E-Procurement Business Architecture

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Preliminary Release

National E-Health Transition Authority

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1 Introduction

This document provides the business architecture for e-procurement.

1.1 Intended Audience

This document is intended for stakeholders in the Australian health supply chain, including state and territory health departments, suppliers to the health departments, and trading hub providers.

1.2 Document Context

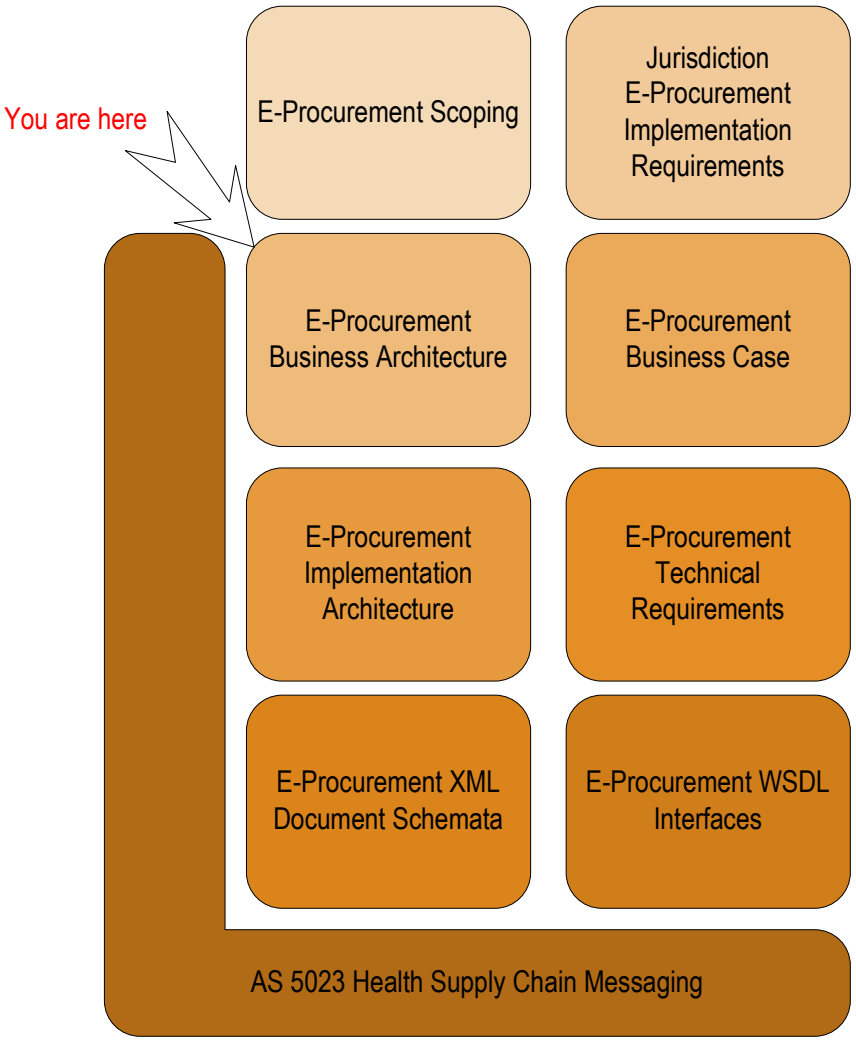

Figure 1: Document Roadmap

The documents shown in Figure 1 are being produced in top to bottom order, with the AS 5023 standard underpinning all of the technical documents.

1.3 Document Overview

The three perspectives on a software architecture suggested by the NEHTA Interoperability Framework are *Organisational*, *Informational*, and *Technical*. We use these perspectives as the major sections of this document.

The document starts with the Organisational Perspective, which shows the roles that various parties play in the proposed e-procurement architecture.

For ease of comprehension, the Technical Perspective is presented next, and the Informational Perspective is shown last. The Technical Perspective explains the workings of e-procurement hubs, and relates closely to the Organisational Perspective, whereas the Informational Perspective relates mostly to documents which can be considered "payload" for the technical architecture. These documents are already well understood in the health procurement domain, and are derived from the relevant Australian Standard.

2 Organisational Perspective

2.1 The Procurement Community

The concept of a *Community* is used in the Organisational Perspective to discuss the collection of entities (e.g. individuals, organisations, information systems, resources, or various combination of these), established to meet some objective. A Community is specified in terms of community roles and a community contract.

In the case of procurement, the objective to be achieved is the exchange of documents in order to affect the purchase of goods or services. The community consists of several community roles. In this case the most important of these are a buyer and a seller, and other roles can include e-procurement hubs, banks, shippings agents and others. The way in which these roles relate to one another is known as a *community contract*, and it is well understood by all parties involved in procurement, and specified in Australian Standard 5023.

2.2 Buyers and Sellers

Procurement is an inter-enterprise process that is conducted with two main roles: a *buyer* and a *seller* with the purpose of the buyer purchasing goods (including services) from the seller. This is done by the exchange of various documents, followed by the exchange of goods and money.

In the NEHTA context, the buyer role is usually played by a hospital, area health service or central procurement agency, which is funded directly or indirectly by a state or territory government. The seller role is usually played by a manufacturer or wholesaler, which are usually referred to as *suppliers*.

The scope of this architecture is limited to the exchange of a small number of documents, within the context of some nominated public processes. The logistics of goods delivery and receipt, and financial transactions are explicitly out of scope; however documents indicating that these actions have taken place may be included in some of the public processes. Public processes are defined as templates for actual interactions that take place, and when implemented, any given public process definition may be instantiated multiple times, with each instance having specific actors playing the roles of the public process. So a given organisation (like a hospital or area health service) may be involved as the buyer in many simultaneous public processes, in the same way that some other organisation (such as an importer or manufacturer) may play the seller role in multiple simultaneous public processes.

The scope of NEHTA standards for e-procurement is the interactions between the buyer and the seller of goods. Processes that are purely internal to a buyer or seller are explicitly out of scope. A number of public processes by which procurement occurs in the Health Domain in Australia are specified in Australian Standard 5023 *Heath Supply Chain Messaging*. Section 2.5 identifies the subset of public processes derived from that standard which NEHTA endorses.

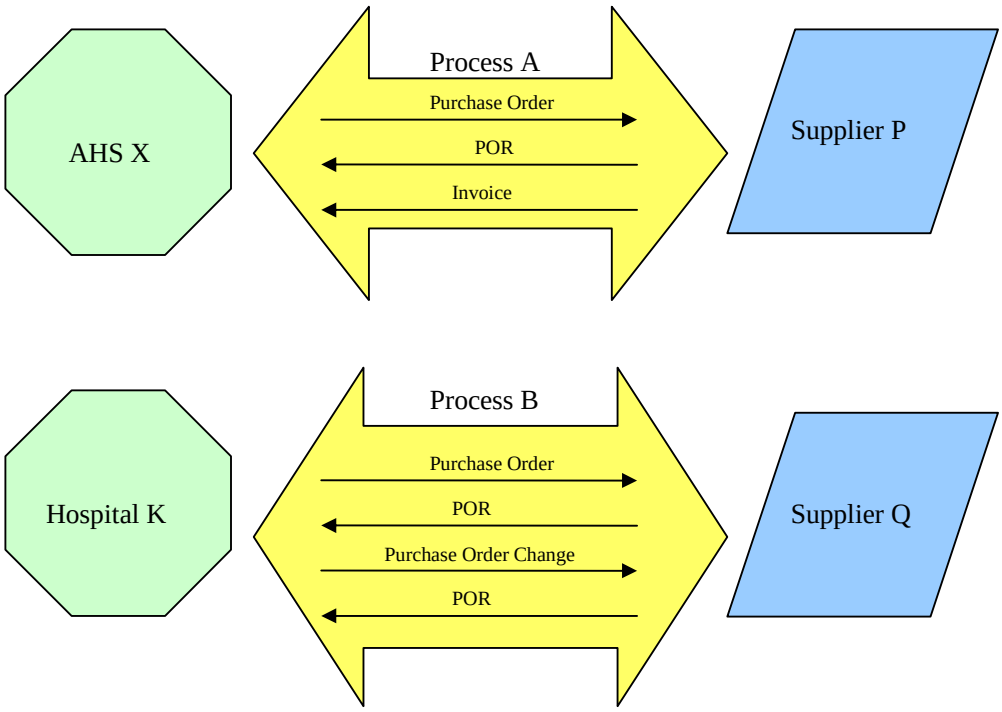

Figure 2. Example public processes in which buyers interact with suppliers

Figure 2 depicts two example high level public process by which e-procurement takes place, with the actual receipt of goods assumed to be represented by documents notifying of their delivery. A number of different public processes are possible. However, we will define only one public process which meets the needs of the jurisdictions, specified in section 4.1.2. As this process has a number of possible cycles and decision points, when a document is transmitted between buyer and seller it is important that the process context for that document is understood.

2.3 Buyer and Seller Interact through Hub

In some cases, the technical infrastructure supported by a buyer and seller may facilitate the direct exchange of documents in the public procurement processes that they share. However, there are many circumstances in which a trusted third party may manage the transmission of these documents on behalf of the buyer and seller. The third party role in the community is usually called an *e-procurement hub*.

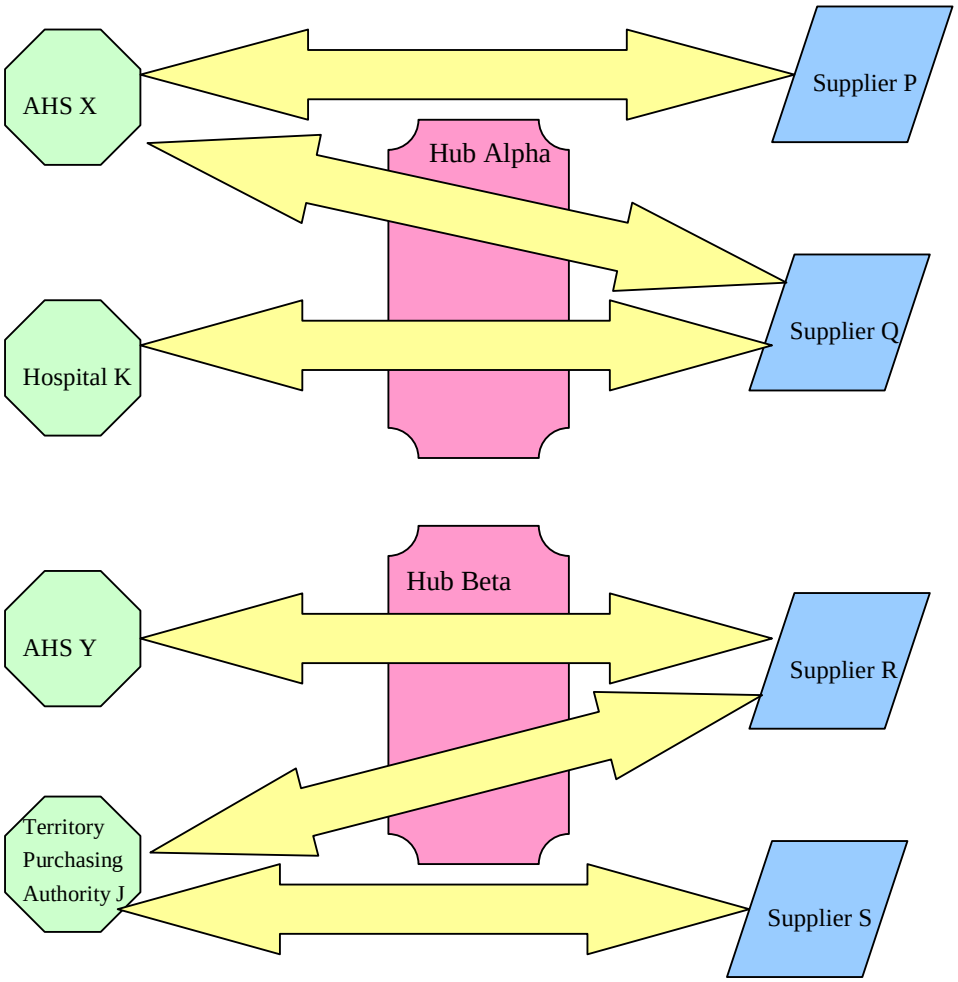

Figure 3. The use of hubs for e-procurement

Figure 3 shows that despite some buyers connecting directly with some sellers, many procurement messages will be transmitted via a hub. There may be many hubs, and they can connect a number of buyers with a number of sellers.

2.4 Hub Interconnect

As shown in Figure 3, there are multiple possible hubs. In fact these hubs act as pre-existing marketplaces for goods, as each hub already has a number of suppliers who are subscribed. The quickest way in which buyers can connect to several pre-existing groups of sellers is for the buyer's hub to interconnect with other hubs to which the sellers are already connected. In this way each party need only connect to a single hub, and the hubs will route documents between one another to allow connection of any buyer to any seller.

Figure 4 shows a single buyer, connected only to a single hub, which is conducting e-procurement processes with a number of sellers, each of which also only connects to a single hub. However, two of the sellers are connected to a different hub from the one the buyer connects to. In this case the hub provides an *interconnect* service, which routes the documents in the public process back and forward between the right buyer and seller, regardless of

which hubs they use. This model can be expanded to any number of hubs. (See Figure 10 for a more complete example.) This arrangement is called a *federated marketplace*.

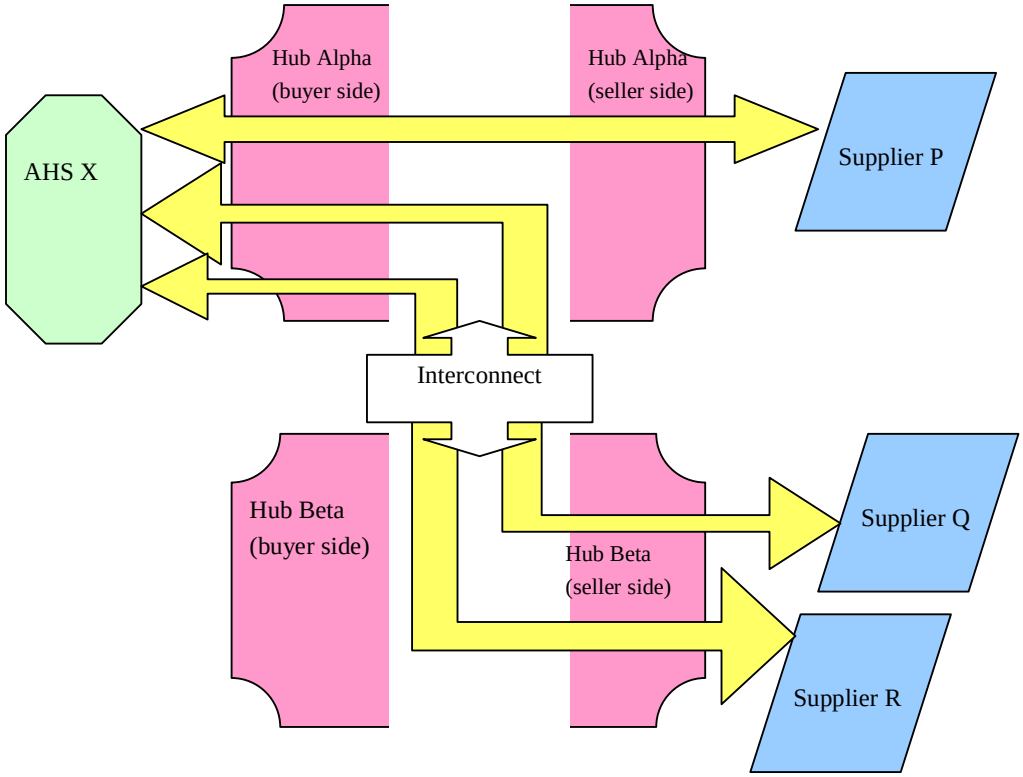

Figure 4. Hub interconnection

2.5 Public Process Model

Australian Standard 5023, *Health Supply Chain Messaging*, shows three generic public processes for electronic procurement, from synchronisation of catalogue data, through purchase order, to order fulfilment, and includes two variations on payment. These processes have been narrowed down to a core set of interactions involving documents starting with Purchase Order and ending with Invoice. All catalogue, order fulfilment logistics and payment related parts of these processes have been deemed out of scope for the first version of the e-procurement architecture.

It is important when exchanging actual e-procurement documents that the process context of the documents is understood, so that correct error handling can be in place when expected interactions defined by the public process do not occur.

This section shows the public process for exchange of all documents that have been identified as important by the jurisdictions (Figure 5). The formal specification of the public process is done using UML 2.0 Activity Diagrams. The use of the documents within the public processes is also modelled, and then the interfaces for communication, and the document types and wrappers (or envelopes) for the documents indicating their process context, can be derived from the models. The approach to this modelling and document derivation is discussed in more detail in Section 4.1.2.

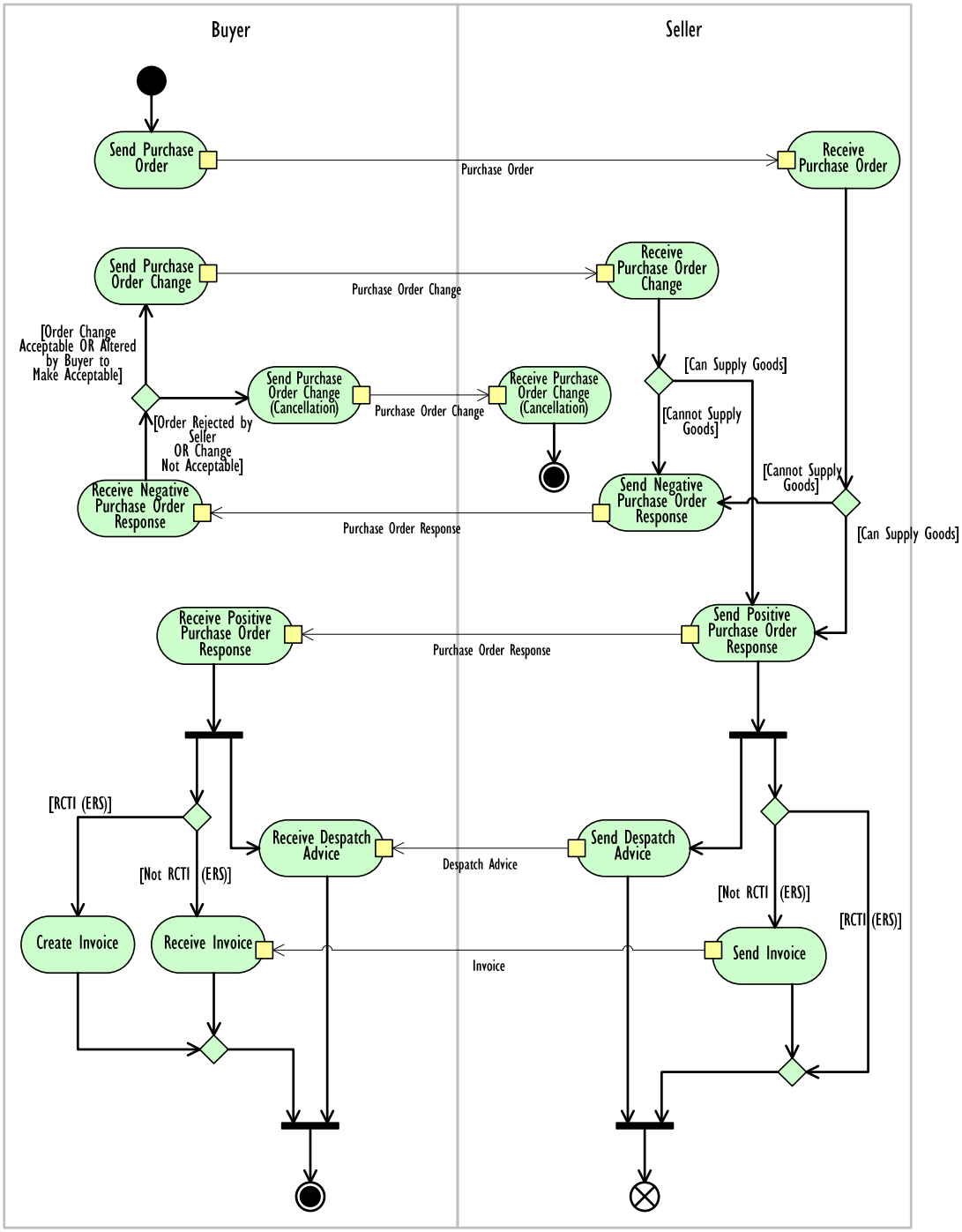

Figure 5. Public Process for Procurement

A textual description of the public process in Figure 5 is as follows:

1. The Buyer sends a completed Purchase Order to the Seller.
2. The Seller determines whether all ordered items are available within the specified timeframes at the specified prices, for delivery to the specified location(s).
    2.1 If the Seller can supply the goods requested by the Purchase Order as is, then a "positive" Purchase Order Response is sent from Seller to Buyer. Go to steps 4 and 5.
    2.2 If the Seller cannot supply the goods as specified in the Purchase Order, then the Seller modifies the Purchase Order line items to reflect their actual ability to supply, and returns the amended line

items as part of a "negative" Purchase Order Response. If the order cannot be fulfilled at all, then a "negative" Purchase Order Response indicating inability to supply is sent.

3. The Buyer receives a "negative" Purchase Order Response (POR). Either (3.1) or (3.2) is chosen depending on the contents of the POR.

3.1 If the Purchase Order Response indicates that none of the ordered goods can be supplied then the Buyer sends a Purchase Order Change with cancellation to indicate that the order is cancelled.

3.1.1 The Seller receives the Purchase Order Change indicating that the order is cancelled. The process now terminates.

3.2 If the Purchase Order Response indicates that an amended order can be fulfilled then the Buyer can either accept the amendments by returning the altered line items from the POR in a Purchase Order Change (POC), or make some additional amendments, and send a Purchase Order Change. Now repeat step 2 using the POC document as the new Purchase Order.

4. The Buyer receives the "positive" Purchase Order Response.

4.1 The Buyer must wait for an Despatch Advice

4.3 The Buyer checks whether the Seller will send an Invoice, or whether the trading arrangement with the Seller requires a Recipient Created Tax Invoice (Evaluated Receipts Settlement). If an Invoice is expected it must be awaited in parallel to the Despatch Advice (i.e. these two documents may arrive in any order).

5. The next two sub-steps happen in parallel (i.e. if Dispatch Advice and Invoice are both to be sent, they can go out in any order)

5.1 The Seller checks whether their trading agreement with the Buyer includes RCTI (ERS), and if not, an Invoice is sent to the Buyer.

5.2 The Seller sends an Despatch Advice to the Buyer at the point that the delivery arrangements for the ordered goods are known.

6. The Buyer receives the Despatch Advice. In parallel an Invoice is created if this is an RCTI process, or an Invoice is received if it is not. Once both Despatch Advice and Invoice are present the process terminates.

3 Technical Perspective

3.1 Introduction

The Technical Perspective of an architecture is intended to provide lower level details of the implementation of a set of services which provide the functionality specified in the Organisational Perspective.

This section discusses the technical functionality provided by e-procurement hubs, including the ability to communicate with suppliers by a variety of mechanisms which are outside the scope of this architecture. It then goes on to specify the messaging infrastructure which will be used for communications between the buyers and hubs, and in some cases between buyers and sellers directly, and in other cases between hubs and sellers.

Finally, a number of other technical considerations are discussed.

3.2 Direct Connection and Hub Transparency

The architecture explicitly allows for a buyer to directly connect to interfaces implemented for e-procurement messaging by a supplier (and vice versa). In Figure 6 the green and red "T pieces" represent the interfaces through which the messages are sent.

This architecture treats any procurement hub (or hubs) that are used as agents to deliver a business document to a trading partner as a proxy for that trading partner. In other words the interfaces and messages supported by the hub are the same as those supported by buyers and sellers that are interacting directly. Figure 6 shows a message being sent from a buyer to a supplier in three different ways, each of which uses the same interfaces and messages. The diagram shows the same message, represented as a yellow square, being sent from Buyer to Supplier, directly, indirectly via a hub, and indirectly via two interconnected hubs.

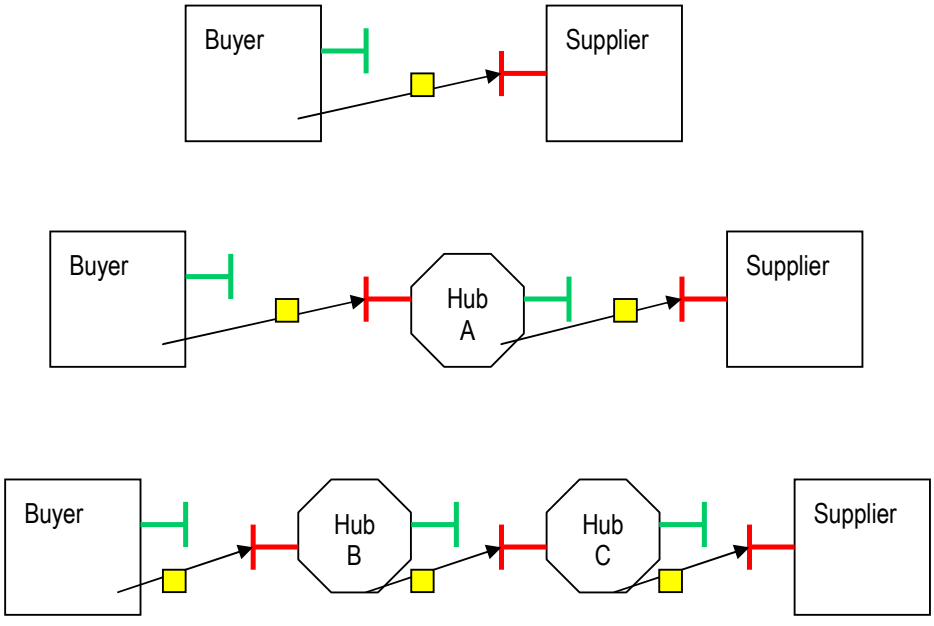

Figure 6: Hub Transparency

The hubs support the same kind of interface as the supplier, and so the Buyer is making the same kind of invocation on the interface regardless of whether

it is sending the message directly to the Supplier, or via one or more hubs. This is what is known in distributed systems as *hub transparency*.

The same mechanism applies to messages sent in the opposite direction – from Supplier to Buyer, except that the buyer-supported (green T-piece) interface would be used instead. As long as the end recipient is correctly identified by the message, it does not matter how many identical invocations on a red Supplier interface are made before the message is eventually delivered from Buyer to Supplier.

The diagram also shows how the hub interconnect model works. That is, each hub acts toward the next caller down the line as if it were the end recipient of the message. Each participating hub will have knowledge of which parties use which hubs for their messaging, and so in practice messages will never need to be sent via more than two hubs – the one contracted for messaging by the buyer, and the one contracted by the supplier (as in the bottom row of the diagram). If both parties are connected to the same hub, then the middle row in the diagram represents the message passing scenario.

3.3 Hub Functionality

3.3.1 Store and Forward

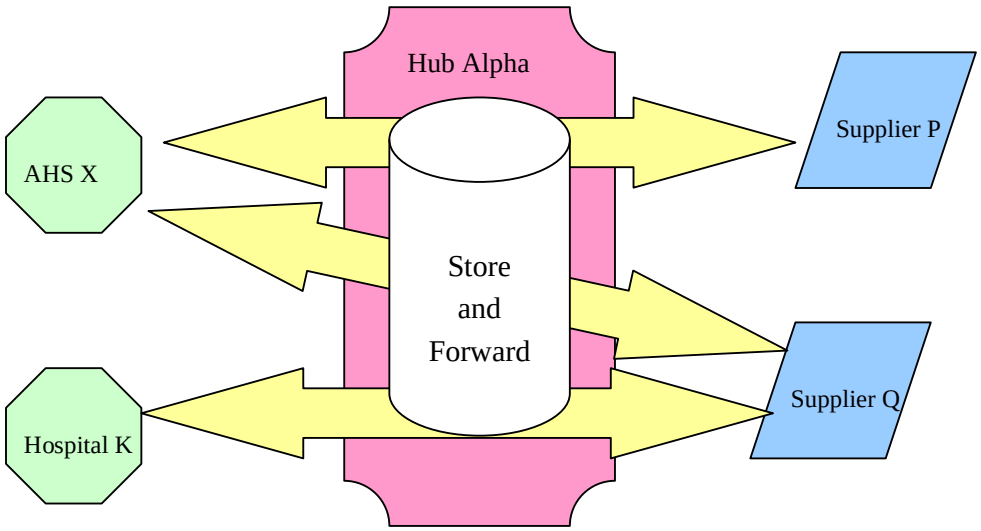

Figure 7. Store and forward capability

One of the primary properties of an e-procurement hub is its high availability to both buyers and sellers, even if buyers and sellers are only infrequently connected. The hub has the role of a post office with mailboxes for all interacting parties, and it reliably stores the documents that are transmitted during the e-procurement public process instances that are being conducted by the buyers and sellers. It stores messages on behalf of both parties, and forwards them when either party connects to it. This has been the traditional role of EDI Value Added Network (VAN) providers.

3.3.2 Message Transformation

In addition to store-and-forward functionality, hubs also provide the ability to transform documents from one syntax to another, and to allow different technical messaging protocols to be used by different subscribers.

The range of communication types between e-procurement hubs and suppliers varies in two aspects: channel (communications protocols) and message format. Message formats include legacy EDI formats, and older XML

standards, as well as proprietary formats and CSV files. The hubs use the term "channel" to mean the technical messaging protocol stack used to convey messages to and from a client of the hub. Technically it is possible for most formats to be communicated over most channels, but in actual usage these tend to come in particular combinations. In Figure 8 the different coloured arrows represent a number of example format and channel combinations. An example from the figure is EDIFACT over A2. In this case the message format is defined by UN/EDIFACT, and A2 is a protocol stack standardised by the IETF that uses HTTP and MIME over TCP/IP or SSL.

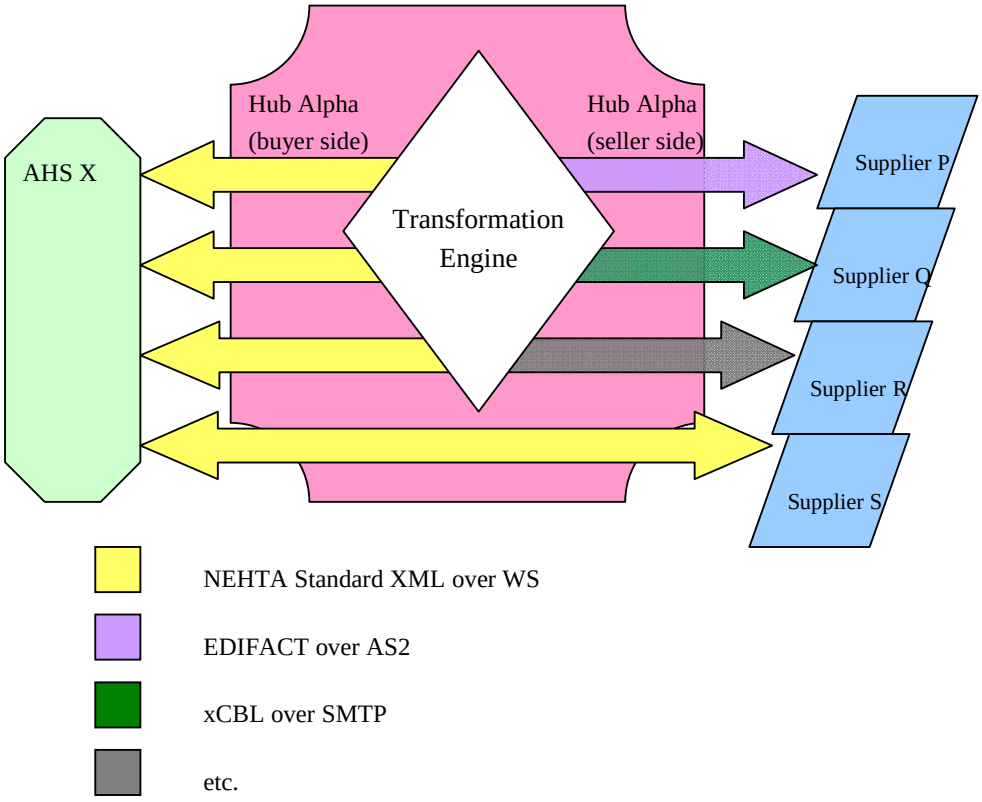

Figure 8. Message Transformation

In Figure 8 there is a buyer (Area Health Service X) which is engaged in several public e-procurement process instances with different sellers. The buyer can use the same technical messaging protocols to send documents formatted using the same XML standard for use by all of the sellers (indicated by yellow arrows in the figure). The hub then transforms the documents into a format preferred by the seller and connects to the seller using their preferred channel. Documents sent back from the seller are also transformed back into the NEHTA format used by the buyer, and the hub connects to the buyer using the NEHTA Secure Messaging protocols.

3.4 Secure Messaging

This section will refer to work done in the Secure Messaging initiative in NEHTA. The approach taken in this project is to use Web Services for messaging, and a Service Oriented Architecture to relate these service to the business requirements. The profile of W3C standards to implement the Web Services stack will include HHTP for transport, WSDL for service definitions, SOAP for transporting requests on service interfaces, and WS-Security for security. WS-Addressing may be used to provide the addressing information required by hubs to route messages between buyers and sellers.

The specific versions of these standards will be determined by the Secure Messaging Initiative, based on the availability of implementations of these standards for the technology environments in which the jurisdictions operate. This will be done in time to coincide with the availability of the public process definitions referred to in Section 2.5, and the technical document specifications referred to in Section 4.1.2.

3.4.1 Protocol Layers

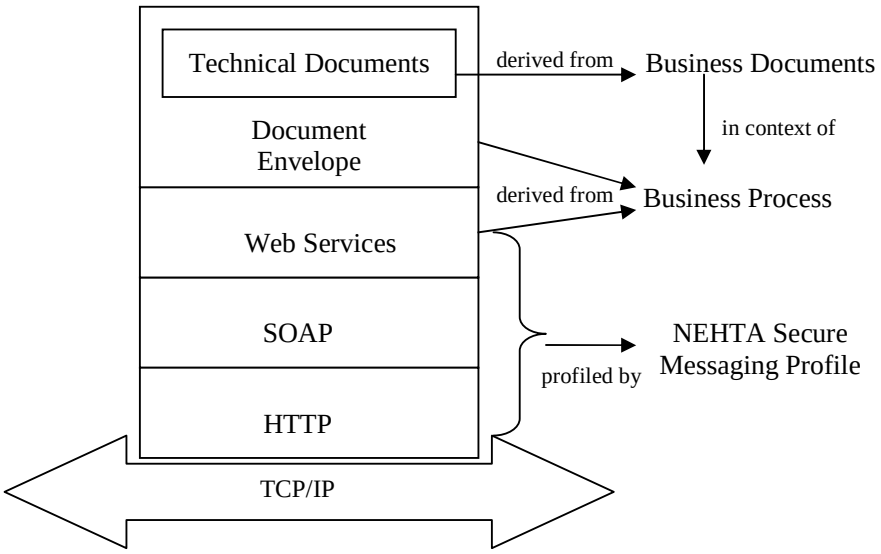

Figure 9. Protocol Layers and their Derivation

Figure 9 shows the protocol stack to be used for e-procurement messaging, and some relationships to other parts of this architecture, and the NEHTA Secure Messaging Protocol. The *Technical Documents* will be XML that conforms to the XML Schemas derived from the *Business Document* specifications in [AS5023]. The *Document Envelope* will contain some business process context, and perhaps addressing and reliability information. The *Web Services* will be interfaces defined in WSDL, derived from the document exchanges in the business process. The lower layers of the protocol will be specified by the Secure Messaging Initiative.

3.4.2 Quality of Service

The Quality of Service characteristics of interactions with an E-Procurement Hub Service are spelled out in the *E-Procurement Hub Service Technical Requirements* document. This document specifies:

- Performance Requirements
- Scalability Requirements
- Availability Requirements
- Security Requirements

3.5 Additional Technical Considerations

Figure 10 shows all of the aspects of Organisational and Technical Perspectives in a single diagram. Aside from the processes and documents, and the derived Web Service definitions that will be used to interchange e-procurement data, there are a number of additional constraints that this architecture imposes.

3.5.1 NEHTA Protocols for Interconnect

The transformation part of the hub's role is logically placed at the seller side of the hub. All messages shall be interchanged between the hubs using the NEHTA standard messages and protocols. This allows each hub to choose which kinds of messages and protocols, over and above the NEHTA standard, they will offer to their sellers, and does not presume that any hub supports any particular non-NEHTA-standard set of messages and protocols.

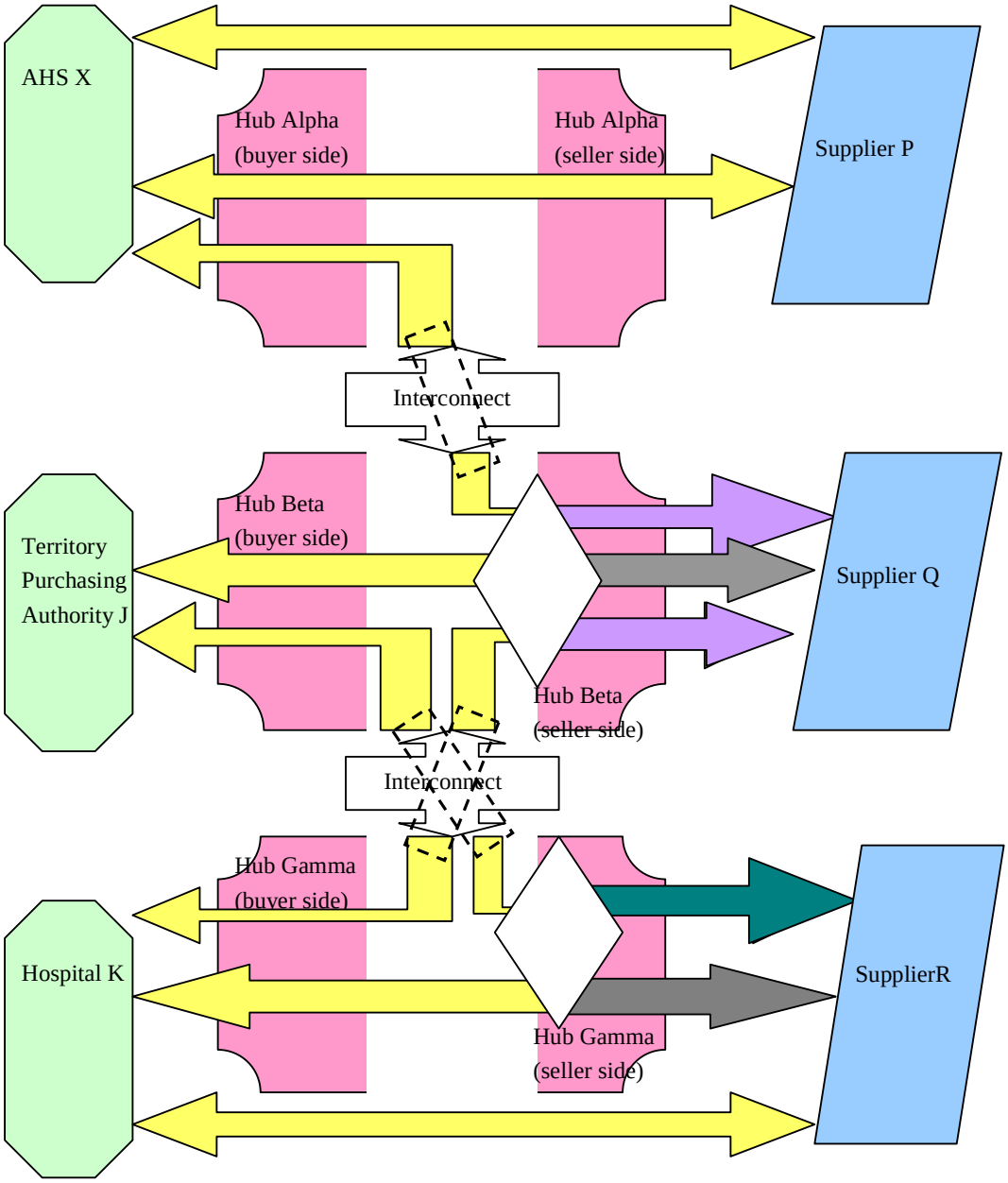

Figure 10. The Overall Architecture

3.6 Enabling Suppliers with Low Technical Capabilities

In addition to the ability for transmission of machine readable documents over various channels to a supplier, e-procurement hubs provide other possible enabling technologies for suppliers who do not have the capability to implement computer manipulations of electronic documents.

3.6.1 Web-based applications

Most e-procurement hub providers implement a suite of web-based applications that allow suppliers (or purchasers) to view human-readable forms of electronic documents using a web browser. In addition, the applications allow the user to create new documents based on the ones that they are viewing. For example, a supplier can log on to the application at the hub provider's web site, and view a new Purchase Order which has been received. They can then create a Purchase Order Response by clicking on a button, and using the web interface to edit line items that cannot be supplied as requested. The Purchase Order Response can then be sent to the buyer, and the buyer can receive it via a standard NEHTA XML message over Web Services.

This kind of web application service is usually coupled with email messages alerting a supplier that they have new documents waiting to be processed at the web site. These web-based applications place a relatively low degree of technical burden on a supplier, and the costs of having an internet connection and maintaining a computer that can receive email and browse the web are usually covered by other aspects of the supplier's business in any case.

3.6.2 Fax and Document Processing Services

The lowest technological capability currently required in order to supply goods to the Health Sector is telephone line and fax machine. The ability of many hubs to create PDF documents from XML messages is already in place. These can be automatically faxed by an application and no human intervention is required. However, in order to receive replies to these faxes, while maintaining all of the efficiencies of e-procurement for the buyer, a document processing service is required where a human re-keys information on faxed documents received from suppliers. This could be facilitated by the kind of web application described in Section 3.6.1. The costs associated with this kind of processing are non-trivial, and would be borne by the supplier (unless some kind of subsidy for small business is instituted as a matter of government policy). Any reasonable volume of document processing will result in costs that probably exceed that of establishing an internet capability.

This kind of service exists in Denmark to assist business to comply with the government's requirement to receive all invoices in electronic form. The cost is one Euro per transcribed invoice, with a subsidy for very small businesses.

4 Informational Perspective

4.1 Document Types

There are sixteen kinds of document identified by IT-014-10-01 in Australian Standard 5023. This architecture will select a subset of these. The standard then goes on to describe these as *data sets* which represent the business documents using a tabular form of fields to be contained in the documents, and business rules for validating the correct formatting of any given document instance. These rules include fields being optional/mandatory, repeating, and having dependencies on other fields.

4.1.1 The Standard Messages

The following is an extract from AS 5023 briefly describing the five messages chosen for Health e-procurement in consultation with the jurisdictions. These are specified in parts 2 and 4 of the standard (the numbering is from the standard):

> *(b) Purchase order*
>
> *Purchase order message including stand-alone order, release against standing offer arrangement.*
>
> *(c) Purchase order response*
>
> *Response to purchase order, indicating ability to supply.*
>
> *(e) Despatch advice/Advance shipping notice*
>
> *Identification and advice of shipment(s) that have been or will be imminently sent to the customer. Customer receipt of the despatch advice message shall precede the arrival of the physical shipment.*
>
> *(f) Invoice*
>
> *Invoice for goods or services.*
>
> *(h) Purchase order change*
>
> *Change to a previously sent purchase order message.*

4.1.2 Technical Document Specifications

4.1.2.1 Buyer Perspective

The data sets (document types) described in AS 5023 are at the business level, and specified independently of any technological framework. The format favoured by NEHTA for technical document specifications is XML Schema (XSD format). This follows the requirement by the jurisdictions for a single format in which procurement business documents can be encoded for transmission to all suppliers.

4.1.2.2 Seller Perspective

There are a number of large suppliers to the health domain which have long standing implementations of EDI messaging. E-Procurement hubs are capable of transforming between XML and EDI messages, and will do so for a set of additional charges. Depending on the hub's business model, these include a charge for implementing the transformation, and/or a charge to transform each document.

4.1.2.3 Deriving the XML Documents

There are two possible approaches to creating XML technical document specifications which use the AS 5023 standard as their semantic specification:

1. Adopt an existing set of technical documents (e.g. GS1 or UBL XML Schema) and provide a mapping from the semantic descriptions in AS 5023 to the fields in the XML document schemas. This approach has three main risks:
    a. There may be some fields described in the standard which do not have an exact equivalent in the chosen technical documents, and mappings may have to use other fields that are do not have similar names, or do not have exactly the correct representation (e.g. using a string to represent a number). This impacts on quality of validation that can be done using the business rules.
    b. Any fields which are in the extant document schemas and which are not used by the mapping are superfluous.
    c. The documents are stand-alone, and do not capture the process context within which the document is to be transmitted. This means that additional work will need to be done to envelope the documents with wrapper information that is designed to represent this context.
2. Apply the UN/CEFACT Modelling Methodology (UMM) to the semantic descriptions in AS 5023. This methodology uses well understood data type libraries, and UML profiles to create the human-readable, but technically well structured UML models of the documents, and the public processes in which they are used. The models include processes, transaction patterns, and documents as derived from the business-level specification. Then these UML models are mapped to XML Schema (and possibly other formats) using a rigorous standard transformation. The XML generated includes reusable document schemas, as well as enveloping schemas to represent the process context, and the interface and bindings types used to transmit the in-context documents. This approach has been applied by AGIMO in its GovDex work to National Name and Address standards. The main risk of this approach is:
    a. Time required to learn the methodology and develop the models may move deliverable deadlines outwards
    b. The derived documents have no relationship to existing document types, and supplier which already implement another kind of XML documents cannot leverage that implementation and make small adjustments, as would be the case in the mapping approach.
    c. The existing mappings to XML Schema and Web Services that come with tools for the methodology may be incompatible in style to the Secure Messaging Architecture.

5 Glossary

Activity Diagram	A UML model and diagramming standard for representing processes and data flows.
AS2	Applicability Statement 2 is a specification about how to transport data securely and reliably over the Internet. It is specified by IETF in RFC 4130. It supports encryption and digital signing, and non-repudiation. It uses HTTP over TCP/IP or SSL.
CSV	Comma Separated Value. A text file format where table column entries are separated by commas, and rows by newlines. This format is often exported from spreadsheets and databases.
EDI	Electronic Data Interchange. A late 1970s initiative to interchange documents between business partners in electronic formats.
GS1	Global Standards 1. A not-for-profit global standards body for bar codes, product data synchronisation and RFID technologies.
HTTP	Hypertext Transfer Protocol. A standard protocol for transferring documents – used in the World Wide Web, and Web Services.
IETF	Internet Engineering Task Force. The body that standardises much of the protocol infrastructure for the internet.
MIME	Multipurpose Internet Mail Extensions
SOAP	Simple Object Access Protocol. A protocol for exchanging XML-based messages over computer network. A fundamental part of Web Services.
SSL	Secure Sockets Layer. A cryptographic protocol for private communications over the internet.
TCP/IP	The fundamental transport protocols of the internet, over which all other application layer protocols (such as SSL and HTTP) are transmitted.
UBL	Universal Business Language. A set of XML documents designed at OASIS for business interchange. Includes all of the e-procurement documents.
UMM	UN/CEFACT Modelling Methodology.
UML	Unified Modelling Language.
VAN	Value Added Network. A store and forward service for transmitting EDI messages between business partners. Historically this was done with modems or leased lines, but now VANs operate over the internet.
WSDL	Web Services Description Language.
XML	eXtensible Markup Language.
XML Schema	A language used to prescribe formatting rules for XML documents.

XSD	XML Schema Description. The file type for XML Schema documents.
UN/EDIFACT	United Nations/Electronic Data Interchange For Administration, Commerce, and Transport. A set of standards established by the UN Centre for Trade Facilitation and Electronic Business.