SWI Project
SWI Semantic Interoperability Discussion Paper
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SWI – SEMANTIC INTEROPERABILITY

Discussion paper

1. Context and objective of this discussion paper

Single Window interoperability (SWI) is the subject of an UNECE activity whose ultimate goal is to produce a Recommendation 36 which will complement Recommendations 33, 34 and 35.

Considering the complexity of the subject, it has been considered wise to subdivide the work into four task forces:

- Business needs involved in SWI
- Semantic aspects of SWI
- Governance of SWI
- Legal aspects of SWI

The different parallel activities will be synthetized twice:

- In the first place, four **discussion papers** will be regrouped and their views harmonized if needed.
- The work will be improved to upgrade the discussion papers and turn them into **White papers** which will be used to structure a Single Window (SW) symposium which address specifically the Single Window interoperability issue. This conference will probably take place end of 2015 but the date is not yet fixed.

This discussion paper is about the semantic aspects of SWI: How can semantic interoperability be achieved?

2. Definitions

- **Semantic** is the study of meaning. Linguistic semantics is the study of meaning that is used for understanding human expression through language. Semantic analysis can be relevant to a number of other domains such as linguistics & semiotics, logic & mathematics, psychology… However, in this discussion paper semantic has a reduced and limited meaning.

  The trend of trade facilitation is to develop the use of information and communication technology in order to exchange data electronically between trading partners. For this it is obvious that the meaning of information exchanged must be identical. Semantic work confronts different ways of naming and describing things unambiguously. In an electronic data exchange, the result is the establishment of national harmonized or standardized data sets. Using these data sets the trading partners assign the same meaning to the information exchanged.

- **Semantic Interoperability** implies that the precise meaning of data exchanged electronically is preserved and well understood in an unambiguous manner, independent of the way in which it is physically represented or transmitted. Separating the model from the technology allows for alignment of business processes while still supporting variations in both business practices and information technology. This is fundamental to the concept of technology neutrality. Particular implementations, however, do require models to be expressed into technology-specific syntaxes

and this can be achieved by using UN/CEFACT's technical specifications, such as UN/EDIFACT (ISO 9735) and UN/CEFACT's Naming and Design Rules for the Extensible Markup Language (XML).

- **SW Semantic Interoperability** is verified when two or more SWs perform mutually agreed business processes using predetermined electronic messages containing data whose meaning is identically interpreted by independent parties because they refer to a mutually agreed standardized data set. These messages can be as simple as sending a document and receiving an acknowledgement but may encompass more complete conversations (choreography of transactions).
- **Business processes** is the detailed description of the way participants intend to play their respective roles, establish business relations and share responsibilities to interact efficiently with the support of their respective information systems. Each business transaction is realized by an exchange of electronic business documents (also called messages). The sequence in which these documents are used, compose a particular instance of a scenario and are presented as use cases. Business processes can often be visualized with a flowchart as a sequence of activities (business process model) with associated decision points or with a process matrix as a sequence of activities with relevance rules based on data within the process.

3. Basic principles and levels of semantic interoperability

Interoperability is achieved at different layers: data-set creation methodology, data sets, business processes and messaging.

3.1. Data set creation methodology

- UN/CEFACT Core Component Technical Specification (CCTS) 2.01 – a methodology for developing a common set of semantic building blocks that represent the general types of business data in use today and for the creation of new business vocabularies and restructuring of existing business vocabularies.

3.2. Data-set level

At a data level, interoperability of two or more countries' data sets is set out within the UNECE Recommendation 34. The ultimate goal is to define one standard set of data and messages to meet all governmental information requirements related to import, export, and transit procedures. One of the objectives of data simplification is to eliminate redundancies and duplication in the submission of international trade and transport data to government authorities.

In the context of SWI, this data-level interoperability may address all import, export and transit procedures between the participating countries. Or it may only address a mutually agreed subset of these procedures. It could alternatively even be enlarged to include other sectors.

The alignment of two or more standardized data sets has important consequences in terms of safe supply chains and trade facilitation for enterprises but do not necessarily mean that business processes and their corresponding electronic exchange of information are identical and do not necessarily lead to cross border exchanges.

It is preferable to base data harmonization on recognized international standards. This should allow inclusion of other participants at a later time, or interoperability with other systems not included within the scope of the SWI project. Depending on the standard organization's participation, such international standards will likely have been the result of key stakeholders in a number of domains and in a number of economies. This approach also provides coordinated updates and version management for exchanged data sets. This is the case of data standards and processes developed within UN/CEFACT, building on several decades of collaboration between countries and between the private and public sectors. Some of the results from this include:

- UNTDED – a joint UNECE and ISO standard with over a thousand data elements. It is referenced within ISO under the International Standard ISO 7372. The Maintenance Agency is composed of inter-governmental and non-governmental bodies.
- UN/CEFACT Core Component Library (CCL) - a library of business semantics in a data model which is harmonized audited and published by UN/CEFACT. The CCL uses Core component Technical Specifications (CCTS) to ensure consistency and interoperability. The library has contributions from many organizations including government and business and deals with cross border trade for messages for Buy – Ship – Pay business processes.

3.3. Business process level

When two national SW systems want to exchange information, they need to have agreements concerning their common business processes. The modelling of these processes should be based on approved modelling techniques such as such as the UN/CEFACT Modelling Methodology, which is based on the Unified Modelling Language (UML).

As outlined in Recommendation 34, when analyzing the harmonization of the data sets, it will be necessary to consider the implications of each data element's use within the context of the related process. Insofar as possible, the related processes should be aligned.

The alignment and harmonization process may result in an overwhelming mass of information. For this reason, the SWs which are seeking interoperability may wish to start by concentrating on certain aspects or domains which will be the initial subject of interoperability, then eventually roll out to other aspects or domains.

- UN/CEFACT Business Requirement Specification (BRS) – The BRS is the mechanism for documenting user requirements and guiding the standards development process.
- Unified Modelling Language (UML) is a modelling language for design systems developed by the Object Management Group (OMG). It can include class diagrams, sequence diagrams, etc.
- UN/CEFACT Modelling Methodology (UMM) is a UML modelling approach to design the business services that each business partner must provide in order to collaborate. It provides the business justification for the service to be implemented in a service-oriented architecture

3.4. Message level (syntax)

Business processes are executed by the exchange of messages. The content of these messages needs to be agreed by both parties: sender and receiver. They are assembled using the above mentioned standardized data sets.

Interoperability at the level of XML Schemas implies the harmonization of naming rules and technical standards (of data models); class diagrams, class level, attribute level should be prolonged with xml schemas.

- This XML Naming and Design Rules (NDR) specification is based on the World Wide Web consortium suite of XML specifications and the UN/CEFACT Core Components Technical Specification (CCTS). This specification defines XML Schema and Schema documents which are published and form the basis of UN/CEFACT standards publications. It has been developed to provide consistent and computer generated XML expressions of libraries created using CCTS specification. Therefore it takes a specific semantic data model and transforms it into its syntactic equivalent.

4. Scope of SW interoperability

The scope of SW interoperability can be understood by reference to two criteria: geographic coverage and sector coverage.

4.1. Interoperability between national regulatory SW (bilateral interoperability)

Two countries that mutually agree on interoperability on partial or complete interoperability of their national single windows. Some examples include:

- South Korea & the Philippines
- The United State of America & Canada
- Oman & Malaysia

4.2. Interoperability of multiple single windows within a same region (regional interoperability)

Multiple countries within a same region agree multilaterally to either create a regional single window with which each national single window will interoperate or to fully align all of their national single windows to achieve full regional interoperability. Some examples include:

- ASEAN Single Window (ASW - government agreement, all types of information)
- African Association for electronic commerce (AAEC)
- Pan-Asian Alliance (PAA - private/ any type of information if bi or multilaterally available)

4.3. Interoperability of multiple single windows across different regions (inter-regional interoperability)

Multiple countries in different regions agree multilaterally to either create an inter-regional single window with which each national (or regional) single window will interoperate or to fully align all of their national (or regional) single windows to achieve full inter-regional interoperability. Some examples include:

- APEC (Asia Pacific Economic Cooperation)
- SELA (Sistema Económico Latinoamericano)

4.4. Sectorial interoperability

It is reminded that the scope of a single window as defined within UNECE Recommendation 33 is a facility that allows parties involved in trade and transport to lodge standardized information and documents with a single entry point to fulfil all import, export, and transit-related regulatory requirements. For practical reasons, governments may prefer to concentrate only on a specific sector when discussing interoperability with partner countries. Some examples can include:

- Air-sector interoperability between countries (eventually using the data model and messages defined by IATA, Cargo XML or CARGO IMP)
- Customs-only interoperability between countries (using the data models and messages defined in the World Custom's Organization Data Model)
- Maritime-sector interoperability between countries (As can be reflected in the European Union's e-Maritime Single Window project, or the MIELE project between Korean & Italy. The work of IMO can also assist in progressing interoperability within the maritime sector.)

5. Framework for measuring semantic interoperability

To be developed.

6. Issues and challenges (miscellaneous)

6.1. Achieving interoperability on a global level

One of the main challenges today is a lack of interest for interoperability outside of limited domain uses. There are however a number of international organizations which are working towards standards which contribute to interoperability on a global level.

ISO-IEC-ITU-UNECE MEMORANDUM OF UNDERSTANDING

These four international standards organizations (International Organization for Standards – ISO, International Electronic Commission – IEC, International Telecommunication Union – ITU, and the United Nations Economic Commission for Europe – UNECE) have concluded an agreement which aims to coordinate the members' efforts on standardization and avoid duplication of work.

One recent joint project has been a proof-of concept whose main goal is to develop semantic interoperability across consumers, industry and governments by reference to the following requirements:

- Clear definition of concepts
- Governance and operation of the vocabulary, in a web-enabled syntax neutral environment
- The processes for discovering concepts and reusing them to foster interoperability
- The process for defining and agreeing extensions to the vocabulary
- Support for multiple representations
- Support for multiple languages
- Implementation support tools, including mapping between native data in applications and the vocabulary
- Use of tools such as SKOS (simple knowledge organization system) and RDF (resource description framework)
- Deployment of the vocabulary – Publicly Available Free of Charge

6.2. Conformance versus compliance versus consistent to international standards

When the implementation of a given solution is defined solely with the terms and within the scope of a given standard, then it can be considered compliant.

When the implementation of a given solution uses all of a given standard and builds upon that, it can be considered conformant. However the extensions which were added may not be interoperable with other solutions since not included within the referenced standard.

When the implementation of a given solution uses only parts of a given standard and builds extensions upon that, it can be considered consistent. Again, the extensions which were added may not be interoperable with other solutions since not included within the referenced standard. What's more, as not the entire referenced standard is used, there is a chance that another party which used the same standard might not be able to align since parts will be missing from the "consistent" solution.

6.3. Actors needing to comply with multiple single windows

In an international supply chain, it is possible that a single actor will need to comply with multiple single windows. This may be obvious for actors with operations in multiple countries, each with their own national single window. However, there can be cases within a national environment with multiple single windows each handling regulatory procedures.

6.4. Different levels of experience

Single window implementers may have varying levels of experience making negotiations of interoperability a challenge. Some long standing implementers may have a very mature system and rich experience background which a country that has just begun its implementation will not have. Such an imbalance may make alignment a challenge as lesser experienced implementers may have requests which are based more on preconceptions rather than on actual experience and application of the principles set out in UNECE Recommendations 33, 34 and 35.

6.5. The importance of context

The impact of sectorial and official contexts on SWI will be important and absolutely necessary. However due to the existence of harmonized data models and standard libraries, it will be possible to establish semantic interoperability between SW systems in a relative sense without prejudicing the remaining differences between different contexts.

From CCTS 2.01 we have selected the following example which illustrates the notion of context and shows that electronic exchanges are not completely standardized precisely because they need to be adapted to the context in which they are used but are nevertheless calibrated by the reference to generic concepts:

An invoicing Business Process uses a piece of information such as Invoice. VAT_ Tax. Amount.*
Invoice. VAT_ Tax. Amount is a Basic Business Information Entity that is based on the Basic Core Component of Invoice. Tax. Amount.
The invoicing Business Process is using Invoice. Tax. Amount in a specific Business Context where the Business Process Context = Purchasing, and the Geopolitical Context = EU.
Therefore the application of Context adds a specialized definition, but in all other respects the Basic Business Information Entity is the same as the associated Core Component of Invoice. Tax. Amount, i.e. it has the same structure and Data type.
*In accordance with rule [B17], VAT would be defined as Value Added Tax in the definition for the Basic Business Information Entity of Invoice. VAT_ Tax. Amount.

In CCTS 2.01 we find 395 occurrences of the string context.

The existence of different contexts in which developments occur results in the adaptation of a particular system to the different national or regional SW systems with which it communicates.

Annexes

I - Cases of SW semantic interoperability

1. Interoperability between regulatory SW systems of two or more countries.
    a. Example 1: Case study Korea Philippines.
        i. MOU
        ii. Terms of reference
        iii. Data alignment; WCO Data model
        iv. Impact on custom law

v. Impact on process and national standardized data sets

b. Example 2 : US Canada Single Window alignment

i. Declaration by President Obama and Prime Minister Harper of Canada

ii. Implementation of the WCO data model

iii. Data alignment package; data match/mismatch; additions, impact on national standardized data sets

iv. No G2G exchanges; priority is on Safe Supply Chains

c. Example 3: Oman Malaysia

2. Global Regional Single Window interoperability

a. ASEAN Single Window

i. Scope: Regulatory and other private information enabling global e-Supply Chains

ii. Goal: To strengthen the coordination and partnership among ASEAN Customs Administrations and relevant line ministries and agencies, and economic operators to effectively and efficiently implement the ASEAN Single Window.

iii. Methods: The member states are committed to adopt relevant internationally accepted standards, procedures, documents, technical details and formalities for the effective implementation of the ASEAN Single Window.

iv. Stakeholders : Customs and OGA, importers, exporters, transport operators, express industries, customs brokers, forwarders, commercial banking entities and financial institutions, insurers, and those relevant to the international supply chain.

b. Example 2 : International Maritime Organization

i. Scope : Port Single Window (authorities at port level)

ii. Outcome : Guidelines for setting up a Single Window system in maritime transport

iii. Methods : UNCEFACT best practices in general

3. Regional sectoral Single Window interoperability

a. Example 1 : e-Maritime

i. Scope : SW for European port authorities

ii. Goal : A uniform SW for European port authorities

iii. Methods : Reference to the CCTS 2.01

iv. Outcome : Models and XML schemas

II: Comparison Matrix of Semantic Interoperability by stakeholders

To be developed.