Towards a Financial Ontology – A Comparison of e-Business Process Standards

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Abstract. Currently, there are multiple standards to support business process integration in different industries, including the financial industry. However, the standards are designed for different purposes and support different processes. Generation of a high-level ontology would provide means to enhance the interoperability between standards and support streamlined processes within the financial domain. This research aims at providing baseline information for future development of such high-level ontology. The study focuses on four main financial business process integration standards: Unified Business Language (UBL), ISO 20022 (UNIFI), Interactive Financial eXchange (IFX) and Financial Information eXchange (FIX), and compares their scope and structure. The study reveals the challenges in ontology creation: only billing and payment procedures are clearly overlapping in the standards, yet the standards refer to data elements differently. For the development of a higher level ontology in the future, the examination of the scattered standards should be performed incrementally in minor steps concentrating on the overlapping elements first.

Keywords: Ontology, business processes, standards, Unified Business Language (UBL), ISO 20022 (UNIFI), Interactive Financial eXchange (IFX), Financial Information eXchange (FIX)

1 Introduction

Network economy refers to the current economic order that is shaped by the information and communication technology, global scale and multiple stakeholders. The interaction and information exchange in different business processes between the network parties is performed using e-business process standards. Currently there are multiple standards covering various areas within the field of networked economy. The standards however differ from each other significantly in terms of their scope and structure: some of the standards are industry specific, some support cross-industrial operations, some provide only very general functionality, some cover very detailed

and some are covering just the general high-level principles. None of the standards have gained a wide cross-industrial acceptance and a dominant position.

The practical interest towards homogenized standards is obvious. In order to offer a wide range of financial services to multiple stakeholders, financial institutions and their information system should support adaptable and compatible information and data interchange. Development of a higher-level ontology would enhance the utilization of different standards and support business-to-business integration within the networked economy.

1.1 Research Problem and Objective

The research problem of the study is concretized in the following research problem:

How could a common high level ontology be developed for e-business processes in financial industry?

The research problem is wide. It is approached by answering the following research questions:

1. How do different standards cover the field of financial information exchange?
2. How are the existing standards constructed and related to each other?
3. What are the basic requirements for ontology to support financial B2B integration?

The main objective of the research is to provide preliminary thoughts and analysis of industry standards and their interoperability. By comparing how existing standards are formed and focused, the study should reveal means on how to start mapping standards for a higher-level presentation. Eventually, the attempt would be to create a financial ontology to support business process integration in financial field.

1.2 Project Scope

The financial business context is wide. The research scope is narrowed to standards that cover business services and cash management services especially. The chosen standards include Unified Business Language (UBL), ISO 20022 (UNIFI), Interactive Financial eXchange (IFX) and Financial Information eXchange (FIX). These standards were chosen by the case company involved in the study (Interview with Jouni Lähteenmäki and Pekka Valta, OP Bank Group). The standards will be presented later in this paper. During the assessment of the standards, the chosen perspective is the bank's point of view. The focus of the study is on transactions and processes between banks and financial institutions or companies e.g. business customers, other banks, stock exchanges or other partners.

1.3 Research Methodologies

The research is conducted using constructive research approach. The constructive approach refers to problem solving via construction of models, diagrams, plans, organizations or other constructs (Kasanen et al., 1993). Constructive research binds

together the problem and its solution with additional theoretical knowledge. Key elements of a constructive approach are the novelty and actual functioning of the solution as well. Kasanen et al. (1993) present a set of phases that are characteristic for a constructive research (Table 1).

Practical usefulness is the primary criterion to evaluate the results of applied studies. The usefulness of a construction cannot be proven until it is exposed to a practical test. A three-phased market-based validation can be used for the assessment of managerial constructions (Kasanen et al., 1993). Weak market test is passed in case a manager responsible for financial results of his or her business unit is willing to apply the construction in question in his or her actual decision making. Semi strong market test is passed if the construction becomes widely adopted by companies Strong market test requires that business units applying the construction have systematically produced better financial results than those who have not. Even the weak market test is relatively strict and it is probably not common a tentative construction may pass it.

Table 1: Constructive research process (Kasanen et al., 1993)

Phase	Description
1. Finding a problem	Find a practically relevant problem which also has research potential
2. Gaining understanding	Obtain a general and comprehensive understanding of the topics
3. Constructing a solution	Innovate .i.e. construct a solution idea
4. Demonstrating the solution	Demonstrate that the solution works
5. Connecting solution to theory	Show the theoretical connections and research contribution of the solution concept
6. Examining the applicability	Examine the scope of applicability of the solution

In context of this research, the attempt is not to build a system that could be tested and run. Instead, the construction will be more like a mind model or a construction of information. The analyzed standards will be compared in order to find differences and similarities in their scope, conceptualization and syntax.

1.4 Structure

The structure of the research report is as follows. First, the research background and objectives are introduced. The research problem is stated and the scope of the study and the structure of the report are presented. Second, we introduce the basic concepts of ontologies. Third, the researched e-business standards are introduced. The examination of standards covers both analysis of their scope and comparison of how they are structured. The findings are concluded in the final section in addition with suggestions for future research.

2 What is ontology?

The challenge of achieving global semantic interoperability stems from more heterogeneous computer systems as networking becomes more and more global (Firat et al., 2002). In order to enhance interoperability, ontology can be interpreted as an interface between data and business process models of computer systems, and human perception or conceptualization of the reality (Hepp, 2007). There are numerous definitions for the term ontology (Hepp, 2007). The term is originally used in philosophy, and definition differences exist for instance between its use in computer science and information systems research. According to one of the most cited definitions, ontology is an explicit specification of a conceptualization (Gruber, 1993).

A conceptualization is an abstract and simplified view of an environment that is aimed to be represented for some specific purpose (Gruber, 1993). A conceptualization consists of objects, concepts and entities and relationships that exist between them (Genesereth & Nillson, 1987). In ontology, the concepts of a domain are often called as classes (Noy & McGuinness, 2001). The classes contain properties that are features and attributes of the class. Ontologies are used for communication, computational inference, and reuse and organization of knowledge (Gruninger & Lee, 2002).

Ontology creation is a creative process: there is no single correct way to build one (Noy & McGuinness, 2001). However, Noy and McGuinees (2001) identify certain fundamental guidelines for ontology creation:

1. Instead of one single best practice for modeling a domain, there are viable alternatives and the best solution depends on the objective.
2. Ontology creation is an iterative process
3. Concepts of the ontology should be close to real world objects (physical or logical) and relationships in the chosen domain.

There are also guidelines or criteria to design consistent and effective ontologies: Gruber (1993) presents criteria for ontologies that aim at knowledge sharing and interoperability among programs that are based on shared conceptualization:

- Clarity: Ontology should define terms objectively and completely to communicate the meaning of concepts effectively
- Coherence: Ontology should sanction inferences that are consistent with the definitions
- Extendibility: Ontology should be designed so that it could be expanded with new terms without a need to revise the original definitions.
- Minimal encoding bias: Conceptualization should be independent from the particular system-level encoding and defined on knowledge level instead.

- Minimal ontological commitment: Ontology should support the knowledge sharing activities with minimal amount of definitions and should not make any claims about the modeled environment.

In general, establishment of a conceptualization and eventually its elicitation, storage, versioning and application make managing ontologies in large-scale applications very difficult (Hepp, 2007).

There is some research done on the use of business process standards in finance (e.g. Castells et al., 2004; Firat et al., 2002; Coates, 2001). For instance Coates (2001) has taken a look at standards such as ebXML, IFX, OFX, ISO 15022 and swiftML. However, a proper ontology has been argued to be lacking for the description of economic and financial information (e.g. Castells et al., 2004). Coates (2001) states that the use of XML-based standards has focused too much on the technology instead of the users' needs in order to make data interchange simpler. This study aims at revealing business process language similarities for an ontology creation especially in financial context.

3 Presentation of Standards

Next, we will present the chosen standards, UBL, IFX, UNIFI and FIX.

3.1 Universal Business Language (UBL)

UBL, the Universal Business Language, is the product of an international effort to define a royalty-free library of standard electronic XML business documents such as purchase orders and invoices. UBL is developed in OASIS Technical Committee with participation from a variety of industry data standards organizations. UBL is designed to provide an entry point into electronic commerce for small and medium-sized businesses. (OASIS, homepage)

Background and development

UBL 1.0 was released on November 2004. UBL 2.0 expands greatly the scope on UBL standard. It was approved as an OASIS Standard in November 2006. The predecessors of UBL standards were the Common Business Library, CBL and the XML Common Business Library, xCBL standards. Latter was derived from the Electronic Data Interchange For Administration, Commerce, and Transport, EDIFACT and X12. EDIFACT is the international Electronical Data Interchange, EDI standard developed under the United Nations. X12 is also EDI standard, developed by American National Standard Institute. xCBL started to use XML schemas. UBL 2.0 is aligning with the United Nations Centre for Trade facilitation and Electronic Business, UN/CEFACT. UBL uses XML schemas, which are defined in accordance with the e-business XML, ebXML Core Components Technical Specification. (OASIS, homepage)

Covered business processes and structure

UBL intends to remove the use of multiple different industry-specific standards by offering a generic XML interchange format. This format can be extended to meet the requirements of particular industries. Most of the UBL implementations require some customization to suit their context of use. This can mean either restrictions or extensions to the standard. UBL can be viewed as a set of building blocks for e-business business components. (McGrath, 2006)

UBL 2.0 business documents cover business processes from sourcing to payment including the commercial collaborations of international trade. The business processes are presented in more detail in Appendix B. (Universal Business Language v2.0, OASIS)

UBL 2.0 consists of 31 common business document types. Each document type is used in one or more business processes. Document types and their categorization under different business events are presented in Figure 1. (Universal Business Language v2.0, OASIS)

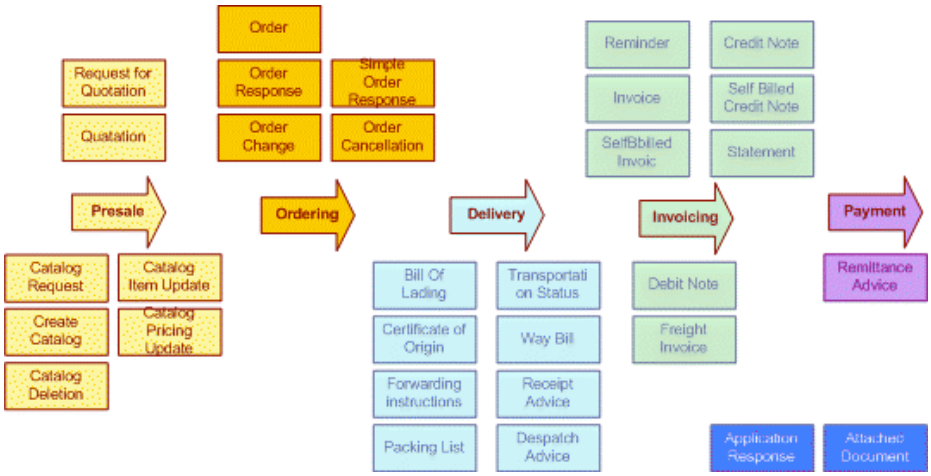

Figure 1: Document types of UBL (Gudmundsson, 2007)

UBL has been designed as a reusable library of Business Information Entities. Document schemas are constructed from different Business Information Entities. BIE's form a modular and hierarchical structure to UBL documents. These BIE's are not created for needs of one document, which could limit application of these schemas. (Universal Business Language v2.0, OASIS)

When using UBL, it has to be agreed, what components the UBL documents actually consist of. The Finnish Information Society Development Centre, TIEKE, has provided implementation guidelines to 12 UBL documents. The aim of this is to harmonize the use of UBL documents across Finnish companies. Despite the guidelines, different industries need to modify documents to fit their industry requirements. (Interview with Heikki Laaksamo, TIEKE)

A financial company participates only in a part of the electronic trade process. A financial company is involved in payment and invoicing and has to deal only with those documents. Documents concerning presales, ordering and delivery are not interesting from financial company's point of view. (Interview with Heikki Laaksamo, TIEKE)

For a bank, the most important UBL document is remittance advice, which is linked to payment part of trade process. In the invoicing part, there are eight different UBL documents. The most important of those are invoice and credit note, because TIEKE has provided for these documents the implementation guidelines. As UBL is using reusable data components, all the invoicing documents have similarities. (Interview with Heikki Laaksamo, TIEKE)

3.2 Interactive Financial eXchange (IFX)

IFX, the Interactive Financial eXchange specification, is an XML-based, financial messaging protocol. The standard is created and maintained by the Interactive Financial eXchange Forum that was formed in 1997. The forum consists of financial institutions, service providers and software vendors. Members of the forum are, for example, Microsoft, Sun Microsystems, Scotiabank, ACORD, Fidelity Information Systems, ACI Worldwide and Bank of America. The forum is open for everybody and the standard is free. (IFX, homepage)

Background and development

The purpose of the IFX standard is to provide a unified way of handling the financial transaction between businesses, the banks and the consumers. The standard was created using as a base the Open Financial Exchange (OFX) and IBM/Integrion GOLD standards. The OFX standard is one of the leading standards between the information systems within one bank. As its successor, IFX is slowly taking over the leader's position because of its richness and more advanced messaging. The standard defines a set of common objects that are very general and industry independent, so the standard can be used for financial transactions across all industries. The principle behind the design of the standard is that the standard is built on a set of defined basic elements, which are used through the whole standard. The standard is flexible, extensible and can be customized according to the implementation guidelines. It can also be further developed to answer the new requirements. Still, the standard is able to maintain its interoperability and consistency. (IFX, homepage)

To be able to answer the real needs and requirements of the financial field, the members of the IFX forum get to influence the development of the standard. The members of the committees and working groups of the IFX forum come from the member organizations. Before a release of a new version, the members of the forum also review and test the standard. (IFX, homepage) This way, the quality is assured and implementation tested, but it also might drag out the release process, if everybody wants to express his or her opinions and suggestions.

As of writing this in January 2008, the newest version of the standard is the version 1.8 that was released in October 2007. The new IFX 2.0 was supposed to be released in 2007 but has not yet seen daylight. Version 2.0 will apparently bring a lot of changes to the standard. IFX Forum talks about a new generation of IFX. They justify this by saying a lot has changed in ten years since IFX started. Some of the changes that version 2.0 will bring are already available in the current version. Several entities will be deprecated and replaced with new ones that already exist. The becoming changes are marked in the current documentation. (IFX, homepage) Many of the changes seem to emphasize the reuse of the entities. Several entities will be replaced with a new one that will be used across the whole standard. The structure of commonly used aggregates will be more consistent. In general, the changes seem to simplify the standard and shape the standard to positive direction. The release of IFX 2.0 has been at the members reviewing phase since February 2007 and is several months behind the schedule (IFX, homepage).

Covered business processes and structure

IFX standard is clearly aimed at banks and other financial institutions. It concentrates purely on the basic services a bank offers. The main areas IFX covers are customer information, accounts, cards, loans, statements, fund transfers, foreign exchange, billing and payments. The standard is mainly targeted for financial processes with consumer customers and small and medium-sized businesses. IFX does not make clear difference between consumer and business customers. Both of them are called customers and they use the same services the same way. When talking about financial services, security is a very important issue. IFX provides application level security solutions for customer authentication that can be used e.g. in online banking, between service providers, with cards at different kind of terminals like ATMs (Automatic Teller Machine) and POS (Point of sale). IFX supports the EMV standard, which is an Integrated Circuit Card (ICC) specification for payment systems developed by Europay International, MasterCard International and Visa International. (IFX, homepage)

IFX Forum does recognize the need for interoperability with other standards and it is working together with other standards organizations like ACORD, ISO, ANSI and X12. The purpose is to cooperate whenever it is possible. At the moment, the latest version of IFX provides integration part with UNIFI (ISO 20022) standard. (IFX, homepage)

Generally, the messaging process in IFX contains always two parts, request and response messages. Messages are named using the abbreviation of the service name and Rq for request and Rs for response, e.g. Customer Add Request <CustAddRq> and Customer Add Response <CustAddRs>. Messages include the elements and their combinations, called aggregates, required for the message. (IFX, homepage)

Each message is a part of a service, a collection of messages. A service wrapper is a document sent by the client or the server including the message requests and responses. The same request-response pattern applies also to the service wrappers. When services are requested, the client sends a Service Request <xxxSvcRq>, where

xxx is the name of the service, and the server answers with <xxxSvcRs>. For example, Customer Add Request is part of the Base Service, so the message appears in the Base Service Request <BaseSvcRq> and it is answered by the server using the Base Service Response <BaseSvcRs>. (IFX, homepage)

The IFX standard consists of 6 services, that all cover the messages of a certain subject. The services are: Base Service, Banking Service, Pay Service, Bill Presentment Service, Valuable Media Service and Root Service. In **Table 2** are described what kind of areas each of these services cover. Appendix A presents the structure of IFX in more detail. (IFX, homepage)

In Pay Service, Payment Batch messages include UNIFI (ISO 20022) Payment messages. These messages are meant for integrating IFX payment messages with the UNIFI payment messages. (IFX, homepage)

Table 2: IFX service coverage

Service	**Covered areas**
Base Service	Messages that perform basic communication functions Service Profile Customer Authentication Customer Profile Accounts and Cards Customer Service
Banking Service	Core-banking capabilities Statements and Account Inquiries Transfers Recurring Transfers Customer Communications Bank Mail
Pay Service	Functionality related to consumer and business payment Managing a list of payees Scheduling individual payments Defining recurring payment models Integration with the ISO 20022 Payment messages using the Payment Batch
Bill Presentment Service	Process of receiving bills electronically Biller and Bill inquiry
Valuable Media Service	Support for the tracking of valuable media such as cash, coins, postage stamps, coupons, checks, and envelopes at client devices (e.g. ATMs, teller cash drawers)
Root Service	Device management and terminal management capabilities (e.g. ATM, POS)

3.3 UNIversal Financial Industry Messaging scheme (UNIFI)

UNIversal Financial Industry Messaging scheme UNIFI (ISO 20022) provides a single standardization approach to support communication interoperability in financial industry.

Background and development

The predecessor of the UNIFI was ISO 15022. Compared to the 15022, UNIFI is an XML based messaging standard that uses more robust, syntax independent development methodology that is based on UML modeling of business processes and transactions. Its scope is also wider and is aligned better with standards of other industries. There are multiple standards (such as RosettaNet, SWIFT, IFX, TWIST etc.) that UNIFI aims at bringing together by providing standardized data objects and grouping them into message models. Message models can be transformed into message formats in desired syntax.

UNIFI standard is developed according the business input of its users: the organizations that desire to develop their financial transactions may submit their suggestions for UNIFI compliant messages. There are three different actors within the ISO organization that evaluate the Registration Management Group (RMG) govern the development and approves business justifications for new standards. It also creates Standards Evaluations Groups (SEG) that represents future users of specific financial areas and validates the message standards. Registration Authority (RA) ensures compliance and maintain UNIFI repository.

Covered business processes and structure

The ISO 20022 standard consists of five parts: International Standards parts provide overall methodology and format specifications for inputs and outputs. Technical specification parts cover modeling guidelines, XML design rules and reverse engineering of UNIFI. In terms of payments, The UNIFI Payments SEG covers financial instruments such as credit transfers, checks, direct debts and debit & credit cards. The business areas range from payment initiation and cash management between various actors to clearing and settlement. There are nine liaison partners to participate in the Payments SEG activities: Euroclear, IFX, SWIFT, TWIST and UN/CEFACT/TBG5. (Technical Committee ISO TC68 Financial Services, 2007)

UNIFI offers both a conceptualization of business processes items that its messages cover and a description of the message structure. The conceptualization part defines a set of business components. Components consist of business elements and associations. The business components may vary according to a business role that depends on the use context of the standard. UNIFI messages consist of message components. Message components are linked to business components and characterized by message elements. Message elements have their analogy in business elements. Business and message rules define specific conditions that should be applied with different components or their elements.

3.4 Financial Information eXchange (FIX)

FIX, the financial information eXchange, is a messaging standard for the trade-related messages.

Background and development

FIX has been developed and promoted through the collaboration of broker-dealers, banks, exchanges, institutional investors and other organizations. FIX is industry-driven messaging standard maintained by the FIX protocol Ltd. The motive for the development of the standard was the need to unify and automate the electronic trading. FIX was first developed in 1992 as a business communication framework for equity trading between Fidelity Investments and Salomon Brothers. Both, the buy side and the sell side in the financial markets deploy FIX. Its users are e.g. mutual funds, investment banks, brokers and stock exchanges. FIX is regarded as the standard electronic protocol for pre-trade communications and trade execution. It is mainly used for the equity transactions in the front office area. FIX is not XML-based standard, like the other standards presented here, but there is also an XML-version of FIX, called FIXML. (FIX, homepage)

Covered business processes and structure

The protocol supports the following electronic conversations between brokers and other financial institutions:

- Equity order submissions, cancellations and replacements
- Equity execution reporting
- Equity order statusing
- Equity trade allocation
- Indication of interest communication
- Completed trade advertisements
- Directed e-mail and news messaging (Financial Information Exchange, Wikipedia)

Listing 1 describes an example FIX message. FIX messages are formed of fields. Each field contains a tag and a value. The field is separated from the next field by a delimiter |. The tag is a string representation of an integer that indicates the meaning of the field. The value is an array of bytes that hold a specific meaning for the particular tag. For example, tag 48 is a securityID and its value is a string that identifies the security. Tag 22 is an IDSource and its value is an integer that indicates the identifier class being used. The value can be readable text. However, fields can be encrypted. The value can also be pure binary. The length field always precedes binary fields. The FIX protocol defines meanings for most tags and a range of tags is

reserved for private use between consenting parties. (Financial Information Exchange, Webopedia)

```
8=FIX.4.2_MCS | 35=8 | 49=PHLX | 56=PERS |
11=ATOMNOCCC9990900 | 52=20071123-05:30:00.000 | 20=3 | 150=E |
39=E | 55=MSFT | 167=CS | 54=1 | 38=15 | 40=2 | 44=15 | 58=PHLX
EQUITY TESTING | 59=0 | 47=C | 32=0 | 31=0 | 151=15 | 14=0 | 6=0 |
10=102 |
```

Listing 1. Example of a FIX message: Order Status Request

The FIX protocol also defines sets of fields that make a particular message. Within the set of fields, some fields are mandatory and others optional. The ordering of fields within the message is generally unimportant. The message is broken into three distinct sections: the head, body and tail. Fields must remain within the correct section and within each section the position may be important as fields can act as delimiters that stop one message from running into the next. The final field in any FIX message is tag 10 (checksum). (Financial Information Exchange, Webopedia)

There are two main groups of messages - admin and application. The admin messages handle the basics of a FIX session. They allow a session to be started and terminated and recovery of missed messages. The application messages deal with the sending and receiving of trade-related information such as an order request or information on the current state and subsequent execution of that order. (Financial Information Exchange, Webopedia)

4 Comparison Between Standards

Next, we will compare the standards and analyze the differences between them. First, we will compare the areas of business processes the standards cover. After that, we will compare the structure and the content of business messages in the standards.

4.1 Business Processes Related to Standards

The chosen standards differ in the processes they cover and the points of view they have obtained. Figure 2 shows the areas each of the standards cover and the overlapping of the areas. UBL is clearly a supply chain standard aimed mainly at industrial companies and it is meant to be used in the communication between the companies. It covers the typical phases of the order and shipment process.

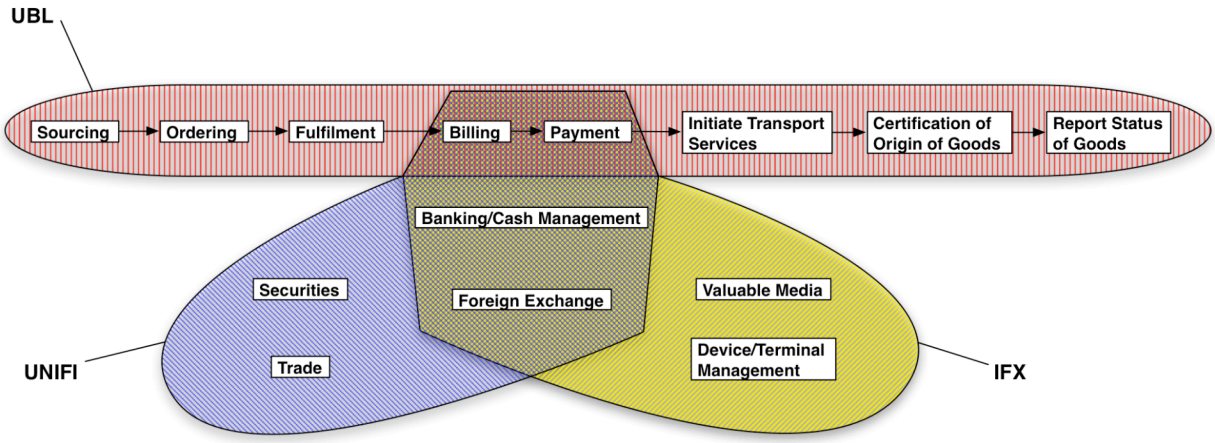

Figure 2: The business processes covered by the standards.

In contrary to UBL, IFX does not deal with the supply chain. From the supply chain perspective, it only handles the billing and the payment transaction part of the chain. IFX is aimed at financial institutions, like banks and other businesses providing financial services. It is mainly meant for communication between the different systems inside a financial institution and between its partners and clients. IFX covers the basic financial processes, like payment transactions and cash management, balance and transaction reporting.

UNIFI is also mainly a financial standard, like IFX, and it is not interested of the full supply chain. Although, UNIFI does not take as strongly the bank's point of view, as IFX does, and in the financial messages it defines, it also offers elements to support the supply chain. UNIFI has been trying to take a role as an integrator. It is very strongly trying to promote cooperation between the standards and is trying to provide a way to integrate UNIFI with as many other standards as possible. That is why UNIFI covers wider area and more processes than IFX. IFX gives the impression it is trying to cover a little bit of everything. Because of that, it does not answer the needs of a financial institution so well.

FIX covers only the equity trading process. It is aimed at brokers and financial institutions that do trading. FIX is very specific standard targeting a small area and because of that, differs a lot from the other three standards.

None of the processes is covered by all of the standards. The areas most of the standards cover are billing and payment. They are covered by UBL, UNIFI and IFX. IFX and UNIFI do also both provide messages for basic banking services and cash management and foreign exchange. IFX covers also the terminal and device management and recognizes also different forms of valuables, like coins, stamps and coupons. Instead, UNIFI covers the processes of the trade of securities and the securities management.

4.2 Structures of invoice messages

From four standards, three, IFX, UBL and UNIFI, concentrate on payment transactions and supply chain messaging, while the fourth standard, FIX, is developed for securities markets and trade transactions only. FIX is very different from three other standards and covers totally different areas. Therefore FIX was left outside the following comparison of the message structures of the standards.

We compared the structures of the messages in IFX, UBL and UNIFI standards. We approached the problem by picking an example message from each standard. We chose the invoice message as an example because it is a very central message in every standard and it has a lot of typical information what messages have. Also the nature of invoice is rather easy to understand without deeper knowledge of financial field.

First we evaluated structures of invoice messages. We looked how data was structured and what kind of entities it presented. After that, we looked what similarities and differences the standards have and what data they include. We did not go through every line of the standards. Instead, we chose the 3 the most essential elements for an invoice, customer, amount and account information, and we investigated how these elements were presented in the messages and what information about them the messages supported.

IFX's invoice is named as bill. It consists of four main components: Bill Identifier, Bill Information, Bill Status and Bill Record. The identifier only identifies the invoice. The main data is structured under Bill Information. There is the basic information needed for an invoice: type, customer, accounts, dates, amount and currency. Bill record consists of the same information as the whole invoice message.

In IFX, there are also optional elements, where only one of the elements can be chosen. Other standards we examined did not have this kind of options and this partly explains why IFX's invoice is shorter than the invoices of the two other standards. Another reason is that the IFX standard covers only the banking side.

UBL's Invoice has more components than IFX's Bill. It is because UBL's Invoice is meant to be a message between trading partners in supply chain and it has also information that is not relevant from the payment transaction point of view. UBL's Invoice consists of 27 different components that are straight linked to the first level of invoice. Although, most of them are not mandatory and usual invoice message does not contain all of them.

The most important entities in UBL's Invoice are accounting customer party, payment means and monetary total. It also contains information about taxes, delivery, payment terms, exchange rate, allowance charge, prepaid payment and parties other than the accounting parties. There is also an invoice line that has similar information than invoice but also information about the items.

UNIFI's Invoice consists of four main entities: invoiced goods, customer and supplier party, and payment transaction. Invoiced goods consist of information about goods the transaction relates to. Payment transaction entity has all the information about the transaction. In UNIFI, the amount information is under the Invoice element

right at the beginning of the Invoice and not under some bigger entity. Tax amount and due date are expressed at the same way.

Basic structures of the invoice messages are presented in Appendix C.

4.3 Differences in data content

We took a deeper look into a few main elements of an invoice. We examined how the data was structured, what data was given and in which format the main information was given.

Customer

First we evaluated the customer element. IFX's customer representation differs substantially from UNIFI's and UBL's customer. IFX's only customer information is Customer Permanent ID.

In UNIFI, the customer information is presented under customer entity. The customer entity consists of basic information, client identification, name and address. There is also information about different accounts and additional information including country and party profile information.

In a UBL message, it is possible to present many parties with different roles, but the customer, from the payment transaction point of view, is accounting customer party. Under accounting party entity there is information about accounts and contacts and party entity, which includes basic information about the party. In the party entity, there are party identification, party name and postal address as there were in UNIFI. There is also a lot of additional information, which cannot be found from UNIFI. Most of this information is not relevant from the point of view of a basic invoice.

Both UNIFI and UBL have information about accounts. In UBL, the account numbers can be presented only in the customer entity, but in UNIFI, there are account entities for different accounts. Party name, address information and party identification code can be found in both standards. Most of the information is, if not different, at least expressed in very different entities.

Customer data presentation in different standards is presented in the **Table 3**. In the table, ID is marked with yellow, name with green and address with red. A star in the end of the name means that it is an entity, which has more entities and elements under it, which are not presented in the table.

Table 3: Customer data structures in different standards.

IFX	UBL	Unifi
Bill	Invoice	Invoice
Bill Information (BillInfo)	AccountingCustomerParty	Customer (Party)
Customer Identification (CustId)	CustomerAssignedAccountID	Address*
Service Provider Name (SPName)	SupplierAssignedAccountID	ClientIdentification
Customer Permanent ID (CustPermId)	AdditionalAccountID	Name
	DeliveryContact*	CountryCode*
	AccountingContact*	Role*
	BuyerContact*	TaxationCountry*
	Party	TradingPartyCapacity*
	MarkCareIndicator	PartyProfileInformation*
	MarkAttentionIndicator	CommunicationNumber *
	WebsiteURI	CreditAccount*
	LogoReferenceID	FinancingAccount*
	EndpointID	InvestmentAccountOwnershipInformation*
	PartyIdentification	InvestmentAccountRelationshipInformatior
	ID	OrderProcessingData*
	PartyName	
	Name	
	Language*	
	PostalAddress*	
	PhysicalLocation*	
	PartyTaxScheme*	
	PartyLegalEntity*	
	Contact*	
	Person*	
	AgentParty*	

Amount

In IFX and UBL, the monetary amount of the invoice is expressed in its own entity. In IFX, there is Bill Summary Amount, which is under Bill Information entity. Bill Summary Amount consists of Amount identifier, code and type. There are also sub-amounts and total currency amount. In total currency amount, there is information about the total amount, currency and exchange rate. In IFX, the amount and the currency are in different elements in contrary to UBL and UNIFI, where the currency is an attribute of the amount element.

In UBL, the amount is expressed in Legal Monetary Total entity. The entity contains the amount information, but there are also classifications of the amount, e.g. tax inclusive and exclusive amounts. In IFX, there is also exchange rate, but in UBL it is expressed in its own entity, which is not presented here.

In UNIFI, there is no larger entity for the amount. Total amount is expressed in the element Total Invoice Amount. There are also elements for allowance, charge and tax amounts. In Payment Transaction entity, there is also equivalent amount and instructed amount. These are amounts of money to be transferred between debtor and creditor, before the deduction of charges.

All the standards have a clear element for the total amount, but there are a lot of differences in other information.

Presentation of the amount information is in **Table 4**. In the table, total amounts are marked as blue. A star in the end of the name means that it is an entity, which has under it more entities and elements, which are not presented in the table.

Table 4: Amount data structures in different standards

IFX	UBL	Unifi
Bill	Invoice	Invoice
Bill Information (BillInfo)	LegalMonetaryTotal	TotalAllowance
Bill Summary Amount (BillSummAmt)	LineExtensionAmount	TotalCharge
Bill Summary Amount Identifier (BillSummAmtId)	TaxExclusiveAmount	TotalInvoiceAmount
Bill Summary Amount Code (BillSummAmtCode)	TaxInclusiveAmount	PaymentTransaction
Currency Amount (CurAmt)	AllowanceTotalAmount	EquivalentAmount
Amount (Amt)	ChargeTotalAmount	InstructedAmount
Currency Code (CurCode)	PrepaidAmount	
Currency Exchange Rate (CurRate)	PayableRoundingAmount	
Currency conversion indicator (CurConvertRule)	PayableAmount	
Bill Summary Amount Type (BillSummAmtType)		
Bill Summary Sub-Amount (BillSummSubAmt)*		

Account

The account information is structured differently in every standard. In IFX, there is the Deposit Account Identifier entity, which contains the Account Identifier element. The value of this element is the deposit account number. There is also Presentment Account Identification entity, where is the billing account.

In UBL, the accounts are in Payment Means entity. Payment Means has four different entities: Credit Account, Card Account, Payee Financial Account and Payer Financial Account. Each one of these has an account number element. Payee Financial Account is quite similar to IFX's Deposit Account Identifier. Each of these has elements for the account number, account type, currency code and information about the bank or financial institution of this account.

In UNIFI, there are nine different account entities in Payment Transaction entity. In addition to the creditor and the debtor accounts, there is also account information for different intermediary agents in the payment chain. Each of these accounts has account number, type, currency and name information. There is also more other information than in the two other standards.

In UNIFI and UBL, there is also account information under party entities. The account information representation is in **Table 5**. Elements that contain the account number information are marked with yellow. These account numbers may have different functions. A star in the end of the name means that it is an entity, which has more entities and elements under it, which are not presented in the table.

Table 5: Account data structures in different standards.

IFX	UBL	Unifi
Bill	Invoice	Invoice
Bill Information (BillInfo)	PaymentMeans	PaymentTransaction
Presentment Account Identification (PresAcctId)	ID	SettlementAccount*
Billing Account (BillingAcct)	PaymentMeansCode	Identification
Biller Identification (BillerId)	PaymentDueDate	Name
Service Provider Name (SPName)	PaymentChannelCode	Status
Biller Number (BillerNum)	InstructionID	AccountInformationRecipient*
Payment Instrument (PmtInst)	InstructionNote	AccountOwner*
Payment type (PmtInstType)	PaymentID	CreditorAccount*
Card Brand (Brand)	CardAccount	CreditorAgentAccount*
Settlement Information (SettlementInfo)	PrimaryAccountNumberID	DebtorAccount*
Settlement Method (SettlementMethod)	NetworkID	DebtorAgentAccount*
Deposit Account Identifier (DepAcctId)	CardTypeCode	IntermediaryAgent1Account*
Account Identifier (AcctId)	ValidityStartDate	IntermediaryAgent2Account*
Account Type (AcctType)	ExpiryDate	IntermediaryAgent3Account *
Account Key (AcctKey)	IssuerID	PreviousInstructingAgentAccou
Account Currency (AcctCur)	IssueNumberID	Identification
Bank Information (BankInfo)*	CV2ID	Name
Payment and Settlement Instruction (PmtInstructio	CardChipCode	Status
Country (Country)	ChipApplicationID	Currency
Payment Format (PmtFormat)	HolderName	Type
Reference Information (RefInfo)*	PayerFinancialAccount*	SubAccount*
Intermediary Deposit Account (IntermediaryDep	PayeeFinancialAccount*	CashAccountLimit*
Fee Charge Allocation (FeeChargeAlloc)*	ID	CashReservation*
	Name	AccountInformationRecipient*
	AccountTypeCode	AccountOwner*
	CurrencyCode	CashBalance*
	PaymentNote	CashEntry*
	FinancialInstitutionBranch	
	ID	
	Name	
	FinancialInstitution*	
	Address*	
	Country	
	CreditAccount	
	AccountID	

5 Discussion

The compared standards are designed for somewhat specific purposes. That is why there seems to be differences in not only in structure but also in the content of the standards. However, there are also differences in the areas that all the standards cover. None of the three standards is able to present all the information the other standards have in one area.

The standards use also different kind of naming patterns. IFX abbreviates all the names of the entities. UBL and UNIFI do not do that. They use the same naming pattern, writing the words completely but all together and indicating the beginning of a new word with a capital letter.

Qin and Taffet (2004) have also studied the vocabulary used in the financial standards and found similar results. They analyzed five DTD's of five standards, Digital Receipt, FIXML (Financial Information Exchange Markup Language), FinXML (Financial eXtensible Markup Language), FpML (Financial Products

Markup Language) and IFX. They compared the names of the elements, the linguistic and semantic patterns and the structures of the DTD's. One of their findings is that all the standards use very similar vocabulary, but the naming conventions, the ways of abbreviating the words, vary a lot.

Comparing the standards is challenging. There are four reasons that make comparing the standards difficult.

First, it is usual that elements that had the same purpose, had different name. For example, we searched reference number of invoice from every standard. It first seemed that in UBL there was no reference number, but in the end we found from UBL's Finnish implementation guidelines that the reference number element was called instructionID. In UBL's documentation, it was only said that instructionID "identifies the Payment Instruction".

Second, the same element is presented in several places, but the elements may have different purpose or data content.

Third, there are many similar elements, but it is difficult to evaluate the real difference between the elements. When the same occurs in all three standards it is difficult to evaluate, which are exactly the same elements. For example, the messages have many different account elements with different names. It is difficult to understand what is the exact purpose of all the accounts and how these accounts are related between the standards.

Fourth, there are differences how the standards are used. In UBL, there are different implementation guidelines. Implementation guidelines specify what information different elements have. There are also industry specific differences how the UBL standard is used.

Montes et al. (2005) have recognized some reasons why building a financial ontology is so difficult. They say the standardization effort has been very slow in the banking field. The financial domain is constantly changing and new products appear all the time, therefore the standards need to also evolve faster than they do at the moment. Because of the competition and the new products, innovative financial organizations are not willing to share their knowledge being afraid of losing the competitive advantage. The complexity of the current standards does not make the task easier either. They also say that building a new ontology based on the old standards is a better approach than directly reusing the old standards. Agreeing about one shared standard is a difficult process for the financial institutions. This is why the common ontology should be descriptive, stay on relatively high level of definitions and avoid complexity to make it easy for everybody to accept.

5.1 Using Suggested Upper Merged Ontology

For a company to be able to support several standards, some kind of translator will be needed to join the different ontologies used by the different standards. Upper level ontology, like Suggested Upper Merged Ontology (SUMO) could be used as such a translator.

Suggested Upper Merged Ontology is a general upper level ontology, that is not focused on any particular domain. The purpose of SUMO is to offer a wide ontology that can function as a connector between different domain ontologies and join them in one shared network. The top levels of SUMO build the base for the ontology and it consists of 11 sections (Figure 3). The Structural Ontology defines the framework for the ontology and sets the definitions for the relations. The second section, the Base Ontology, defines the basic structure and the types of element, like physical and abstract entities and objects and processes. Based on these two sections, nine other sections are constructed that define different basic data types and metrics, like Set/Class Theory, Numeric and Temporal sections. The core of SUMO, the general ontology formed by the 11 sections, provides a base for a so-called Mid-Level Ontology (MILO) an ontology that works as a bridge between the abstract content of the SUMO and the rich and detailed ontologies of the various domains. SUMO offers ontology for several domains, like Finance, Communications, Countries and Regions, Economy, Engineering Components, Geography, Government and Military. (SUMO, homepage; Pease et al., 2002)

The strength of SUMO is that it is mapped to the WordNet, large lexical database of English. SUMO covers in total 20,000 terms and 60,000 axioms together with the associated domain ontologies. It is developed by the IEEE Standard Upper Ontology Working Group, SUO WG and owned by the IEEE. SUMO is free and available under GNU General Public License. SUMO is written in the IEEE Standard Upper Ontology Study Group Knowledge Interchange Format, SUO-KIF language. (SUMO, homepage; Niles & Pease, 2001)

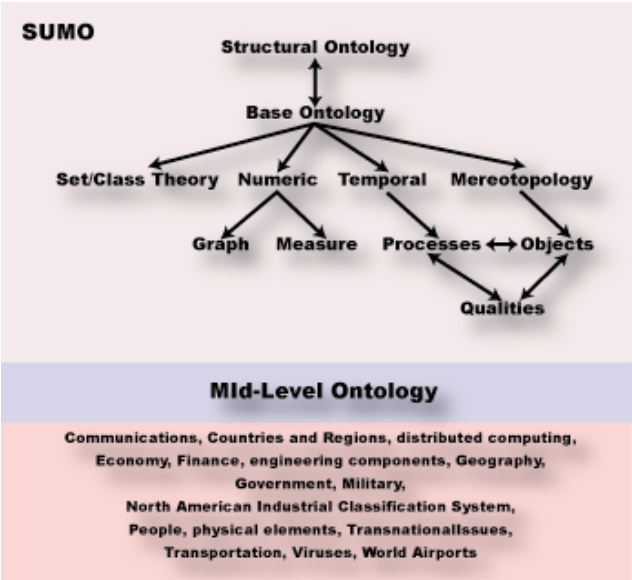

Figure 3: The structure of SUMO (SUMO, homepage)

The main obstacle in joining the different standards is their way of naming and structuring the elements differently. We faced often the problem of not knowing if the two elements meant the same thing or not. This could be solved by mapping the elements of each standard to a common ontology, like SUMO that has already a defined financial ontology. The financial institution can map their own ontology used in their information systems to the SUMO and find this way the correct matches for each term. The solution is also extensible since new standards can be added by mapping them to the SUMO ontology. (Figure 4)

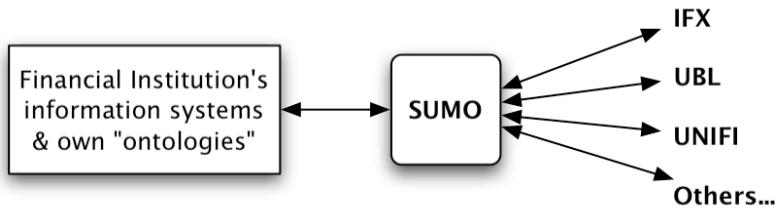

Figure 4: SUMO as a translator between the standards and the ontology used by the financial institution.

5.2 Benchmark to existing studies

The benchmark of related studies is highly recommended in order for the high-level ontology development to be able to grasp the essential of the granular and evolving field of financial industry. Haller et al. (2008) used SUMO and a similar approach we suggested in their work where they developed a complete supply chain ontology based on RosettaNet. They have mapped unit type concepts in RosettaNet to SUMO to define the relations between different unit types and different ways of using them.

Before the building of an ontology is started, it would be worthwhile to get acquainted with research on how to improve interoperability between standards. Jayasena et al. (2004) have studied the interoperability issues of financial standards. They represent a case study, where they have used the COntext INterchange (COIN) Approach to resolve the conflicts between different standards. They have chosen three standards, IFX (Interactive Financial Exchange), OFX (Open Financial Exchange) and SWIFT (Society for Worldwide Interbank Financial Telecommunication). They compare the Electronic Bill Presentment and Payment messages in each standard to the case financial institution's internal context. They raise the conflicting elements and produce solution formulas to transform the conflicting elements of each standard to the format the case financial institution uses internally.

6 Conclusions

In this study, the standards were examined bottom-up: the existing standards were compared in order to find relations and similarities.

As the standards have very different structures and scope, it is difficult to start creating an ontology based on one standard or a group of standards with bottom-up approach. The top-down approach from existing higher-level ontologies would possibly help in covering the wide range of the elements. Financial ontology could be created based on a higher-level ontology. We suggest that SUMO would be a good alternative for the higher-level ontology.

Preliminary financial ontology could be created without thinking about the different standard the ontology is supposed to cover. Only the scope of the ontology could be taken into account. After a preliminary financial ontology has been created, the different standards could be mapped to it although, the financial ontology could be expanded while mapping the standards to it. It can be difficult to create financial ontology from scratch. It might still make the process of mapping easier if there were a common basis for the ontology before the mapping of the standards is done.

A specialist in the financial field and the financial standards should do the financial ontology creation. Deep knowledge of the financial field is essential in understanding the financial terminology and structures. Knowledge of the financial standards and their implementation guidelines is also needed to understand the real meanings of the elements. If the financial ontology is created with top-down approach, it would be easier to divide the tasks of ontology creation and standard mappings to different specialists.

Regardless of the chosen approach, the future research should continue the comparison of standards started here in this study.

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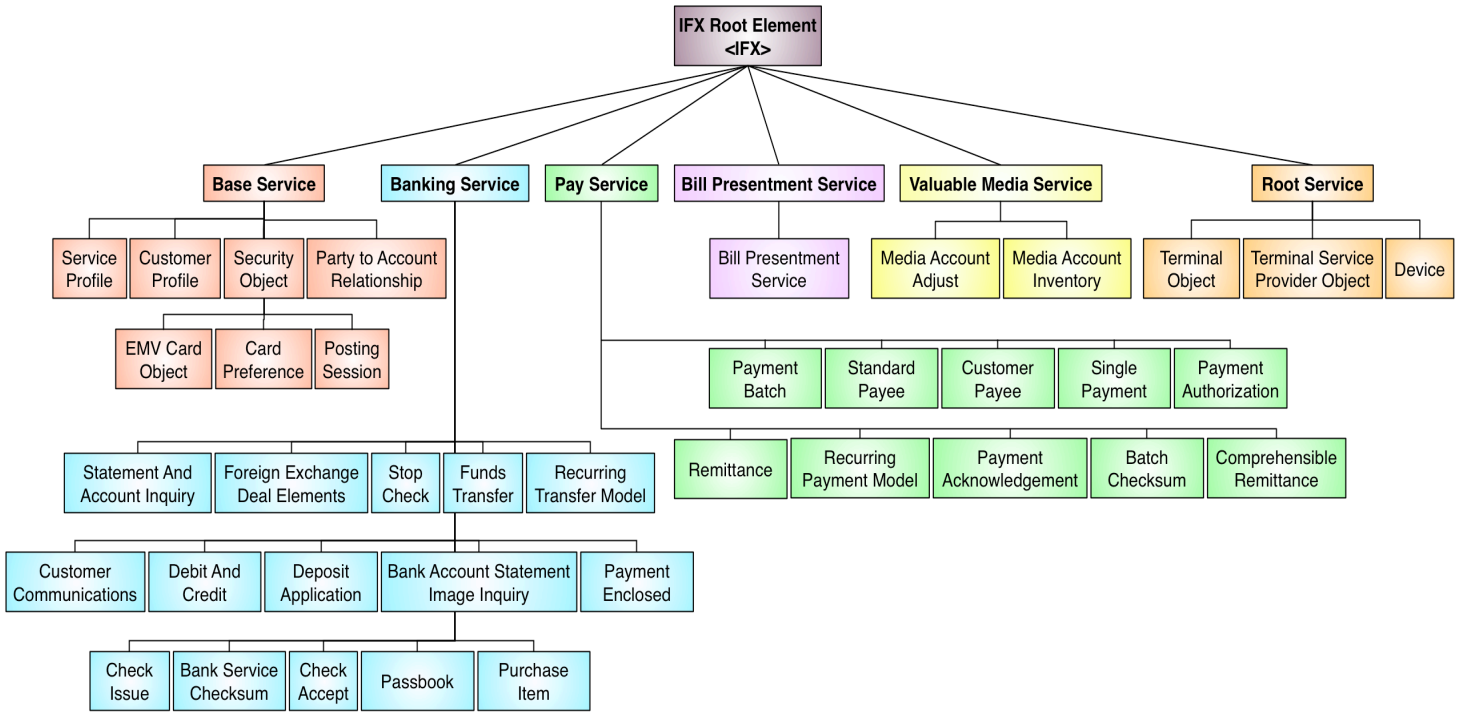
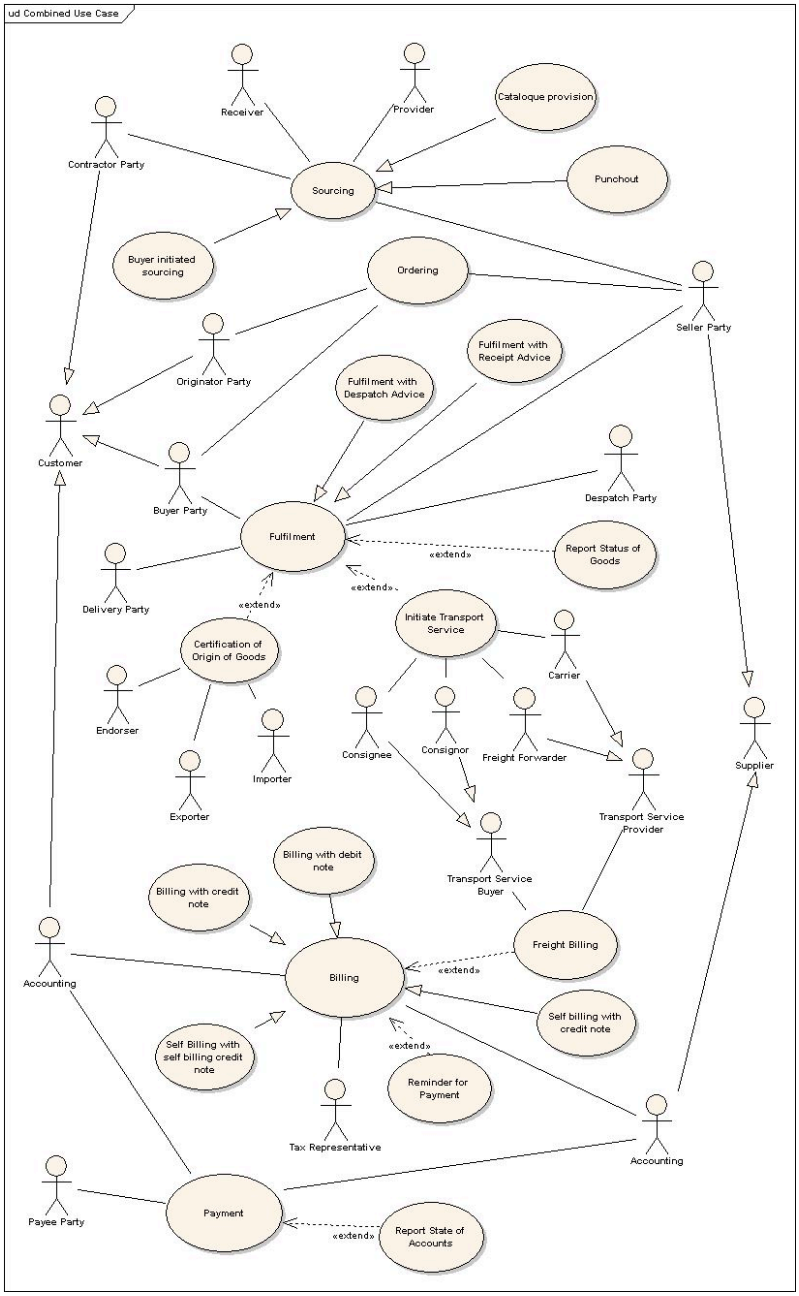
8 Appendices

Appendix A. The structure of the IFX standard



Appendix B. Business processes covered by UBL (McGrath, 2006)



Appendix C. Basic structures of invoice message in different standards.

*A star at the end of the name means that name is an entity, which has more entities or elements under it.

IFX	UBL	UNIFI
Bill	**Invoice**	**Invoice**
Bill Identifier (BillId)	UBLVersionID	CopyIndicator
Bill Information (BillInfo)	CustomizationID	IdentificationNumber
Bill Type (BillType)	ProfileID	IssueDateTime
Customer Identification (CustId)	ID	PaymentDueDate
Service Provider Name (SPName)	CopyIndicator	Status
Customer Permanent ID (CustPermId)	UUID	TotalAllowance
Presentment Account Identification (PresAcctId)	IssueDate	TotalCharge
Billing Account (BillingAcct)	IssueTime	TotalInvoiceAmount
Biller Identification (BillerId)	InvoiceTypeCode	TotalTaxAmount
Service Provider Name (SPName)	Note	TotalTaxableAmount
Biller Number (BillerNum)	TaxPriceDate	Type
Bill Summary Amount (BillSummAmt)	DocumentCurrencyCode	InvoicedGoods (Goods)
Bill Summary Amount Identifier (BillSummAmtId)	TaxCurrencyCode	Description
Bill Summary Amount Code (BillSummAmtCode)	PricingCurrencyCode	FreightChargesPrepaidOrCollect
Currency Amount (CurAmt)	PaymentCurrencyCode	Incoterms*
Amount (Amt)	PaymentAlternaticeCurrencyCode	Quantity*
Currency Code (CurCode)	AccountingCostCode	QuantityTolerance*
Currency Exchange Rate (CurRate)	AccountingCost	ShipmentDate
Currency conversion indicator (CurConvertRule)	LineCount	Charge*
Bill Summary Amount Type (BillSummAmtType)	InvoicePeriod	PaymentTransaction*
Bill Summary Sub-Amount (BillSummSubAmt)*	OrderReference*	Tax*
Due Date (DueDt)	BillingReference*	Transport*
Bill Date (BillDt)	OriginatorDocumentReference*	Product*
Opening Date (OpenDt)	ReceiptDocumentReference*	Price*
Close Date (CloseDt)	DepatchDocumentReference*	InvoiceFinancingTransaction (Invoice)
Payment Instrument (PmtInst)	ContractDocumentReference*	Customer (Party)
Payment type (PmtInstType)	AdditionalDocumentReference*	Address*
Card Brand (Brand)	Signature	ClientIdentification
Settlement Information (SettlementInfo)	SignatoryParty*	Name
Settlement Method (SettlementMethod)	DigitalSignatureAttachment*	CountryCode*
Deposit Account Identifier (DepAcctId)	OriginalDocumentReference*	Role*
Account Identifier (AcctId)	AccountingSupplierParty*	TaxationCountry*
Account Type (AcctType)	SellerSupplierParty*	TradingPartyCapacity*
Account Key (AcctKey)	AccountingCustomerParty*	PartyProfileInformation*
Account Currency (AcctCur)	CustomerAssignedAccountID	CommunicationNumber *
Bank Information (BankInfo)*	SupplierAssignedAccountID	CreditAccount*
Payment and Settlement Instruction (PmtInstruction)	AdditionalAccountID	FinancingAccount*
Country (Country)	DeliveryContact	InvestmentAccountOwnershipInformation*
Payment Format (PmtFormat)	AccountingContact	InvestmentAccountRelationshipInformation*
Reference Information (RefInfo)*	BuyerContact	OrderProcessingData*
Intermediary Deposit Account (IntermediaryDepAcct)*	Party	Supplier (Party)
Fee Charge Allocation (FeeChargeAlloc)*	MarkCareIndicator	Address*
Notify Required (NotifyReqd)	MarkAttentionIndicator	ClientIdentification
Biller's View Detail Preference (ViewDtlPref)	WebsiteURI	Name

Statement Image (StmtImage)
Bill Reference Information (BillRefInfo)
Bill Status (BillStatus)
Bill Status Code (BillStatusCode)
Effective Date Time (EffDt)
Status Modified By (StatusModBy)
Bill Record (BillRec)
Bill Identifier (BillId)
Bill Information (BillInfo)* same as before
Bill Status (BillStatus)* same as before
Bill Payment Status (BillPmtStatus)*

LogoReferenceID
EndpointID
PartyIdentification*
PartyName*
Language*
PostalAddress*
PhysicalLocation*
PartyTaxScheme*
PartyLegalEntity*
Contact*
Person*
AgentParty*
BuyerCustomerParty*
TaxRepresentativeParty*
PayeeParty*
Delivery*
PaymentTerms
Identifier
PaymentMeansID
PrepaidPaymentReferenceID
Note
ReferenceEventCode
SettlementDiscountPercent
PenaltySurchangePercent
Amount
PenaltyPeriod*
SettlementPeriod*
PaymentMeans
ID
PaymentMeansCode
PaymentDueDate
PaymentChannelCode
InstructionID
InstructionNote
PaymentID
CardAccount
PrimaryAccountNumberID
NetworkID
CardTypeCode
ValidityStartDate
ExpiryDate
IssuerID
IssueNumberID
CV2ID
CardChipCode
ChipApplicationID
HolderName
PayerFinancialAccount*
PayeeFinancialAccount*
ID
Name
AccountTypeCode

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TradingPartyCapacity*
PartyProfileInformation*
CommunicationNumber *
CreditAccount*
FinancingAccount*
InvestmentAccountOwnershipInformation*
InvestmentAccountRelationshipInformation*
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CreationDate
CreditDebitIndicator*
CurrencyOfTransfer*
DebitPurpose
EquivalentAmount*
InstructedAmount*
InstructionForDebtorAgent
InstructionForFinalAgent
InstructionForFirstAgent
Instrument*
PaymentDueDate*
PaymentTransactionIdentification
PoolingAdjustmentDate
Purpose*
TransactionDueDate
CurrencyExchange*
SettlementAccount*
CreditorAccount*
CreditorAgentAccount*
DebtorAccount*
DebtorAgentAccount*
IntermediaryAgent1Account*
IntermediaryAgent2Account*
IntermediaryAgent3Account *
PreviousInstructingAgentAccount*
ChargesInformation*
PaymentTransactionCharge*
ChequeInstruction*
ExchangeRateInformation*
DirectDebitMandate*
CreditorAgent*
DebtorAgent*
ForwardingAgent*
InstructedAgent*
InstructingAgent*
IntermediaryAgent1*
IntermediaryAgent2*
IntermediaryAgent3*
PreviousInstructingAgent*

	CurrencyCode PaymentNote FinancialInstitutionBranch ID Name FinancialInstitution* Address* Country CreditAccount AccountID AllowanceCharge* PaymentExchangeRate* TaxExchangeRate* PricingExchangeRate* PaymentAlternativeExchangeRate SourceCurrencyCode SourceCurrencyBaseRate TargetCurrencyCode TargetCurrencyBaseRate ExchangeMarketID CalculationRate MathematicOperatorCode Date ForeignExchangeContract* PrepaidPayment ID PaidAmount ReceivedDate PaidDate PaidTime InstructionID LegalMonetaryTotal LineExtensionAmount TaxExclusiveAmount TaxInclusiveAmount AllowanceTotalAmount ChargeTotalAmount PrepaidAmount PayableRoundingAmount PayableAmount TaxTotal* InvoiceLine*	InstructionForCreditorAgent* InstructionForNextAgent* Creditor* Debtor* InitiatingParyt* Receiver* UltimateCreditor* UltimateDebtor* PaymentInstrument* PaymentTypeInformation* RegulatoryReporting* RemittanceInformation* PaymentTransactionChain* SettlementInformation*