SWI – SEMANTIC INTEROPERABILITY
Discussion paper

1.   Context and objective of this discussion paper

Single Window interoperability is the subject of an UNECE activity which 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 : is there an interest in exchanging data between different SW systems
- Semantic aspects
- Governance and technical aspects of SW interoperability
- Legal aspects of SW interoperability

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 deadline if the forthcoming UNCEFACT Forum (September 2014).
- The work will be improved after the Forum to upgrade the discussion papers and turn them into **White papers** which will be used to structure a new conference Single Window conference which address specifically the Single Window interoperability issue. This conference will take place in 2015 but the date is not yet fixed.

This discussion paper is about Semantic aspects: How is semantic interoperability 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. Other domains relevant from a semantic analysis exist such as linguistics and semiotics, logic and mathematics, psychology.
  In this discussion paper, semantic has a reduced and limited meaning.
  The trend of trade facilitation is to develop the use of ICT in order to exchange data electronically thus dematerialized 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 and the result is the definition of national harmonized or standardized data sets - SDS). Using these data sets the trading partners assign the same meaning to the information exchanges.
  However defining SDS is not sufficient to trade electronically. The partners do not exchange information parcels.
  They execute business processes BP, by means of procedures materialized by information flows themselves often implemented as electronic documents e-Docs.

- **Semantic Interoperability** [1] is – following Wikipedia – "the ability to automatically, correctly and accurately interpret the information exchanged, in order to produce results as defined by the end users of both systems. To achieve semantic interoperability, both sides must refer to a common reference model for information exchange. Also the content of the information

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[1] Definition of interoperability by IEEE: Ability of a system or a product to work with other systems or products without special effort on the part of the customer. Interoperability is made possible by the implementation of standards.

requests must be unambiguously defined, so that what is sent is the same of what is understood".

- **SW Semantic Interoperability** is verified when two or more SW perform mutually agreed business processes using predetermined electronic documents (in short e-Documents[2]) containing data which meaning is identically interpreted by independent parties because they refer to a mutually agreed standardized data set. A business process is a sequence of electronic documents constituting a conversation. A conversation can be as simple as sending a document and receiving an acknowledgement but may encompass more complete conversations (choreography of transactions).

- **Business processes** is in the case of SW a collection of related, structured activities or tasks that produce a specific service or product (serve a particular goal) for a particular customer or several customers. It can often be visualized with a flowchart as a sequence of activities with interleaving decision points or with a Process Matrix as a sequence of activities with relevance rules based on data in the process.

- **Procedure** is a series of tasks to be imposed. It usually respond to requirements that are not questionable by the operator executing the procedure. For example, we talk about security procedure or administrative procedure or judicial procedure. In the case of regulatory obligations, procedures are defined by law, directives, and other texts.

- **Interconnectivity** characterizes two SW systems which are interlinked by means of functional services such as communication protocols, messaging systems, security services, and business process execution solutions. Semantic interoperability builds on interconnectivity of SW systems to enable electronic trading[3].

3. Basic principles for semantic interoperability analysis

- **Data level**

At data level semantic interoperability is obtained by applying the Recommendation 34 with an extended scope to cover the National Single Window [NSW] of two or more countries. A Standardized Data Set - SDS - is thus defined either by the confrontation of two (or more) pre-existing SDS followed by their alignment or by the definition of a mutually agreed SDS. The SDS may cover a subset of all the possible exchanges and may be extended in a second step to cover a wider domain.

The alignment of two or more SDS have important consequences in terms of safe supply chains and trade facilitation for enterprises but do not necessarily mean that business processes and their corresponding e-Documents are identical and do not nessarily lead to crossborder exchanges.

- **Business Processes and e-Document levels**

When two NSW systems want to exchange information, they need to have agreements concerning their common business processes. It is recommended to produce models of business processus using the Unified Modelling language – UML – following UN/CEFACT modalities which constitute the UN/CEFACT Modeling Methodology or UMM.

Commentaire [RM1]: In Rec 34, both terms Process and procedure are used.

Commentaire [RM2]:

Commentaire [RM3]: We might say that a business process is the implementation of a procedure.

Commentaire [RM4]: US and Canada have signed an agreement to establish a common SDS ased upon the WCO data model but their documents and processes are different.

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[2] e-Documents have other names in the standards elaborated by different Standard doing organizations. UN/CEFACT names e-Documents Messages (such as Order Message), the ebMS messaging specification names e-Documents PayLoad, and Transaction sets are often used to name e-Documents. The term Message is somewhat confusing since it is also used to name the messaging system used to exchange information over telecommunication networks.

[3] A detailed presentation of the concepts of semantic interoperability and of interconnectivity can be found in the ISO 14662 Third edition Open EDI Conceptual model (2010). Semantic interoperability is named Business Operation View and Interconnectivity is named Functional Service View.

Business processes are executed by the exchange of e-Documents. The content of these documents need to be agreed by both parties, sender and receiver. They are assembled using the Standardized data set.

The obtain interoperability of business processes between associated Single Window systems, it is necessary to perform the tasks similar to the tasks described in Recommendation 34, namely capture/define/analyse/reconcile, but applied to their shared business processes.

This analysis can build upon the experience gained by the UNeDocs project.

The effort to establish semantic interoperability of two or more SW systems is important and should be done step by step, prioritizing a selection of domains important for the SW concerned.

4. Levels of semantic interoperability

- Reference to TDED[4]: The TDED has 1083 elements; their definitions are available from the UN/ECE web pages. The TDED model is also very close to implementation as it is directly translatable to UN/EDIFACT data elements (EDED). TDED brings interoperability at the data level.
- Reference to the specification of Core Components CCTS 2.01 or 3.0[5]. without feed back to the UN/CEFACT Core Components Library CCL (case of UBL). Reference to CCTS brings interoperability at the data level due to the applications of the same rules defined in the specification. According to OASIS, these rules are not producing identical results between their different users because the rules in the CCTS specification are subject to interpretations.
- Reference to CCTS and to the UN/CEFACT Core Components Library (CCL). CCL is a more abstract specification than TDED, based upon the CCTS. CCL has around 6000 elements. However all TDED elements are not explicitly included. CCL that can represent several TDED elements in a more generalized CCL definition. The definition is also much more extensive and contains a number of fields of various function. When a Single Window interoperability program is developed it may create new Core components in which case it is recommended to populate the UN/CEFACT CCL using the Data Management Request procedure.
- Definition of a Standardized data set between different two or more SW (based upon Rec 34 with an extended scope)
- Definition of mutually agreed models. Reference to UML models, various diagrams, business processes.
    - Class diagrams, Class level, Attribute level
    - Use case diagrams, sequence diagrams etc.
- Interoperability at the level of XML Schemas. Harmonisation of naming rules and technical standards (of data models) - Class diagrams, class level, attribute level – should be prolongated with xml schemas.

    UN/CEFACT XML Schema definitions are based on UMM metamodel adherent business process models. The UNCEFACT naming and design rules specification (NDR) is used by UN/CEFACT to define XML Schema and XML Schema documents published as UN/CEFACT standards. The NDR was supposed to be used by other Standards Development Organizations interested in maximizing inter and intra-industry interoperability.The lack of a universally

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[4] TDED is maintained by a Maintenance Agency in which participate a large number of organizations among which UN/CEFACT, ISO, WCO, ITU, OASIS.

[5] The Core Components approach described in this document is more flexible than current standards in this area because the semantic standardisation is done in a syntax-neutral fashion. Using Core Components as part of the ebXML framework will help to ensure that two trading partners using different syntaxes [e.g. Extensible Markup Language (XML) and United Nations/EDI for Administration, Commerce, and Transport (UN/EDIFACT)] are using Business Semantics in the same way on condition that both syntaxes have been based on the same Core Components.

accepted specification for naming and designing rules for XML schemas creates differences between the final XML schema output even when reference is made to CCTS. It must also be reminded that in UNCEFACT two versions of CCTS are concurrently used in association - for XML schemas production - with two NDR specifications.

5.   Scope of SW interoperability

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

- Between national Regulatory SW : examples 1) Korea Philippines – 2) US Canada – 3) Omar Malaysia
- Regional SW: examples
    - ASW (government agreement, all types of information)
    - African Association for electronic commerce
    - PAA (private/ any type of information if bi or multirally available; KT Net will not be able to cover regulatory, TradeXchange will)
- Inter Regional SW: Case of APEC or SELA.
- Sectoral: IATA e-Freight interlaced with WCO Data model. Note : IATA e-Freight is not a SW system. It should be part of (component) or associated to a widening number of NSW or RSW systems.
- Interoperability through intermediairies: Port of Genova - KL Net - UNIPASS (MIELE project) or NEAL-NET – KL Net - UNIPASS.

6.   Framework for measuring semantic interoperability

To be developed.

7.   Issues and challenges (miscellaneous)

The current situation is characterized by a lack of global vision and interest for interoperability other than limited to a domain, knowing that a domain can cover a significant number of countries or a whole activity at the world level (case of IATA).
The trend is to move from local or regional semantic interoperability towards a world semantic interoperability already announced by the WCO data model, the IATA e-Freight set of XML standards. This move must acknowledge the importance of the contexts in which the standards are used, this notion being clearly defined in the WCO documents. But the influence of contexts is not limited to the regulatory domain.

7.1.   The UNCEFACT production is progressed along parallel tracks with two alignment programmed

- TDED, EDIFACT, the first world standard, important installed base
- CCTS 2.01 and CCTS 3.0 are specifications which are used to produce component stored in libraries (Core Component Library)

To amend this, the UNTDED Maintenance agency has established a project which consists in aligning the TDED, the EDED and the CCL.
The goal would be to complete the update of the TDED and EDED within six months of project start. Update of the CCL within 12 months.

Other organizations interested in working on semantic interoperability (including business processes) are associated in the ISO-IEC-ITU-UN/ECE MEMORANDUM OF UNDERSTANDING[6] which has recently launched another project which 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 and RDF
- Deployment of the vocabulary – Publicly Available Free of Charge

7.2. What means precisely Reference to world standards?

The meaning of "Reference to world standards" elaborated by UNCEFACT, WCO, ISO etc. varies between the organizations claiming that they are conformant to these standards.
Different levels can be observed:

- Implementations based upon CCTS 2.01 and/or 3.0
  - Problems arising from the interpretation of the rules of the CCTS specifications according to OASIS.
- Reuse of CC from CCL
- Reuse of UMM Models, BRS, RSM, XML Schemas

Some countries such as Japan have demonstrated an interest in producing a reduced "national" CCL and from this to deduce predeveloped ad hoc structures ready for implementation, with special consideration for SMEs needs.

Important differences have been observed between different data models, revealed at the level of Class naming, attribute definition (see annex). The consequence is that to establish semantic interoperability users need to develop ontologies (or mappings). This is what the project of alignment between TDED_EDED_CCL wants to do but other ontologies can be defined such as between EDIFACT and X12C.

- Unilateral decisions
  - WCO proposes two sets of e-Documents, one expressed in EDIFACT, the other in XML (ebXML)
  - IATA e-Freight discards EDIFACT

7.3. What are the stakeholder's options or constraints or obligations?

Certain categories of stakeholders are confronted to different requirements and specifications. Transport services providers, freightforwarders, hauliers can be cited as an example.
In Europe, they are faced to:

- e-Maritime in EU which implies UBL2.1,

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[6] These four de jure standard doing organizations, in association with other interested parties such as OASIS, GS1, OAG are working in the scope of a Memorandum of Understanding to specify a framework of cooperation between the International Standardization Organizations in the field of electronic business.

- PCS standards which intend to progress their harmonization[7]
- IATA e-Freight now exclusively using XML standards.
- and WCO data model for regulatory exchanges.

Sui generis initiatives:
- National Payment Message Standard in Thailand: 8 banking messages. Extension to ASW foreseen. Coherence with ISO 20022? [8]

7.4. Difficulties arising from the different levels of experience

Important differences between regional levels of developments: long standing practitionners (PAA) versus new comers.

7.5. The importance of contexts

The impact of sectoral and official contexts on SWI will be important and absolutely necessary (illustrated by WCO or IATA e-Freight which produce standards adapted to different contexts such as phytosanitary message for China). 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 occurences of the string context.
In CCTS 3.0, the notion of context has been more precisely defined in section 9 (the string context has consequently only 231 occurences). We read in that section that further refinements of the notion of context will be the result of the work of UN/CEFACT to define a Context Methodology specification. This work has reached the ODP step 5. It is not published as an UNCEFACT final specification. Once the final version of that specification is published, the section 9 of CCTS 3.0 will be deprecated.

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[7] The European Port Community System association recently turned into International Port Community Systems Association. IPCSA proposes a strategic alliance between Port Community Systems and Single Window. The ultimate goal would be to establish the "Gateway to a National Single Window" consisting of both the community systems (for maritime freight and air freight) and the central government system. In order to support the objectives of a National Single Window, the Gateway to a Single Window would consists of a purely public section (NSW) and a public-private section (PCS).

[8] In the recommendation 33 we read : The Recommendation also suggests that participating authorities and agencies should co-ordinate their respective controls through the Single Window and should consider providing facilities for payment of relevant duties, taxes and fees.

At the present time we give the description of the context categories in section 9 of the version 3.0 of the CCTS.

Context Category	Description
Business Process	The business process name(s) as described using the *UN/CEFACT Catalogue of Common Business Processes* as extended by the user.
Product Classification	Factors influencing semantics that are the result of the goods or services being exchanged, handled, or paid for, etc. (e.g. the buying of consulting services as opposed to materials).
Industry Classification	Semantic influences related to the industry or industries of the trading partners (e.g. product identification schemes used in different industries).
Geopolitical	Geographical factors that influence business semantics (e.g. the structure of an address).
Official Constraints	Legal and governmental influences on semantics (e.g. hazardous materials information required by law when shipping goods).
Business Process Role	The actors conducting a particular business process, as identified in the *UN/CEFACT Catalogue of Common Business Processes*.
Supporting Role	Semantic influences related to non-partner roles (e.g. data required by a third-party shipper in an order response going from seller to buyer).
System Capabilities	This context category exists to capture the limitations of systems (e.g. an existing back office can only support an address in a certain form).

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. Participation in multiple SWI initiatives has been implemented by TradeXchange of Singapore which is a partner in SWI systems of PAA, ASW and participates in APEC regular SW interconnection workshops. TradeXchange adapts to all these environments but influences them.
We can also mention the adaptation of the WCO data model to different contexts as it has been explained in September 2012 in Vienna during the CEFACT Forum.
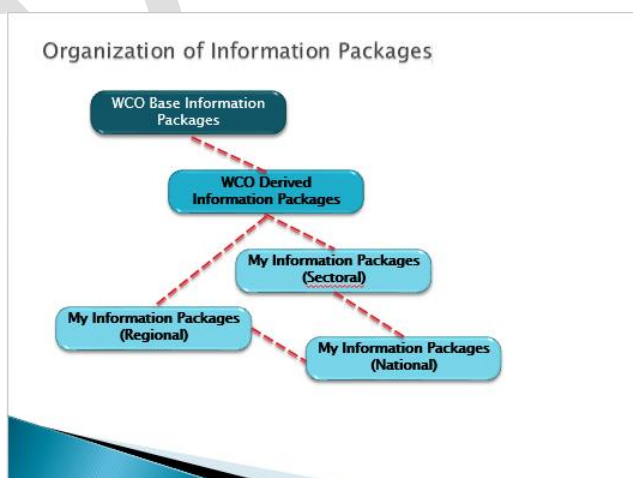
8. Conclusion

Issuing Recommendations and guidelines might not be an easy task unless general trends and methodologies are not defined and adopted by various organizations and programs. Should not we recommend a two step approach, step one consisting in elaborating rules to be used by large initiatives or projects or existing systems in order to provide guidance to their developments and alignment so as to facilitate interoperability. WCO is a good example with the possibility to use and customize (context) the WCO data model with either EDIFACT or XML.

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, new trend towards XML ISO 28005

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 as subsets of UBL2.1
   b. Example 2 : NEALNET (North East Asia Logistic information services network)
      i. Scope : SW (Information sharing) for transport and logistics between China, Japan and Korea; four nodes : Highways freight stations, airports, rail way freight stations, ports
      ii. Goal: Interoperability of transport and logistic information systems between the three countries for all modes of transport. Logistic information sharing.
      iii. Methods : Data harmonization, UNCEFACT(where available), complementary developments, EPCIS
      iv. Stakeholders : ports, rail, airports, freightforwarders, ship owners, LSC providers
      v. Step 1 : information sharing between the three countries
      vi. Step 2 : extension with Europe, APEC, PAA

4. Initiatives contributing to Single Window interoperability on a world scale without constitution of Single Window systems
   a. Example : IATA e-Freight
      i. Scope : SW for air transport
      ii. Goal : e-freight trade & transport messages should "feed" Customs and OGA messages
      iii. Methods : Alignment with international standard setting (WCO Data model, UNCEFACT TDED-CCL, ICAO)

iv. Outcomes : ==Business Models== (e-freight Operating Procedures); ==XML Schemas (exclusively)==; A tool box facilitates world deployment

v. Stakeholders : 1. Shippers 2.Freight Forwards 3.Carriers 4.Ground Handling Agents 5.Customs Brokers/Agent 6.International and National Organizations 7.IT Service Providers (as Observers)

vi. Step 1 - Digitize core transport docs: Air Waybill, House Manifest, Consignment Security Dec. (CSD), Flight Manifest

vii. Step 2 - Digitize core commercial docs (invoice/Packing list/HAWB) and Special cargo docs.

II: Comparison Matrix of Semantic Interoperability by stakeholders

To be developed.