SINGLE WINDOW
ARCHITECTURE

PART VII
VOL 2
To build anything that is large, complex and multi-faceted requires a solid architecture. To build a Single Window environment, detailed architectural descriptions ranging from business architecture, data architecture, application architecture and technology architecture must be produced. In Single Window, a well-developed and comprehensive architecture will save money and protect investment.
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1. Introduction

In the context of Single Window, architecture is the process of aligning the strategic vision for trade facilitation and regulatory controls with information technology. The architect’s task is to breakdown this vision into its components in order to put together clear and coherent descriptions, definitions, maps and standards for data, business processes, and technology. The architect can provide the **big picture** of how the Single Window will function in order to meet the organization’s strategic goals while also producing the **detailed blueprint** for functional, trade-facing services.

1.1 About this Part

This Part explains the architectural contexts of the Single Window environment. It provides information on Single Window architecture to strategic planners, technology specialists and program managers. Those with a background in designing and executing large, enterprise-scale Information and Communication Technology (ICT) projects can also benefit from this material while preparing strategic plans for building Single Window solutions.

1.2 Relationship with Other Parts

This document is Part VII of Volume 2 the WCO Compendium on ‘Building a Single Window Environment’. The document builds on concepts of architecture described in the WCO Capacity Building Compendium 2010 and applies them to the Single Window environment. It refers to the practice of architecture in the field of information management and relates this practice with the challenges posed by the Single Window approach.

Architecture comprises architectural description. Architects of a Single Window environment would be concerned with different types of architectural descriptions such as **business architecture**, **information architecture**, **application architecture**, **security architecture** and **technology architecture**. There are different Parts in Volumes 1 and 2 of the Compendium dealing with this issue: Part III of Volume 1 provides the strategic options and value drivers in a Single Window environment. Part III, Volume 2 provides a catalogue of basic business processes in a Single Window environment. Part VI, Volume 1 deals with the principles of service design. Business architects will find these three parts are useful in developing the business architecture. Information and data architects will find Volume 2 Part III on Data Harmonization valuable as it provides the blueprints of information. This Part brings together different aspects of business, data and technology into a common theme with the goal of promoting architectural thinking.

2. Architecture & Single Window Environment

Part I, Volume I explains that Single Window could be viewed as a collection of services provided by regulatory agencies to the actors in international trade. Through its services, the Single Window operator manages value streams for the stakeholders by using its technology and organizational resources. To produce the services, people, processes, information and technology components will be developed. These components must be brought together under a coherent architecture.
Single Window architectural processes drives the overall planning, design and development of a Single Window. Some experts call architecture the ‘master plan’, which is an essential ingredient in Single Window development. It is also well-understood that architecture is prepared and signed-off very early in any software development project.

2.1 Why architecture?

A simple system such as an ‘employee payroll package’ can be built by a few individuals, requiring minimal efforts, using simple data structures and code using simple tools. Typically, such a package would be operated and maintained by an accountant. The package would use few set of spreadsheet and database tables – and provide appropriate payroll services to employees. Such systems are relatively easy to build using simple tools and can be maintained by a few individuals.

Building larger systems, however, requires teamwork. No sooner we start building larger and more complex systems, we would begin to begin to realize that such systems require:

a. **Models** that act as artefacts for communication within the team
b. **Process** to build the system from start to finish
c. **Skilled resources** following proven processes
d. **Planning** the work breakdown structures
e. **Powerful tools** to increase productivity

The Single Window environment comprises systems of enormous scale and complexity. It is also a ‘software intensive’ system. It is easy for the project managers to start the development of the Single Window with simple services. However, as the scale and scope of a system increases, the tasks become ever more complex. Project risks regarding costs, quality and time increase. Processes become ever more important to meet schedules. Stakeholder engagement and co-ordination amongst specialists in technology become vital tasks. To help navigate effectively through all these issues, experts see a vital role for architecture.

2.2 What is Architecture?

Architecture is commonly understood in terms of buildings in the real estate. The architect of a building produces several architectural artefacts. The building façade, structural blueprint, plumbing networks, electrical wiring and data cabling, staircase and elevators, safety sensors and building management systems. Each of these artefacts represent architecture but none of them alone is the architecture.

All large systems comprise several major components, and the way these components are related to each other defines the structure of the system. These components interact in some complex ways. Architecture defines these interactions. Architecture is not expressed through a single structure. It is not possible to produce one single structure and call it the architecture of the system. Essentially, architecture defines major system components. For example, the structural blueprint of a building is the major component defined by architecture. The rest of the architectural description is produced by defining the interaction between various components. In the context of an organization, it helps provide a shared sense of understanding of the whole enterprise.
Architecture is not easy to define. Problems in producing a self-contained definition led some experts to say that “architecture is what architects produce.” In fact, architects produce architectural descriptions, which are collection of documents loosely referred to as the architecture. IEEE 1471-2000 (ISO/IEC 42010:2007) provides a systematic approach to describing the architecture process, giving us the understanding of the issues involved. The following description uses the key words from this approach applied to the Single Window Context, which are highlighted below.

2.3 Single Window in Architectural Terms

In a Single Window environment, the stakeholders may operate large systems. The concerns of the stakeholders in a Single Window lie at the root of the architecture. These concerns help identify architectural descriptions. Part VI, volume 1 explains how rigorous descriptions of services can be developed through user stories or use cases. These descriptions are expressions of the stakeholder concern containing both functional and non-functional requirements. Functional requirements are reflections of the business logic and minimally impact architecture. What impacts architecture more profoundly are the non-functional requirements usually represented by words that end with ‘ity’ such as reliability, maintainability, security, availability, accessibility, usability, quality, navigability and so on. These ‘ities’ translate directly into architectural constructs.

Systems don’t exist in a vacuum; they inhabit in an environment. The Single Window environment comprises systems from Customs, Agriculture, Quarantine Services, Veterinary & Animal Health Services, and Food Safety & Inspection Services etc. These systems may have over the years invested in information technology projects, business processes and human resources. These investments would have been made in pursuit of organizational goals or missions of the respective organizations. Each stakeholder has his viewpoint. For example, return on investment is a viewpoint.

Each participating agency would have made investment that was justified based on the projected returns and the timeframe to recover value. Other stakeholders viewpoint could be could ease of integration between systems. Further, a viewpoint establishes the method for creating models. To serve the viewpoint of information flows, one could create the domain information models.

To appreciate various viewpoints, experts have developed different frameworks for ‘enterprise architecture’. These frameworks accommodate multiple views. A popular way of representing these multiple views is shown in the diagram below:
These four layers are common to all organizations participating in the Single Window project. It would be possible to describe their respective data, application, and technological architectures. In the same manner, it would also be useful to draw-up the layers of architecture for the Single Window system.

### 2.4 Enterprise Architecture

To summarize, *architecture* is documented using *architectural descriptions*, which comprise different *views* that are developed and aggregated through *models*. Multiple views of the same organization would not be useful unless they are strung together in a framework. The practice of ‘Enterprise Architecture’ and architectural frameworks integrates these disparate views. Three examples of approaches are listed below:

a. Experts have developed different methodologies to develop these views. For example IBM’s Rational Unified Process (called RUP 4+1) describes the software process as comprising the logical, process, development and physical views to describe different scenarios.
b. The US Department of Defense Architectural model (called DODAF) uses three views—these are (i) the operations view that identifies the activities that have to be performed and who performs them. (ii) The systems view defines the systems that fulfill the operational needs focusing also on information exchanges (iii) the technical standards view defines the applicable technical standards, notations and conventions. These three views are interdependent.

c. A more elaborate architecture framework is described in the Zachman Framework (www.eacoe.org) for describing the enterprise. It includes the Scope view, Owner’s view, Designer’s view Builder’s view, out of context (or Detailed View) and operational view. Each view is elaborated through a model, which is integral framework.

Enterprise Architecture has been defined variously by different authors definitions but this document uses the following definition: “Enterprise Architecture is the organising logic for business processes and IT infrastructure reflecting the integration and standardisation requirements of the firm’s operating model.” (Source: Massachusetts Institute of Technology (MIT): Centre for Information System Research)

These streams of developments culminated in the widely known framework of TOGAF (TOGAF stands for The Open Group Architecture Framework.) Under this framework, Enterprise Architecture is divided into three different architecture domains namely Business Architecture, Information Systems Architecture and Technology Architecture. The authors of the Single Window Implementation Framework (SWIF) (Hofman, Keretho, Phuaphanthong, Pikart, Tan, & van Stijn, 2010) adapted TOGAF for the planning and implementation of a Single Window. By applying the TOGAF enterprise architecture methodology the Single Window Implementation Framework helps produce the strategic architecture and masterplan.

*Figure 1 TOGAF framework [Courtesy The Open Group]*
2.5 Single Window in Japan – An Evolving Architecture.

The following is an example of how an architectural masterplan evolved over a period of time. In its lifetime, the Japanese system of Cargo clearance has morphed itself into a Single Window. The above diagram shows how the architecture of Japan’s Single Window was developed. NACCS or “Nippon Automated Cargo Clearance System” is an integrated national Single Window system, but two decades ago it started as a modest air cargo clearance system. It gradually grew to cover all modes of transport (Air & Sea NACCS). Initially, it was a central computer with direct data connectivity to all users in the government and the private sector. Subsequently, it introduced comprehensive EDI interfaces and web interfaces. Thereafter it took steps to integrate through data interchange with FAINS (Food sanitation), ANIPAS & PQ-Network (Animal & Plant Quarantine) and JETRAS. This resulted in the emergence of a "one stop service" or a virtual Single Window system. It is a comprehensive trade information platform which was developed jointly by the participating government agencies.

The above figure shows how the Japanese system integration was being planned. It was based on an architectural vision of seamless port clearance and cargo clearance. The progression of the architectural vision is shown in a time horizon in which the yearly progression of systems into a Single Window service is achieved progressively. Without architectural vision, it would be difficult to converge the various OGA systems into a Single Window solution.

In a practical example of the application of Enterprise Architecture, David Siah (Siah, 2008) explains the phases involved in the adaptation of Enterprise Architecture for a Single Window solution. It is argued that Enterprise Architecture processes drive the alignment between business strategy and program management defining the scope of individual projects and maintaining traceability between project goals and strategic business drivers. This makes Enterprise Architecture processes essential for e-government solutions. The logical flow for deriving the different
architectural components starting with the business drivers from various participating border agencies has been explained.

2.6 Single Window Business Architecture

A Business Architect begins by developing an understanding of the strategic drivers. The main themes of a Single Window are (i) drive towards business simplification (ii) co-ordinated approach to regulatory controls (iii) trade facilitation using ICT techniques and (iv) Co-ordinated actions between Customs and other Government agencies.

The Business Architect models value streams. Value is lost when it takes too long to clear cargo. Value is put at risk when clearance times become unpredictable. Similarly, when traders suffer excessive compliance costs, when regulatory compliance is compromised, government revenue is lost or public safety and security are put at risk, the supply chain participants lose monetarily. Businesses provide value to customers and thus generate revenue. So, the value creation path defines value streams in business enterprises. Similarly, one can model value preservation in the regulatory sphere. Of course, it makes sense for a trader to model and represent the cargo clearance process through a value stream diagram.

The Business Architect does not merely look at the business process; he also produces clear descriptions of the interactions between organizational strategies, processes, roles/structures and organizational performance. Using this intimate knowledge, he assesses how a change in one aspect impacts the other components.

The Business Architect role in a Single Window project is critical because it helps uncover the gaps between the high-level goals of the participating government agencies and their ability of the current systems to fulfil them. The Business Architect then develops "charters" to plug those gaps. Prior to Single Window, a trader needs to access different web portals belonging to different government agencies to complete a transaction. Very often data used in different portals is not in sync with one another, causing numerous difficulties in executing transactions. A Business Architect would look at this as a gap affecting several other areas of organizational effectiveness. Different agencies perform distinct trade-related functions and therefore must maintain trader profiles which are not often up-to-date. This introduces a separate set of problems. In this situation, let us say that the Business Architect charters in a proposal for "single sign-on" and "common business entity account management" to be shared among the different portals of the participating government agencies. With the introduction of these chartered components, the business process landscape changes significantly. Prior to Single Window, a trader needs to access different web portals belonging to different government agencies to complete a transaction. Very often data used in different portals is not in sync with one another and incorporate the changes introduced into the entire system. It is the Business Architect's job examine these interactions and to highlight the attendant changes that single sign-on would bring to the overall ecosystem.
The role of a Business Architect is often confused with that of a business process specialist. The latter is skilled in developing and detailing business processes and in highlighting the process bottlenecks. A business process specialist can also redo the processes in the light of the proposed changes and document the simplification achieved as a result.

The Business Architect examines whether the future strategies and scenarios match with organizational capabilities, and what, if any are the capability gaps. For example, under Single Window, it is proposed to introduce risk-assessment techniques whereby most of the risks will be addressed upfront through the interdiction of consignments based on selectivity criteria provided by participating government agencies. Do the participating government agencies have the capability to develop and maintain selectivity criteria? Do they maintain compliance histories in respect of products they are accustomed to handle? Can they validate new risk criteria against historical trends? Do they maintain risk registers? Are there any organizational roles and operating procedures to ensure that risk management strategies are developed, operated and monitored? So, the Business Architect looks at individual solutions, not in isolation but as part of a cross-functional roadmaps to address the identified gaps in organization structure and roles. Thus, the process of risk-based selectivity comes with cross-functional dependencies that relate more to business capability of the organization rather than just the process flow.

Whenever, a strategic review is undertaken, the Business Architect comes into play. A Business Architect typically has a general understanding of the state of the art in ICT, with a strong understanding of the functional domain, and keen awareness of the business motivation embedded into organizational structures and the interdependencies.
A Business Architect looks at the organizational capability (capability models), what drives different organizational units and key organizational roles (motivational models), how value is captured or preserved in the process flow (value streams analysis), activity intensity models depicting the corners of an organization where most of the critical work gets done (heat and risk maps) etc. Again, the role of a Business Architect should not be confused with that of a Business Process specialist who specializes in requirement elicitation, use case development and documentation of business processes.

It is not uncommon to produce high-level business architecture in lay terms. For example, the Canadian Government published document titled Single Window Framework describing the business vision of the Canadian Single Window (Canada Border Services Agency, 2008), providing the a high level description of the concept of the initiative and its benefits. Other experts have developed templates for the producing master plans for the implementation of a Single Window. It is also observed that Single Window implementation requires collaboration with agencies involved in providing services in national e-Governance programmes. (Apostolov, 2008).

Architectural descriptions however have to be systematically developed and rigorously presented. At the same time, these descriptions have to serve as effective tools of communication. The fine balance between readability and technical rigour can to be met by following any of the well-known frameworks. Most enterprise architectural frameworks contain layered approaches to architectural description.

These frameworks recommend the creation of the business architecture as the starting point. Business architecture focuses on business capability, its resource structure and how it uses them to produce business value. Business architecture results in the elaboration of workflows and the collaboration between organizational units to produce end-user services. It also provides the defining features of the engagement between service providers and service consumers.

Some examples of discussions that can take place in the context of Single Window Business Architecture are:

- What checks are participating agencies performing and which of these need to be performed after goods arrive physically? Who performs those checks, and can they be delegated to a single official? What training is required to perform these checks?
- How is the hand-off between Customs and other agency going to take place? Would they be co-located? How will they communicate between one another?
- What legal changes would be required if we cross-empower Customs officers and food & drug officers in each other’s functions?
- Where does documentary examination take place, given that the entire documentation is available online? Can documentary inspection be arranged at a remote location?
- Can we arrange to receive bonds and securities in any office, regardless of the place of import or export?
- What kind changes become possible when Customs officers provide release decisions using hand-held devices instead of desktop based operations.
- If warehouse operators can be entrusted with the stuffing of containers, should Customs supervise the stuffing?
The container yard operator has introduced RFID tags to all containers. What changes are possible as a result of this measure in Customs control of the yard operations?

Is it possible to remove officers of all participating agencies from the terminal gates and rely only upon a framework where only a single agency is in control?

These are examples of some of the discussions a Business Architect can help moderate and guide. However, the end-products he would work with are the Business Capability Model and the Business Operations Model.

The Business Capability Model is especially useful in assessing organizational capabilities and how those are extended across the organization. According to Gartner’s glossary, Business capability modelling is a technique for the representation of an organization’s business anchor model, independent of the organization’s structure, processes, people or domains. Business capability models help organizations articulate their capacity in terms of its processes, organization and expertise needed in order to perform core functions. An array of functional modules can reflect an administration’s business capability.

The adjacent diagram provides a view of the functional capability groupings shown as vertical blocks. The horizontal blocks are common system capabilities that underpin all of the functional capabilities. Together, the system capabilities and functional capabilities find expression in the Business Capability Model. As we drill further down into individual blocks we can see the reflection of the organization’s true business capabilities. For example, the adjacent diagram outlines the block dealing with Risk Management & Controls. The generic functional components provide what the Single Window is capable of handling.
Under the umbrella of risk management and controls, there are several components starting with the management of targeting and selectivity to inspection, verification, compliance measurement, commodity profiling and the like. Each block articulates an organizational capability. The grouping of capabilities to support the application of risk-based controls would suggest that they are inter-related. For example, targeting and selectivity helps interdict consignments for inspection. Commodity profiling may help identify risk criteria, which will determine risk rules. These rules will not only help operate selectivity criteria but also help in determining the basis for inspection and examination of cargo in the real-time, cargo interdiction at checkpoints or terminal gates, and post clearance audit based controls. In the short term, controls may be applied for on-the-spot compliance verification and in the medium term, systematic compliance measurement would help.

During the process of development of a Single Window, Business Capability Models provide a useful communication tool regarding the overall scope of the solution. Such models not only convey the requirements to the solution provider, it also helps assess business capability of all the participating government agencies and to help map their respective functional roles.

<table>
<thead>
<tr>
<th>Agency</th>
<th>Customs</th>
<th>Plant Quarantine</th>
<th>Animal Quarantine</th>
<th>Food &amp; Drug Admin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Capability ↓↓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commodity profiling</td>
<td>Mature</td>
<td>Initial</td>
<td>Initial</td>
<td>Mature</td>
</tr>
<tr>
<td>Risk-rule development</td>
<td>Mature</td>
<td>Non-existent</td>
<td>Non-existent</td>
<td>Non-existent</td>
</tr>
<tr>
<td>Inspection capability</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Initial</td>
</tr>
<tr>
<td>Personnel presence at checkpoint</td>
<td>Always present</td>
<td>Not present</td>
<td>Not present</td>
<td>Present for surprise checks</td>
</tr>
<tr>
<td>Use of audit based controls</td>
<td>Mature</td>
<td>Non-existent</td>
<td>Non-existent</td>
<td>Non-existent</td>
</tr>
<tr>
<td>Post surveillance clearance of commodities</td>
<td>Non-existent</td>
<td>In quarantine stations</td>
<td>Extensive</td>
<td>Extensive</td>
</tr>
</tbody>
</table>

The above tabulation helps compare functional capability of organizations participating in a Single Window. Artefacts of business architecture help establish the as-is and to-be positions in respect of each function. Capability and performance gaps are identified and addressed well it time before Single Window functionality comes into operation.

3. Application Architecture

The application architecture provides arrangement of the supporting software application components that make-up the solution. It includes the IT systems, IT services and functional use cases. The application architecture is supported by the information architecture such as data objects, electronic messaging artefacts and rules and controls over information. The entire set of applications also need to be supported by technology. Information architecture provides a holistic picture of the
intra and inter-organizational flows of information and would include the enterprise data dictionary and the conceptual data model. For example the WCO Data Model which has been described as the data blueprint for the Customs and cross border regulatory agencies could be part of the data architecture. This is explained briefly in the following paragraphs.

4. **WCO Data Model as Data Architecture**

Single Window Environment brings together a number of information systems that interact with each other. In order that these information systems work together and interchange data efficiently, there is a need to produce the common information architecture. This architecture is essential in order that the conflicts between data are eliminated and each of the participating systems in a Single Window is conformant.

Single Window participants are often found to be operating IT systems based on different technology platforms, business processes and data definitions, making it difficult to produce interoperable systems. It is commonplace to have conflicts occurring between information models of participating agencies. For example, in the Australian standard data set (SDS), it was reported that there were more than a dozen different definitions of the term ‘exporter’ in different governmental systems.

In addition to conflicts in definition, there could also be conflicts in the way the definitions are represented in different ways (example: the coded representation of exporter is a maximum of 13 characters in one system and a maximum of 15 characters in another. Structural conflicts could occur when information used in one system is structurally different from those that are used in another system. Experts (Glushko & McGrath, 2008) have documented different types of conflicts that can occur and come in the way of interoperability. Content conflict could occur when two parties use different sets of values for the same component – different code sets being used to describe a coded data element or where the same set of values are used for different set of components (e.g. when codes used for units of measure and unit of quantity interchangeably). Encoding conflicts occur when different types of syntax are used. Even when the same syntax is used, if there are structural differences (for example, the structure of an address), it is not possible to share information.

These conflicts can be resolved only when a common information model is used by all participants. To guide players within a Single Window into using standard data architecture, the WCO Data Model has defined the generic content of information for cross-border regulatory agencies. By aligning with the WCO Data Model, Cross-border regulatory agencies can produce and use common content, semantics, syntax and structures for the Single Window Environment. Chapter 4 of Volume II describes techniques of Single Window Data Harmonization, which is the methodical approach to collecting, defining, analyzing and reconciling information for a Single Window Environment.

5. **Technology Architecture**

The arrangement of technology components is described in the technology architecture – interface components, security components, messaging, workflow and database management components are part of the workflow architecture. All these elements are supported by infrastructure components.
such as hardware, software platform (operating systems) and networking (infrastructure architecture).

<table>
<thead>
<tr>
<th>Database Architecture</th>
<th>Application Integration Architecture</th>
<th>Security Architecture</th>
<th>Network Architecture</th>
<th>Platform Architecture</th>
<th>Management &amp; Governance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDBMS</td>
<td>Extraction &amp; Translation</td>
<td>Authentication &amp; Authorization</td>
<td>Data/ Voice/ Video</td>
<td>End-user Devices</td>
<td>Configuration Management</td>
</tr>
<tr>
<td>Master Data Management</td>
<td>Data Transfer</td>
<td>Encryption</td>
<td>Comm. Protocols</td>
<td>Peripherals</td>
<td>Service Management</td>
</tr>
<tr>
<td>Archiving &amp; Storage</td>
<td>Transaction Management</td>
<td>Device Security</td>
<td></td>
<td></td>
<td>Capacity Management</td>
</tr>
<tr>
<td>File &amp; Tablespace Management</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Figure: Technology Architectural framework**

Technology Architecture forms the ‘Phase D’ of the TOGAF Cycle. It consists a set of definitions reusable standards, guidelines, individual components and configurations that are technology-related. By technology-related is meant the different layers of technology eg platform, network, security, application integration, database and governance tools/ Technology Architecture also describes the way these components should be reused to provide the core IT infrastructure-related services through these technical areas. For a Single Window project, it is necessary to establish the Technology Architecture before application development can begin. In the TOGAF Cycle, application development doesn’t begin until Phase E, which is the very next phase.

Technology Architecture must take into account front offices and back offices located in buildings geographically distributed around the country and the functions and services handled in these offices. The criticality of functional services must be assessed in terms of the organization’s core business processes (such as cargo reporting and goods declarations, risk management, post-event activities, pre-arrival and preventive activities, trader account management and policy support). These offices also form the major information generating, information processing and information consuming units. The non-functional requirements necessary to support these core business processes and information flows have a direct bearing on the technology architecture,

Using the analogy of architecture in real-estate once again, it is nearly impossible to effectively build or maintain a large building (say, a high rise) without being in possession of accurate architectural documents – the blueprints for structural, plumbing, electrical wiring, heating, cooling and a variety of other systems and sub-systems. In exactly the same way, a Single Window Environment cannot be effectively built in a multi-agency setting without knowledge of their architecture. Most managers
understand the structural components of their organization through their organization charts where it is easy to locate functional units (such as operations, enforcement, audit, statistics, policy etc) and the reporting relationships and hierarchies. This is a simplistic view of the organization’s architecture. It is possible to draw multiple architectural views of the organization with each view providing distinct value to the process of build and maintaining systems. Enterprise Architecture is the discipline that examines these views.

5.1 Architecture & Total Cost of Ownership

In the event of a breakdown, the building manager keeps the relevant blueprints handy for the repair activity. These blueprints are even more vital for major renovation or refurbishing activity. Likewise, to support the strategic management process of the ‘enterprise’, it is necessary to produce and maintain the relevant organizational blueprints. One of the main reasons for investing in enterprise architecture is to ensure that Information Technology assets are responsive to the strategic activities for Customs. Enterprise architecture provides the strategic context for the deployment of IT systems. It is one of the ways to ensure that the Customs executive management understands the value of Information Technology and its indispensable role in achieving the strategic goals for Customs.

Investment into a Single Window without having the enterprise architectural view is very risky. For example, as the Single Window solution grows, IT systems need to be in line with the organization’s Information Security architecture. New and need to fit with the already existing systems and procedures.

Together, these capabilities and resources define entrenched ways of doing business by both individual government agencies and the private sector organizations. Single Window moves away from this intra-organizational ‘command and control’ operation to one of collaborative exchanges between all stakeholders government agencies. To that extent, a Single Window project has disruptive influence on the status quo.

To understand how the shift to a ‘Single Window mode’ of operating can be achieved, it is essential to produce a rigorous description of the structure and functioning of each of the participating Cross-Border Regulatory Agency, its components and their inter-relationship. Such a description should include the following:

- Organizational structure, roles and goals – in relation to meeting the objectives of cross-border regulation.
- Business processes, business information flows and information systems that participate in service delivery.
- The logical organization of the functions, resources and capabilities of the organizations at the level of businesses. This will include the role that information systems play in the service delivery process.

The specialist task of producing such a description is that of an enterprise architect. Enterprise architecture is a discipline that specializes in providing a architectural solution, which helps produce the IT strategy based on business strategy and providing the background for the organization to improve its effectiveness. Section 8 of the WCO Capacity Building Compendium 2010 provides a
detailed overview on the practice of Enterprise Architecture. The essence of ‘Enterprise Architecture’ is about “finding direct links between the business imperatives of the enterprise and the deployment of technology in order to achieve some kind of alignment between the two.” Such an alignment enhances the possibility for an optimum use of available resources and getting rid of redundant resources. Enterprise Architects help streamline the organization’s use of Information and Communication Technology (ICT) in order to ensure high Return on Investment (ROI) and low Total Cost of Ownership (TCO).

Architectural development also has a capacity building angle. In general, reforms in Trade Facilitation depend on political will. Ideas and initiatives such as the Single Window Concept need strong political support over sustained periods of time. Ideas of architecture can help rally divergent forces towards forging a consensus on the common needs. A country’s internal motivations for reform can find a voice in documents of architecture. Architectural blueprints help countries identify with something concrete on the agreed future and course of action.

In recent time, the role of platforms in technology has increased. A platform is a pervasive service driven by compelling technology. It users can’t afford to be without it, and different types of businesses and software developers bind their own applications to it.

6. Service Oriented Architecture

In Part I of Volume 1, it was mentioned that a Single Window may be understood as a collection of services that support the core regulatory functions of import, export & transit and trade facilitation. These services are predominantly enabled by the information and communications technologies. The appointed Single Window operators (or orchestrators) provides (or supports) the enablement of these services on behalf of CBRAs through a common platform. Broadly, these services result in the regulatory clearance of goods, means of transport and crew.

The ‘services’ paradigm places at our disposal a number of useful technical and managerial tools that can help answer many questions that we may face in the process of building a Single Window Environment. The taxonomic analysis of Single Window Service allows the breaking-up of larger services (business-oriented description of services) into more elemental business services. These business services are supported by IT application services and infrastructural services. To illustrate, the service to process import and export goods declaration is dependent on a service that fulfils cargo examination. For Cargo-examination to occur, the services of scheduling and calendars services of the inspecting staff may have to be invoked. While services describe the fulfillment of a business need, business processes provide the steps involved in fulfilling a business service. One can rearrange business processes to fulfill the same service. All these services have underlying IT and infrastructural components.

Traditionally, these services were established by the respective government departments and logistics service providers as disjointed, discrete services, with little thought given to the interlinkages. At the core of the electronic Single Window is the notion of ‘joined-up’ services in which the focus is on service outcomes for the client. The taxonomy of services helps in charting the process of joining-up and provides a framework to scope Single Window-related projects. Experts have suggested that a typology and a hierarchy of services is a useful methodology for analysis.
A reasonable classification that brings out the dependencies is critical for describing the currently provided services and their inter-relationships. It provides a common language to business analysts and technology architects enabling the platform for effective decision making. This description can be exploited in developing the business and technology architecture for the Single Window Environment.

The most important part of designing the Single Window solution is to describe the ‘to-be’ state of the trader’s (or brokers/transporter’s) ‘experience’ of a transaction. A statement of description of this ‘to-be’ would serve as the binding link for all stakeholders as they engage in a series of activities of architecture and design.

Each Government Agency can provide a separate view of its services. However, the Single Window concept requires that these should be imagined from a whole of Government and regulatory agencies perspective. Whichever way it is conceived, Service Oriented Architecture provides a clear way forward in delivering a scalable and maintainable Single Window Environment.

Service-Oriented Architecture (SOA) begins with a strong focus on the business services. It does not focus on the technical infrastructure (servers, storage etc) and its associated technical services. SOA is an architectural approach and is technology neutral. This architectural approach is strongly rooted in business services and therefore it is a reasonable choice for architecting the Single Window Environment. Service Oriented Architecture can facilitate the implementation of change in information systems. Traditional IT systems were pieced together by rigidly integrating hardware, software and networking making it difficult to implement. Service Oriented Architecture advises the building of software applications using components that are easy to assemble and build. These building blocks are not pieces of software but are business services that are performed in order to fulfill business needs. Commonly used services can be re-assembled to create new services. Organization for the Advancement of Structured Information Standards (OASIS) developed a standard Reference Model for Service Oriented Architecture (OASIS Technical Committee on SOA, 2006).

In the Single Window environment, the concept of re-usable service components is extremely useful. In spite of differences in areas of regulation, most cross-border regulatory agencies require common business services. These relate to inspection of cargo, crew and means of transport, documentary examination, recording of test results, drawing of samples, computation of duties and taxes, risk assessment framework etc. These service components are re-usable firstly in the sense of business operations and then in the sense of the underlying software service components. While the subject of inspection may vary between government agencies, the stages of process are the same, while the parameters for calculation of duties, taxes and fee may vary, they are all linked to the process of levy and collection. Payment services can be abstracted into utilities that can service all payments arising in the course of cargo clearance.

The Information Technology (IT) components that underpin the reusable services are building blocks that are loosely coupled. This enables re-use of the component. Such loose coupling minimizes the impact of change. Service Oriented Architecture relies upon common parlance use of terms. Where the service consumer (being a software component) requests for a service from a service provider (another software component). The exchange service request and service response is driven by messages and the quality of service is governed by service contracts between the interacting service components.
These characteristics require a ‘service’ to be a self-contained unit whose performance does not depend on the state of other services. It is a logical encapsulation of self-contained business functionality. This autonomous nature of a service component allows software developers to remove it, make changes and plug it back without impacting other components. Services can be orchestrated. This implies that services can be rearranged or re-ordered to suit business purpose. This is of considerable value in handling business processes in a Single Window environment. The figure below shows the ability of SOA components to be orchestrated into

A service communicates with another service using messages. For services to be work together, messages should be interoperable and should work across platforms. These messages should be able to describe and discover services. These should be reliable and secure and based on industry standards.

### 6.1 Implications of SOA for Single Window

Single Window Environment involves exchange of electronic documents (or information units) using standard communication interfaces between the trader’s systems and CBRA systems and between CBRA systems. Standard communication interfaces need to be developed for communications to take place between different service components. Web services are based on international standards.

It is useful to visualize Single Window as a collection of IT driven business services, which form into non-overlapping categories and hierarchical structures. This helps understand the composition of services in terms of IT components. The application architecture under SOA favours loose coupling (modules are easy to detach and re-attach) as against tight coupling where software components are tightly integrated, resulting in compact but inflexible solutions.

Loose coupling of components help identify and lower of cost of services, since software components contribute to specific services. This also helps derive the return on technology and application investments. Historically IT investments were made based on the tight integration between hardware software and networking. The trend on ‘SOA enablement’ started several years ago under which existing (or legacy components) were converted into SOA components by wrapping software interface around them and making them re-usable. While this was expensive, it became an imperative for organizations since the current market environment required the organizations to be lean and agile.
To summarize, Service Oriented Architecture (SOA) is recommended for building the Single Window Environment for the following reasons:

a. SOA is built based on the notion of services. Single Window being Collection of Services makes SOA an attractive conceptual basis.
b. Management understands the attributes of service operations- service availability, service quality, and cost of services. SOA clearly identifies with these concepts and brings them to life.
c. Single Window Environment involves integration of multiple systems investments made by a number of agencies. SOA facilitates integration requires Single Window be made on the perspective of IT architecture – SOA as the imperative – description of SOA and how SOA can drive interagency integration. Why SOA is the right approach in the current environment.
d. SOA can be designed to be event driven. In Chapter 6 of Volume 1, we had proposed that workflow of business processes should be event driven. Each event in the supply chain would result in incremental flow of data. Depending upon the state of the transaction, different players can access different sets of data to enable them to progress in a Single Window Environment.

e. SOA development is aligned with the software support lifecycle, it enables integration and assembly of disparate software components helping in leveraging existing applications and infrastructure.
f. Under SOA, services are not seen to belong to particular systems or network. Therefore, SOA enables usage of services provided software application services within the Single Window Environment, regardless of the location of the system. It however does not mean that participant can access all services. Appropriate authentication and authorization can be supported at various levels to ensure dynamic connectivity and organization between services.
g. Single Window, by nature involves composite services. SOA provides the ability build composite applications based on requirements of different CBRAs.
h. The discipline of SOA helps build an common taxonomy of services and information models.
i. SOA is against building proprietary, built to custom applications. It helps deliver better business value than those delivered by proprietary applications.

In the WCO Survey on Single Window Developments (please refer to Section 1 of this volume, the commonly used business processes and services in a Single Window Environment were described. One of the emerging themes from our study is that success in developing a Single Window environment depends on the ability to identify and establish the basic services that run across government departments and converting them utility-grade services which are:

- Widely used valued within the Single Window user community.
- Highly standardized and cannot be customized easily
- Highly available and fail-proof
- Simple to access using known and openly available interface
- Supported with commonplace skills.

Examples of these type of basic services are identify management, authentication management, electronic messaging, transaction routing, document workflow, document repository services, regulatory information services for products, product identification, visibility services for cargo, containers, and means of transport etc would qualify in this category. In order to support theses ‘utility grade’ services, SOA provides the architectural paradigm.

The technology components that support SOA are commonly understood and explained by various authors. Specific technologies that enable SOA will not be described in this document. However, the standards for SOA Reference Architecture exist. The draft standard produced by the Open Group (The Open Group, 2009) describes SOA architecture as comprising 9 layers. The industry provides solutions of different description to fulfill the functionality of these layers, which are described variously by different technology vendors.

7. Conclusion

This Part introduces the concept the architecture in an organization and the role of enterprise architects as developers of master plans for the Single Window Environment. It describes the different architectural views that can be prepared in order to support the high-level planning of a Single Window solution. In order to support the strategic management process of the ‘enterprise’, it is necessary to produce and maintain the relevant organizational blueprints.

One of the main reasons for investing in Enterprise Architecture is to ensure that Information Technology assets are responsive to the strategic activities of the organization by providing the strategic context for the deployment of IT systems. It is one of the ways to ensure that the executive management understands the value of Information Technology and its indispensable role in achieving the strategic goals for the organization. IT investment without having the enterprise architectural view is very risky.

The enterprise architectural view includes business architecture that describes the functions of the organizations and how it performs them. Information architecture provides a complete picture of the intra and inter-enterprise flow of information. It includes the conceptual data model. The inventory of software applications that that serve the organization’s business objectives and missions would form a part of the application architecture. This architectural view also describes how the
applications fit in with each other as well as with the overall business purpose of the organization. The software platform that mediates between applications – called middleware provides the software environment for the execution of applications. Technology architecture deals with these issues and drives other architectures such as security and software architectures.

Subsequently, this Part dealt specifically with Service Oriented Architecture as the basic paradigm for building large-scale solutions based on information and communications technology. Defining ICT projects in terms of business services can help deliver results transparently to project stakeholders. Drawing upon the concept of Single Window as a collection of services which can be deployed using information and communication technologies, Service Oriented Architecture is proposed as the bedrock of design and deployment of software applications. Service Oriented Architecture or SOA as the name implies, is architecture.

Service Oriented Architecture is a methodology involving the use of IT in designing and implementing business services. It has replaced the practice of monolithic architecture that was prevalent for over three decades. It is a fundamentally different way of thinking about IT solutions including software development that has the business side of the enterprise at its heart and can serve as the focus of efforts to integrate different IT applications.

The WCO Data Model which has been described as the data blueprint for the Customs and cross border regulatory agencies could be part of the data architecture. The chapter explains that WCO Data Model supports the manner in which data gets created in the business processes of international trade. It helps us in arriving at a simple functional model for Single Window. The resolution of internal conflicts in data structures and content between different government agencies ensures meaningful communication of information and the analysis of information and documentation is the bridgehead to effective requirements analysis for the Single Window environment. Data architecture is a critical aspect because finding architectural patterns simplifies the identification of the rest of the requirements.

Finally, the central idea of this Part is that architecture can help rally divergent forces towards forging a consensus on the common needs. A country’s internal motivations for reform of international trade can find a voice in documents of architecture. Architectural blueprints help project participants identify with something concrete on the agreed future and course of action. Visualizing Single Window as a collection of IT driven business services and helps understand service composition in terms of IT. Technology platforms for SOA produced by different vendors may vary but all have the underlying philosophy that favours loose coupling over tight coupling. Since this has implication for costs of IT platform and operations and consequently the ‘cost of services’ which is a determinant of the Return on Investments.