework could be achieved by creating a common interface through which data may be exchanged where each individual has a unique identifier. Meanwhile, apparently plenty of time is spent on searching for and aggregating data from multiple sources to facilitate decision making on a given scenario. Such a time would have otherwise used on other developmental aspects. In addition, other critical resources are unnecessarily incurred in the process including financial and human resources.

Consequently, the majority of respondents from the survey accentuated that information is mostly useful when shared. Furthermore, organizations usually have mixed or what is sometimes referred to as heterogeneous computing environments in terms of hardware, operating systems, software applications, active and passive network devices, servers, database management systems, and communication protocols.

This research was, therefore, carried out to examine how best can public institutions in the country leverage systems interoperability to enhance efficiency and consistency in the service delivery.

The Problem Statement

Today's business environment is characterised by the use of Information and Communication Technology (ICT) based systems and infrastructure. Inter- and intra-communications is needed presently than ever. Information sharing and information exchange is commonplace. Various decisions that affect human, economic, political and personal lives are made based on the information available. The key issue in the entire process of information sharing is timely availability of credible information to support decision making. Information are mostly generated, processed and stored in silos. As a result there are a lot of inconsistency, duplications, errors, and sometimes lack of reliable information to facilitate informed decision making at different levels. This adversely affects the planning aspects because the information at hand does not suffice the needs because, in most cases, they do not reflect the reality on the ground. Based on NHS (URT, 2015) Interoperability Handbook, the issue here is not that information does not exist but that is not readily available when required for decision making because it is not interlinked. This study attempts to look into systems interoperability aspects as a way to overcome the above-mentioned problems of information sharing or information exchange amongst

various entities to facilitate informed decision making, especially, within and amongst the Government Ministries, Departments and Agencies (MDAs).

Motivation for Conducting this Study

Prior to conducting this study, the author encountered several scenarios or incidents that triggered the curiosity to undertake this study. Initially, the author was compelled to queue for nearly six hours in order to register for the National Identity Card issued by the National Identification Authority (NIDA). Later on, the author found himself stuck in a long queue for registering in the Biometric Voter Registration System (BVR) which is administered by the National Electoral Commission (NEC). The other day, went through a similar situation queuing for several hours in quest for getting issued with the Passport at the Immigration Department under the Ministry of Home Affairs. Similarly, the author queued for a considerable length of time at Tanzania Revenue Authority (TRA) for a driver's license. In all aforementioned cases one is compelled to provide similar credentials including personal particulars such as full name, date and place of birth, residential address, and biometric fingerprints.

Personal particulars for a given individual remains the same if well captured from authentic source and well preserved no matter which entity collected the data. Data collected by different entities from one and the same individual might result into data inconsistency and data duplication. In the meantime, decisions that are made based on inconsistent data are likely to be skewed and subjective. Consequently, it is somewhat costly to maintain multiple information systems if they are not interlinked because each system has to be updated independently with the same data. Whereas when systems are interoperable updates are effected into one system and are replicated into the rest of the systems. It is against this background that the author initiated an inquiry to establish what it takes to make related information systems interoperable USFG (2007).

LITERATURE REVIEW

In literature, several scholars attempt to define and describe the term in many different ways. For instance, BusinessDictionary.com (2015) describes Interoperability as the ability of a computer system to run application programs from different vendors, and to interact with other computers across local or wide-area networks regardless of their physical architecture and operating systems. Interoperability is feasible through hardware and software components that conform to open standards such as those used for Internet (West, 2003). By cross-examining this definition, one may simply infer that interoperability refers to both software and hardware. Much as this paper focuses more on presenting and critically discussing interoperability from the information systems perspective, it also concisely highlight on hardware devices interoperability. The underlying reason for discussing hardware devices interoperability at this point is that information systems and software applications greatly depend on the hardware to perform their intended functions.

An operating system, for example, cannot run on its own in the absence of computer hardware such as Read Only Memory (ROM), Random Access Memory (RAM), Hard Disk Drive (HDD), Central Processing Unit (CPU) and all other hardware parts of a computer system. Furthermore, data and information traverse from one point to another via a computer network which is made up of many different hardware components including cables, connectors, routers, bridges, switches, hubs, servers,

storage devices, and repeaters. All the aforementioned hardware components of a computer and that of computer networks are never manufactured by the same manufacturer. However, for a computer to function properly all hardware therein have to co-exist and work together in a collaborative manner. This is though not that simple unless they are all manufactured based on the internationally recognized standards. Both software developers and hardware manufactures need and have to conform to standards at all times (West, 2006). Standards are there to make hardware products and software more usable.

On the other hand, Healthcare Information and Management Systems Society (HIMISS, 2013) delineates interoperability as the ability of different information technology systems and software applications to communicate, exchange data, and use the information that has been exchanged. Adding that, interoperability means the ability of information systems to work together within and across organizational boundaries in order to enhance effective delivery of services in question. According to HIMISS (2013) there are three levels of information systems interoperability namely Foundational, Structural and Semantic as described hereunder. Foundational interoperability allows data exchange from one information system to be received by another and does not require the ability for the receiving information technology system to interpret the data.

Structural interoperability refers to an intermediate level that defines the structure or format of data exchange (i.e., the message format standards) where there is uniform movement of data from one system to another and meaning of the data is preserved and unaltered (Cargill, 1989). Structural interoperability defines the syntax of the data exchange. It ensures that data exchanges between information technology systems can be interpreted at the data field level.

Semantic interoperability provides interoperability at the highest level, which is the ability of two or more systems or elements to exchange information and to use the information that has been exchanged. Semantic interoperability takes advantage of both the structuring of the data exchange and the codification of the data including vocabulary so that the receiving information systems can interpret the data.

A real life example of systems interoperability is the interoperability between the National Examinations Management Systems at the National Examination Council of Tanzania (NECTA) and the Central Admission System (CAS) at the Tanzania Commission for Universities (TCU). Applicants to higher learning institutions in Tanzania do not need to present their academic results for Ordinary and Advanced Secondary levels to the CAS system. All they do is to specify their index numbers for both Ordinary and Advanced level after which CAS system invokes NECTA system to retrieve examination results for each applicant. This sort of systems interoperability helps in many different aspects including getting authentic examination results for each applicant, avoiding errors emanating from data entry and getting rid of forgeries and all sorts of malicious nature on examination results.

Theoretical Framework

Systems Interoperability Concept in Nutshell

Seamless exchange of information from multiple systems is the fundamental catalyst behind the ever-increasing demand for systems interoperability. Practically, information required for decision making originate from heterogeneous systems that are not necessarily located in vicinity neither created by the same developer or manufacturer, hence the need for systems interoperability. System interoperability involves several components including hardware, software, communication protocols, and network infrastructure.

Hardware Standard and Software Standards

One cannot talk of systems and devices interoperability without hardware and software standards. Cargill (1997) and Cabinet office (2014) stress that software standards enable software to interoperate. To this end, Apter, Giannini, and Sunderman (2008) describe four different ways through which that a standard can be developed namely De Facto, Ad hoc, Mandated and Consensus standards as indicated in Figure 1. The first three types of are usually created in somewhat a similar way whereas consensus standards are created a bit differently.

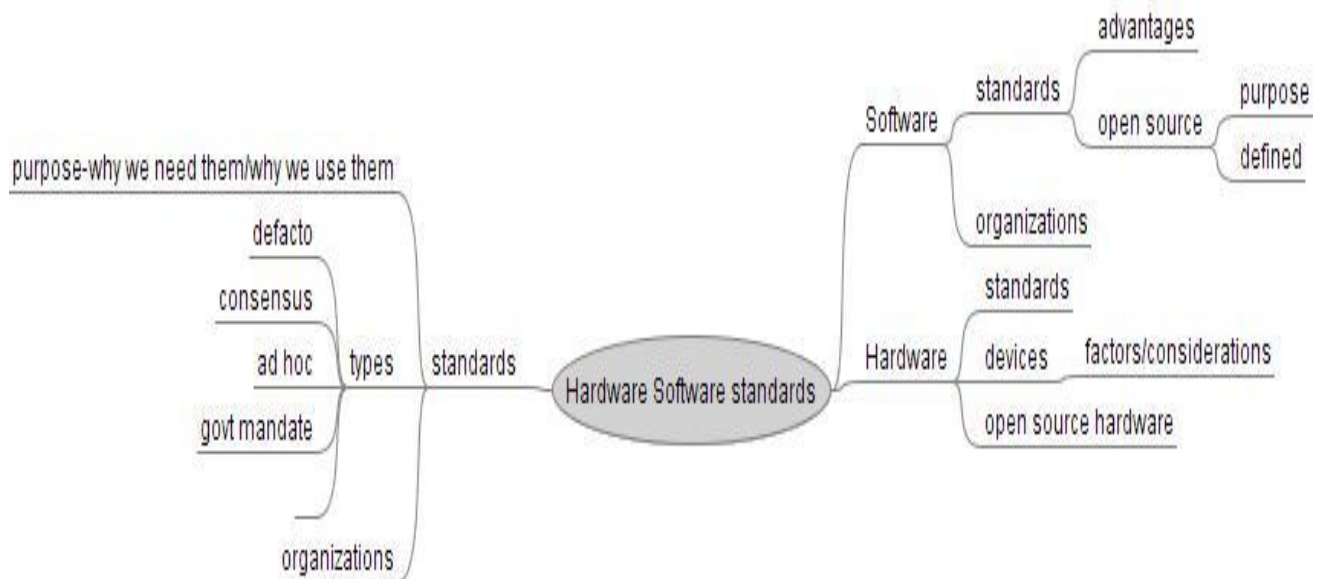


Figure 1: Hardware and Software Standards [Source: Apter, J, Giannini, Rose, and Sunderman, C. (2008)]

According to Apter, Giannini, and Sunderman (2008) Ad hoc Standards are created by a group of interested people and organizations agree on a standard specification. It is informal and are mutually agreed on by the participating groups. De Facto Standards are created when a single vendor controls a large enough share of the market to make its product the market standard. An example of this type of standards is Microsoft. Government Mandate Standards emerge when a government agency creates a standard and legislates its use. Consensus Standard as the name suggests refers to a format, language, or protocol that has been approved by formalized committees that are open to participation by all interested parties and operate on a consensus basis. Generally speaking, standards make hardware products and software more usable and bring about interoperability.

There are several Organisations or bodies around the world that create and set standards for hardware and/or software products to ensure appropriate systems and devices interoperability. Krechmer (2005)

observes that Standards Organizations in the realm of computing include: International Standards Organization (ISO); International Telecommunication Union (ITU); Institute of Electrical and Electronic Engineers (IEEE); American National Standards Institute (ANSI); Video Electronics Standards Association (VESA); and World Wide Web Consortium (W3C) just to mention a few.

According to Simcoe (2006) standards are used to govern the interaction of products and components in a technological system. This means that, they are the shared language that information systems use to communicate with one another. Standards are particularly important when it comes to systems and devices interoperability in an environment where there are large numbers of interdependent information systems and computing devices.

In addition, Cabinet Office (2014) argues that by implementing the Open Standards Principles for software interoperability, data and documents formats, government bodies are supporting the delivery of:

- i) A level playing field for open source and proprietary software providers competing for Government IT contract;
- ii) Improved flexibility and ability for government to cooperate with other bodies, citizens and businesses; and
- iii) More sustainable cost in government IT projects

Advantages of Systems Interoperability

As public and private organisations continue to depend more and more on computing systems, the need for information systems interoperability becomes more vivid. There are numerous advantages of systems interoperability (NACFAM, 2001) such as reducing operational costs and complexity, enabling best-of-breed systems deployment and leveraging existing investment. TechNet (2015) further describes the advantages of systems interoperability as follows.

Reducing operational costs and complexity: Organisations around the world continue to work in mixed computing environments presently and for the foreseeable future. The ability for the relevant systems to work together greatly reduces the cost of building and supporting a heterogeneous infrastructure. Furthermore, homogeneity offers substantial benefits in reducing the operational cost and complexity of an organisation's infrastructure.

Enabling best-of-breed systems deployment: Users may have business requirements that can only be delivered with specific applications or platforms. For example, different Operating Systems such as Apple Macintosh, Windows, and Linux provide a rich platform to either build solutions or buy commercial "off-the-shelf" application packages. This best-of-breed environment meets the requirements for rapidly deploying solutions hence interoperability aspects. However, it is clear that each Operating System needs to work with the other environments in use in the organization; otherwise, the potential benefits of the new solution would be reduced. So interoperability is a key requirement that can help ensure users meet their demanding business needs.

Leveraging existing investment: Organisations have a large and diverse range of systems installed in their environments. The move to new platforms needs to be gradual and evolutionary. Interoperability between new environments such as business-specific applications and existing systems is critical to the success of the platform in question in the organisation. Another key trend is the requirement to “Web enable” existing applications, allowing access to the key systems on host environments from the intranet or Internet. This Web enabling effectively extends the functionality of existing applications and protects the investments that organizations have made.

Interoperability Challenges

Interoperability is, perhaps, the most critical issue facing organisations and businesses that need to access information from multiple yet heterogeneous information systems information systems (Park and Ram, 2004). However, it is unlikely that many organisations have the ability to create a totally homogeneous environment. To achieve the desired level of interoperability certain key elements and/or conditions must be met as illustrated in Figure 2. First and foremost, there must be a clear need or simply purpose for linking the systems or applications in question. Secondly, there must be willingness amongst the key stakeholders including systems owners, systems managers and systems users at large. Thirdly, there must be underlying standards for systems compatibility that will enable the systems to be interoperable. Fourthly, there must be appropriate technical infrastructure to support the interoperability. Last but not least, there must be adequate technical know-how amongst IT professionals.

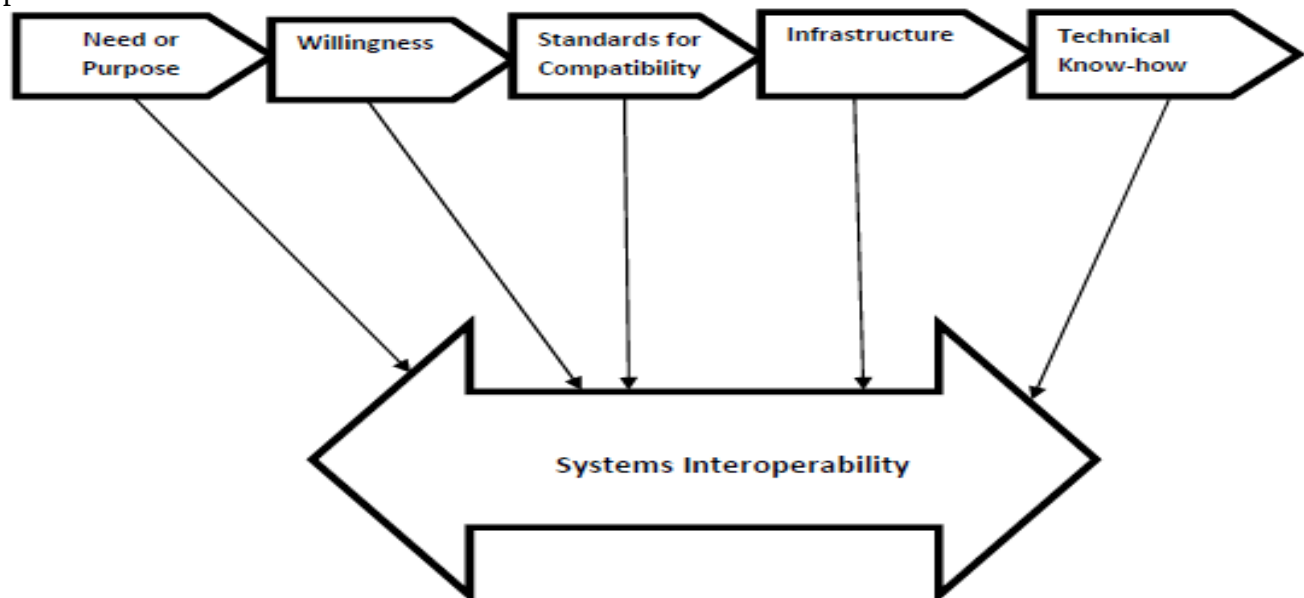


Figure 2: Requirements for Systems Interoperability [source: Author's own]

Each of the elements in Figure 2 is vital if two or more systems are to be interoperable. This means that absence of one or more of any of the above elements will adversely affect the entire process for systems interoperability. It was reveal that (NACFAM, 2001) it is more costly, inefficient, and time consuming to implement, deploy and maintain multiple yet related systems independently than running the systems in an interoperable mode.

RESEARCH METHODOLOGY

This research employed several research methods all of which were aiming at collecting relevant data for the purpose at hand. Research methods used include face-to-face interviews with mostly IT professionals that are working with various organisations, experts, consultants, and users at large within Dar es Salaam. Under this method a total of 35 people were interviewed to get their views on systems interoperability as a concept, advantages and importance of systems interoperability, desired extent of systems interoperability especially in Tanzania, and challenges facing systems interoperability locally and internationally.

The second research method employed was email survey using unstructured questionnaire in which questions similar to those posed in the face to face interview were distributed to 50 individuals via email. In this method only 39 respondent returned questionnaires duly filled. The third research method used for data collection was desk research whereby a number of relevant publications including (NHS, 2015; HIMISS, 2013) were consulted in relation to this research work to complement inputs from the other two methods used. Data collected from the first two methods that is interview and questionnaires were primary data type whereas secondary data were collected from the selected literature. The last method used was personal observation which is part of action research. According to Kawulich (2005) and Marshall & Rossman (1995) observation methods are useful to researchers in a variety of ways. The author, being part of the society in which the study was conducted, took liberty to observe the state of affairs for nearly two years after which come out with some of the findings stated under the motivation section of this article.

FINDINGS

It came out clearly from all 35 respondents that all critical public information systems are not interoperable in the real sense of the term as indicated in Table 1.

Table 1: Interoperability Status for Key Public Information Systems

Info. System Name	TRA-TIN	TRA-Drivers' License	TCU-CAS	TZ-Passport System	NEC-BVR	NIDA-ID System	RITA Certificate Sys.	Lawson HR&Payroll
TRA-TIN		Interoperable	No Int.	No Int.	No Int.	No Int.	No Int.	No Int.
TRA-Drivers' License	No Int.	Interoperable	No Int.	No Int.	No Int.	No Int.	No Int.	No Int.
TCU-CAS	No Int.	No Int.	Interoperable	No Int.	No Int.	No Int.	No Int.	No Int.
TZ-Passport System	No Int.	No Int.	No Int.	Interoperable	No Int.	No Int.	No Int.	No Int.
NEC-BVR	No Int.	No Int.	No Int.	No Int.	Interoperable	No Int.	No Int.	No Int.
NIDA-ID	No Int.	No Int.	No Int.	No Int.	No Int.	Interoperable	No Int.	No Int.

System								
RITA Certificat e Sys.	No Int.	No Int.	No Int.	No Int.	No Int.	No Int.	Interoper able	No Int.
Lawson HR&Pay roll	No Int.	No Int.	No Int.	No Int.	No Int.	No Int.	No Int.	Interoper able

From Table 1, it is clear that nearly all key public institutions are not interoperable. In such a situation where there are silos of information that are independently collected, processed and stored; data inconsistency and duplication is inevitable. When prompted on what could be the root course of non-interoperability of the public information systems 96% of the respondents cited unwillingness amongst business process owners as the fundamental obstacle. Other major reasons mentioned by the respondents as hindrance for public systems interoperability include but not limited to inadequate supporting infrastructure such as network and electrical grid 74%; Non-adherence to hardware and software standards 88%; Inadequacy of technical know-how 60%; and Need for purpose 52%. Other minor reasons given include lack of national level policies and guidelines to support systems interoperability 31%; lack of political will for integrating key public information systems 24%; and lack of awareness on the importance of systems interoperability 43%. From this analysis it is evident that in order to harness the full potential of ICT and get the optimal value for money the government needs to it is design, implement and deploy a national level framework for systems interoperability. Such a framework will identify which information systems need to be interoperable with other relevant systems and for what purpose. Eventually, this will bring up the much needed data accessibility, reliability, consistency, accuracy, and timely availability for informed decisions making. The proposed national level systems interoperability framework should consider all mission-critical public information systems at large and should allow for systems scalability.

Information Generation, Storage and Processing

Nearly all 39 respondents consistently explicated that a multitude of information and data are ubiquitously generated from multiple sources on real time. Respondents argued that perhaps, information is the most widely generate item than anything else in the world. Information generated is of different types, formats, sizes, structures, from different sources, and in deferent forms. This necessitates the availability of a variety of information systems and devices for storing, processing and presenting the information in question. Informed decisions are always made based on availability of reliable information emanating from authentic sources.

CONCLUSION AND RECOMMENDATIONS

One needs not to overemphasize the importance and benefits of information sharing or exchange through systems interoperability. Meanwhile, it is important for decision and policy makers to note that systems interoperability comes at a considerable price, meaning that institutions that aim at implementing systems interoperability should set aside sufficient funds for the interoperability projects. Given the current setup in terms of mission critical systems deployment in Tanzania, it is imperative that a national level framework for systems interoperability be worked out and deployed

timely by the relevant Authorities. The proposed framework should provide a unified view of the underlying representational and reasoning formalism for the semantic mediation process within the systems. This framework will then be used as a basis for automating the detection and resolution of semantic conflicts among heterogeneous information sources. Development, deployment and institutionalization of such a national level framework for systems interoperability will serve many purposes including reducing systems maintenance costs; ensuring data consistency and accuracy; enhancing transparency in government operations; enhancing information security; facilitate planning and proper resource allocation; and more importantly it will facilitate decision making based on reliable data. It is, further, recommended that the recently established Information and Communication Commission (ICT Commission) under the Ministry of Work Communication and Transport (MWCT) should play a pivotal role in coordination all Government Ministries, Departments and Agencies (MDAs) that are hosting various mission-critical Information Systems to discuss on how best such systems can make use of each other to become interoperable. This will eventually not only help the Government to have reliable and consistent data upon which to make informed decision but also to significantly cut down the overall total cost of running ICT projects.

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