

**IMPROVING UCCNET-COMPLIANT B2B SUPPLY-CHAIN
APPLICATIONS USING A CONTEXT INTERCHANGE FRAMEWORK**

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ABSTRACT

UccNet (<http://knowledgebase.uccnet.org>) is a globally centralized B2B electronic data platform for storing trading product item information and hosted by the non-profit international standardization institute EAN-UCC. It is an emerging B2B data communication standard for the retail industry with significant potential impact. Many US retailers are requesting their international suppliers for compulsory subscription by the year-end of either 2004 or 2005 and many major IT software providers and consulting firms specialized in supply chain management are preparing packaged services/solutions for this imminent demand.

In light of the increasing importance of UccNet on both the technology and application sides, this paper attempts to advance the following argument: Though UccNet establishes an architectural framework to resolve the many-to-many connectivity issue and data synchronization issue through a centralized product database and a uniform numbering system (i.e., Global Trade Item Numbering), there are context discrepancy issues remaining to be addressed. We show with a real case study that context discrepancy is inherent in the international trading applications where UccNet is intended to be used. Naturally, international trading partners tend to define and describe product item information differently. That difference, either due to the culture or the geographical location, is not considered in the original design of UccNet. As an example, the attribute “width” contained in the database schema of UccNet would be filled by a China-based supplier in ‘meter’ and yet be interpreted as ‘feet’ by the US retail buyer.

We show how the Context Interchange Framework, operating under the rationale of local autonomy and speaking to the resolution of context mediation issue, can be nicely incorporated into the existing UccNet framework to constitute theoretically a more complete technical solution and practically a more useful B2B supply chain business solution.

Keywords: B2B, Retail Supply-Chain, UccNet, Data Connectivity and Synchronization, Context Interchange, Data Semantics

1. RETAIL SUPPLY CHAIN AND UccNet

Supply Chain Management (SCM), as being actively discussed in academia and progressively diffused into various industrial sectors, was originally forwarded to address a fundamental problem in today's business environment, namely the "bullwhip effect" [LPW1997]. The bullwhip effect explicated a phenomena where the market demand fluctuation gets distorted and amplified through the involvement of multiple supply chain parties (retailers, distributors, logistic service providers, manufacturers,...) when they do not share information and design their forecast plans and execute their work plans separately from their trading partners. B2B collaborative commerce, built upon a pre-agreed technological information-sharing mechanism and a co-planning process, was a pragmatic effort to attend to each compositional phase of SCM activities including, demand forecasting, order fulfillment, manufacturing, shipping, and track-and-trace event handling. In the retail industry, one ongoing initiative is called CPFR (Collaborative Planning, Forecasting, and Replenishment), which had gained support from many major retailers in the US, and non-profit standardization institutes (GCI: Global Commerce Initiative, GSMP: Global Standard Management Process, and Supply Chain Council). Under that initiative, a B2B mechanism (predominately Electronic Data Interchange, EDI) is critical to ensure correct, consistent, and timely information sharing and exchange. That being said, the retail industry has been known to suffer a mess of synchronizing their data with that of their upstream suppliers. For example, a study conducted by A.T. Kearney [Ucc2003] for the US retail industry revealed that:

- \$40 billion, or 3.5 percent, of total sales lost each year are due to supply chain information inefficiencies;
- 30% of item data in retail catalogues is in error, each error costs \$50-\$80 US dollar to correct;
- Companies spend on average 25 minutes per SKU per year on manual cleansing activities;
- 60% of all invoices generated have errors; 43% of all invoices result in deductions; each invoice error costs between \$40 - \$400 US dollars to reconcile;
- An average of four to six weeks is required to introduce a new product.

To respond to such information inefficiency between trading partners, Uniform Code Council (UCC) and European Numbering Agency (EAN International) merged as EAN-UCC and had worked together with GCI to develop a global e-catalog platform named UccNet, for two major issues in the retail supply chain: 1). to resolve the overwhelming many-to-many data *connectivity* issue when multiple suppliers need to transact electronically with multiple buyers; and 2) to resolve the product *coding discrepancy* issue for trading product item description. Regarding to the former issue, a globally centralized database *GlobalRegistry* (Figure 1) [Ucc2004] was devised to allow suppliers and retailers to connect to each other on a single-entry-point basis so as to exchange product item information without having to deal with the interfacing complexity. Regarding to the latter, a global product-coding scheme GTIN (Global Trade Item Numbering) system was proposed and applied as the key identifier for *GlobalRegistry*. UccNet is at present gaining acceptance and adoption in the retail industry. Since its inception, UccNet has established itself as the central product item electronic trading platform for the retail industry, with endorsements by EAN International, the Voluntary Inter-industry Commerce Standards Association (VICS), the Global Commerce Initiative (GCI), The Food Marketing Institute (FMI), the American Hardware Manufacturers Association (AHMA), the Grocery Manufacturers of America (GMA), and other industry groups and trade associations. Major retailers including

Wal-Mart, Ace Hardware, Lowe’s, Home Depot, Food Lion, and many more have subscribed to UccNet. Reportedly, more than 750 companies have joined UccNet to date and more than 60,000 products have been registered [FG2003]. These retailers are currently piloting UccNet projects within their organizations and requesting their domestic/international suppliers for compulsory subscriptions. As a support, the following is an excerpt from Wal-mart to its international suppliers:

“At Wal-Mart, we expect to receive all item data electronically by January 2004 through either Wal-Mart’s Supplier Quote system (used by those who supply us with custom product), Wal-Mart defined standard spreadsheets, or through UccNnet. Our direction is UccNet.”

As to the result, many suppliers have already leveraged *GlobalRegistry* to publish and update product information. Accurate and complete data dramatically reduce expensive supply chain information discrepancies. UccNet users claim reduced losses due to invoice discrepancies and product delivery errors of 50 to 60 percent; a 30 percent improvement in the quality of purchase orders; improved speed to retail shelves for new items and price changes by 80 percent; and increased retail scanning accuracy to 99.8 percent.

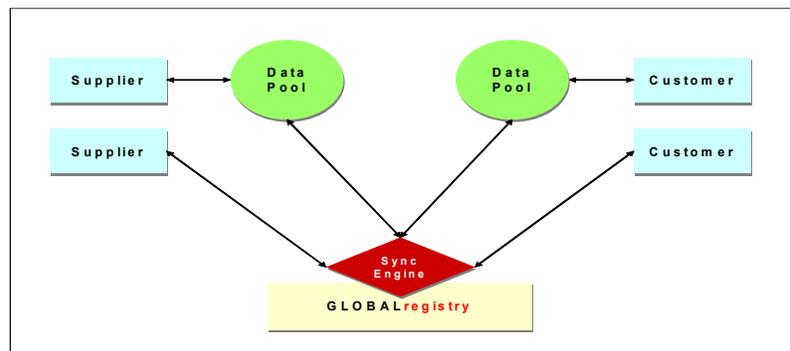


Figure 1. GlobalRegistry

2. UccNet APPLICATIONS AND THE STRUCTURE OF GlobalRegistry

Subscription of UccNet begins with applying for a corporate entity identifier called GLN (Global Location Number). After subscription, the subscribing suppliers can upload their internal product data in prescribed XML-based schema format onto *GlobalRegistry* for publishing. Prior to uploading, each product item must be equipped with a GTIN which functions as the key attribute of *GlobalRegistry*. The subscribing retailers also identify the UccNet item categories for which they wish to receive notifications. On a continuous basis, the suppliers may add/change/delete product items with authorization from the UccNet system pertaining to a publication. Authorization of an item within UccNet means that the retailer indicates that they accept that item definition and internalize that acceptance into their own data stores. When newly registered public item is published, changes or deletions are made in the categories they have pre-designated, the subscribing retailers will also receive instant notifications. (Figure 2) [Ucc2004]. Indeed, UccNet is an information-sharing B2B platform for international trading partners providing a basis of data synchronization- connectivity, naming, and coding. It is

essentially a B2B foundation for trading partners to proceed with supply chain activities and allows for collaborative inter-process to take place.

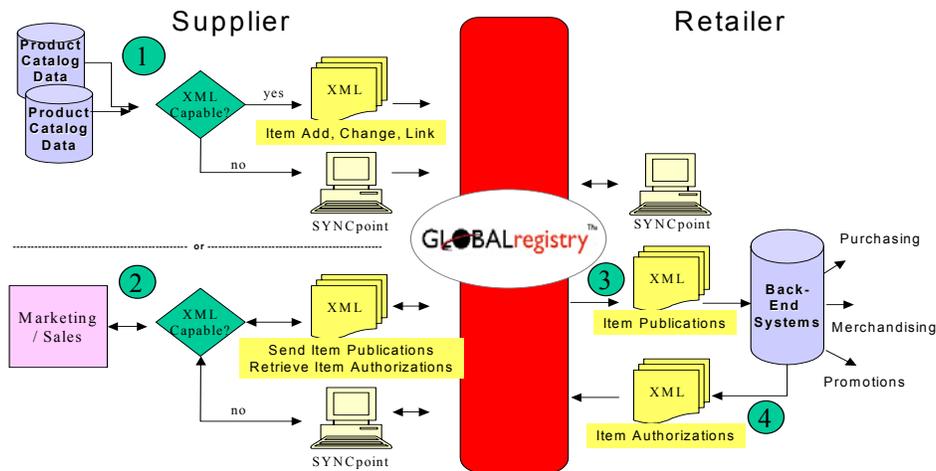


Figure 2. Use of GlobalRegistry

While at the current stage UccNet is more like an e-catalogue service and casts more influence on retailers' existing sourcing/merchandising functions, the intent of having a data-synchronized central data store was to streamline other important activities of retailer's operations as well. Figure 3 shows a B2B SCM roadmap of a supermarket retailer [Shaw2002], and Figure 4 depicts UccNet's agenda in utilizing *GlobalRegistry* as a full-fledged retail supply chain enabler [Ucc2004]. Both pieces of support indicate the great importance of UccNet and its tremendous weight on the efficiency of the retail supply chain.

TIME FRAME	TODAY			SHORT TERM				LONG TERM	
TRANSPORT TYPE	Paper	Electronic		Electronic				Electronic	
TRANSPORT VEHICLE		EDI	UccNet	EDI	Others	UccNet	KIOSK	Others	UccNet
Item Data	x					x	x		x
Price	x	x	x	x	x	x	x		x
Promotion	x	x	x	x	x	x	x		x
Purchase Order	x	x	x	x	x			x --->	x
Invoice	x	x	x	x	x			x --->	x
Advance Shipping Notice		x	x	x	x			x --->	x

Figure 3. Example B2B SCM Roadmap

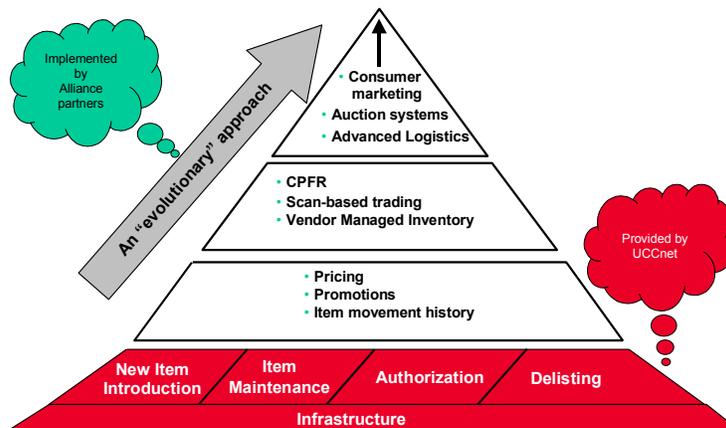


Figure 4. UccNet’s agenda in utilizing *GlobalRegistry*

The negotiation, communication, and settlement of ordering, pricing, inventory, and promotional data are the most central activities for international trading. Today’s practices are however still labor-intensive, repetitive and error-prone. Trading partners often communicate these supply chain activity information in an ad hoc manner, leading to great insufficiency and time delay. These issues can lead to loss to trading partners such as out-of-stocks, excess inventory, untimely delivery, and low consumer service. To accommodate the diverse applications, there are basically five types of item information (Table 1) with the total of 162 attributes contained in *GlobalRegistry*.

TYPES OF ATTRIBUTES	EXPLANATION	EXAMPLE	AFFECTED PARTY
Core	Basic info that is core to a product’s definition	Item’s identifier, size and weight	Trader/Supplier, Retailer
Category-specific	Info. related to the item’s product category	Item’s substitutes if the item isn’t available	Trader/Supplier, Retailer
Manufacturing-specific	Info. related to how the items are produced, assembled and packed	Item’s output form and packing format	Manufacturer, Retailer
Logistics-specific	Info. related to how the products are stored, moved, and transported	Number of layers that can be fit into a pallet	Supplier/Logistic Service Provider, Retailer
Transaction-specific	Info. related to how the transaction terms are fulfilled	Item’s price, arrival date	Supplier/Distributor, Retailer

Table 1. Types of Information in *GlobalRegistry*

3. CONTEXT DISCREPANCIES IN UCCNET AND BUSINESS SCENARIOS

While UccNet is a breakthrough in promoting data synchronization, the current effort mostly relies on syntactic integration, rather than semantic integration, of suppliers’ and retailers’ data sources. Present mandates on using *GlobalRegistry* as the centralized data store only address the reconciliation of syntactic and structural descriptions of product items. For instance, the

attribute naming, XML schema, attribute types (e.g., string, numeric, Boolean), and allowed values are all well considered in UccNet's current design. Yet there are semantic integration issues, in particular context discrepancy, remaining un-addressed and yet having great implications to the various UccNet applications (i.e., merchandising, pricing, promotion, logistics, etc.). "*Context*" refers to the meaning of a piece of datum that is subject to a set of implicit assumptions when data are created, interpreted, and used. One simple example is that a value "5" for the attribute "product width" can mean either "cm" or "inch" depending upon the measurement systems prevalently practiced by the trading partners located in different national/geographical regions. These assumptions about context, though being elemental to what a data synchronization standard should entail, are currently absent in the framework of UccNet.

This paper postulates that since UccNet is intended to promote global commerce, trading partners (international suppliers and retailers) are very likely to operate under distinct contexts due to the nature of their different organizational, legal, procedural, and cultural conditions. We maintain that to the extent the context discrepancy issue was left open and not considered in UccNet, the true value of data synchronization will be limited and thus the benefit of UccNet applications and innovative collaborative process (e.g., CPFR) will be very difficult to reap.

We were able to collect scenarios corresponding to the usage of the five types of attributes in *GlobalRegistry* from a case study. Within this case study, what are highlighted are the business problems accrued from each step of an international trading deal and the root cause of context discrepancy. ABC (we use ABC as an acronym for a real company) is a top China-based international trading firm supplying more than 50,000 types of goods to 350 buyers located in 40 countries. ABC's trading product lines are very wide, but mostly in consumer packaged goods (CPG), apparel, and hard-line categories. Its buyers include many US's major retailers such as Wal-mart, Home Depot, Staples, Target, and due to its quality trading record once received the best supplier award from Wal-mart. Meanwhile, ABC is a member of the local EAN meaning that it publishes its offered product items in a product database (name it *LocalRegistry*) hosted by the local article-numbering agency. Conceivably, *LocalRegistry* is not fully compatible with the global product *GlobalRegistry* for the former is mainly used for local trading purpose while the latter is mainly an international standard compliance to its US buyers. Now, the following scenarios exemplify the context issues when ABC plans to subscribe to the UccNet standard and exchange trading data with its US buyers:

Scenario 1: [Core attribute]- Context discrepancy subject to different measurement systems used in China and the US.

- | |
|---|
| <ul style="list-style-type: none">- <i>GlobalRegistry's</i> attributes "height", "width" and "length" are assumed to take "inch" while <i>LocalRegistry's</i> counterpart attribute are assumed to take "cm".- <i>GlobalRegistry's</i> attributes "FlashPointTemp", indicating the flashpoint temperature for hazardous material, is assumed to take "Degrees Fahrenheit" while the local convention is assumed to take "Degrees Celsius". |
|---|

Scenario 2: [Category-specific attribute]- Context discrepancy subject to different safety regulations used in China and in the US.

- *GlobalRegistry's* attribute "Replaceltem" indicates the GTIN of an item that a product is replacing. Now ABC may supply the attribute with the value of another item GTIN functionally substitutable to the item of absence both of which meeting the local safety standard but in fact considered as un-replaceable in the US because the item of absence has a safety certification proof in the US but the latter doesn't.

Scenario 3: [Manufacturing-specific attribute]- Context discrepancy subject to different cultural systems in China and in the US.

- *GlobalRegistry's* attribute "PackageType" is used in the apparel industry indicating whether the item is of the size: 'S', "M", "L", and "XL". Now ABC's contract manufacturers in China might interpret "M" as the medium size for Asians and manufacture accordingly while ABC's US buyers mean the medium size for Americans, which are very different in sizing.

Scenario 4: [Logistics-specific attribute]- Context discrepancy subject to different logistic systems in China and in the US.

- *GlobalRegistry's* attributes "ti" and "hi" refer respectively to the number of items that can fit on a single layer on a pallet and the number of layers on a pallet. This is an important piece of information for logistic service providers to optimize logistic work on load distribution when goods arrive in the distribution center (e.g., Wal-mart's cross-docking distribution strategy). The issue arises when the standard pallets being used in Asia (mostly 100 * 100) are different from the standard pallets used in domestic US (100* 120). Consequently, the values for "ti" and "hi" filled by the Asian suppliers based on the former pallet capacity will be misleading and caused troubles for a LSP in the US adopting the latter pallet standard.

Scenario 5: [Transaction-specific attribute]- Context discrepancy subject to different inter-commerce trading terms.

- Many US retailers request their suppliers to operate under the trading terms of "DDP; Delivered Duty Paid" or "DDU: Delivered Duty Unpaid" instead of "FOB: Freight on Board", requiring the suppliers to bear goods ownership (and thus logistic cost) until the arrival of the retailers' distribution center (Vendor-Owned Inventory) or even site stores (Scan-based Trading). These new trading terms post conditional interpretations to the *GlobalRegistry's* attributes "SuggestedRetailPrice" and "ArrivalDate". While the two attributes are interpreted as product cost only and arrival at the departure port of country of origin under the trading term of "FOB", they are interpreted as product cost plus logistic cost and the arrival at the DC (in the case of Vendor-Owned Inventory) and stores (in the case of Scan-based Trading) under the new trading terms. What makes things worse is that these trading terms are not part of the content of *GlobalRegistry* but are important assumptions of correct interpretations of the values of the two attributes.

4. CONTEXT INTERCHANGE FRAMEWORK ON TOP OF UccNet

The above scenarios illustrate some of the context discrepancy issues within *GlobalRegistry*. We propose to add MIT's work on the COntext INterchange (COIN) framework [BGL2000, GBMS1999, Mad1999], illustrated in Figure 5, to Uccnet's current design. COIN is an integration strategy designed to address the problem of semantic inter-operability. The novelty of this approach lies in the elegant separation of the domain model and the source model, a wrapping interface that encapsulates the format of the underlying data sources, and a powerful

abduction engines to automatically detect and reconcile context discrepancy of the dispersed data sources in a heterogeneous environment.

In the COIN architecture, each source (whether a traditional database or a web resource) has a defined context (shown at the lower part of Figure 5.) Likewise, each user, or user organization, has its own defined context (shown at the upper right of Figure 5). Note that no changes are required to any of the sources or the users. Whenever any user requests information from one or more sources, the context mediator examines the auxiliary context knowledge, determines if any conflicts exist, and performs any needed conversions.

Recent functional extensions of COIN have been applied in the *aggregator* [FMG2002a, FMG2002b] and *semantic-web* application areas. It is our argument that COIN can be well applied to fill the technological gap in several areas:

- Concept-wise, COIN assumes a source-mediator-receiver model. The source and receiver each declares their own local context. The context mediator, the heart of COIN and functioning on top of a domain model, assumes the major responsibility of semantic conflict resolution. COIN has developed various interfacing specifications for source and receiver for easy connection. COIN's research positioning is similar to UccNet, with only the differentiation on the focus of syntactic integration (for UccNet) and semantic integration (COIN). The marriage of the two systems in any of four possible configurations shown below can advance one step further to a truly data synchronization platform.
- Architecture-wise, COIN is a "middleware" information service that introduces minimal intrusion to existing information systems and honor local autonomy, which are both important features as an add-on service to UccNet. The nature of international trading applications and retail supply chain applications would require the current trading partners to smoothly transit to the UccNet systems yet meanwhile reserve local autonomy of workflow, legal conventions, and culture-specific operations. For instance, while ABC needs to maintain membership of *LocalRegistry*, COIN can be used as an intermediary mediation service between and *GlobalRegistry* and *LocalRegistry*.
- Representation-wise, the library of conversion functions and elevation axioms embedded in the COIN system has sufficient expressive power to model the relationship between the "context" and the "described data". While some context can be captured in the ontological domain model (i.e., the semantic relationship modeling tool) inherent in COIN, some can be expressed with minimal manual coding as conditional statements that trigger the necessary conversions for context conversion (e.g., the pallet scenario). It can be conceptually shown that COIN with its technical elements available, including the ontological store, the axiom set and the reasoning engine, can address the semantic integration issues laid out earlier in the scenarios.

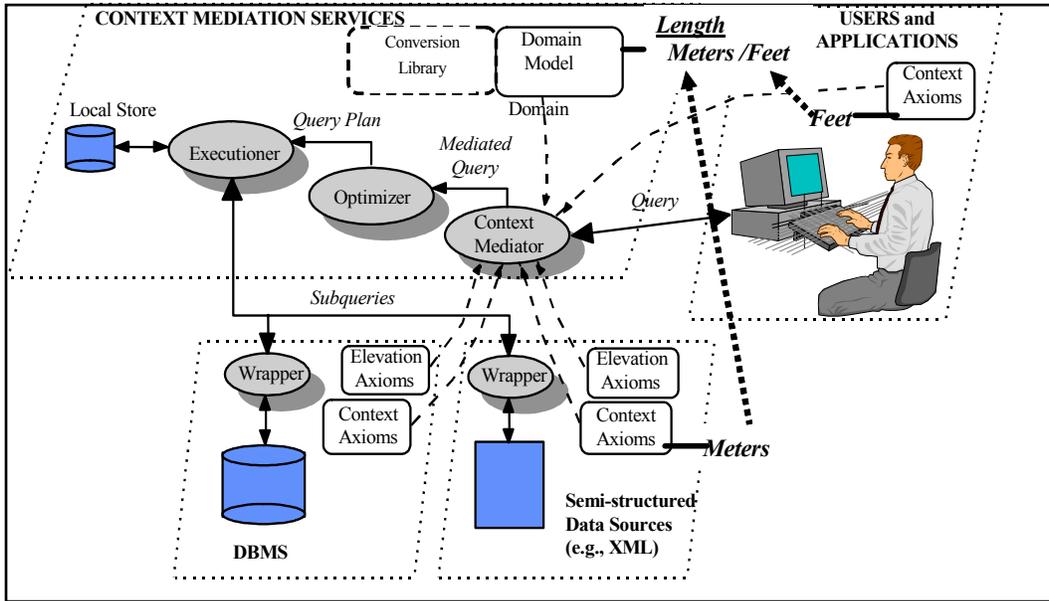


Figure 5. Context Interchange (COIN) Architecture

Practically, there are four possible configurations, shown in Figure 6, that enable COIN to be incorporated as an “add-on” service; each configuration would play a different business role and implies different integration focus to COIN.

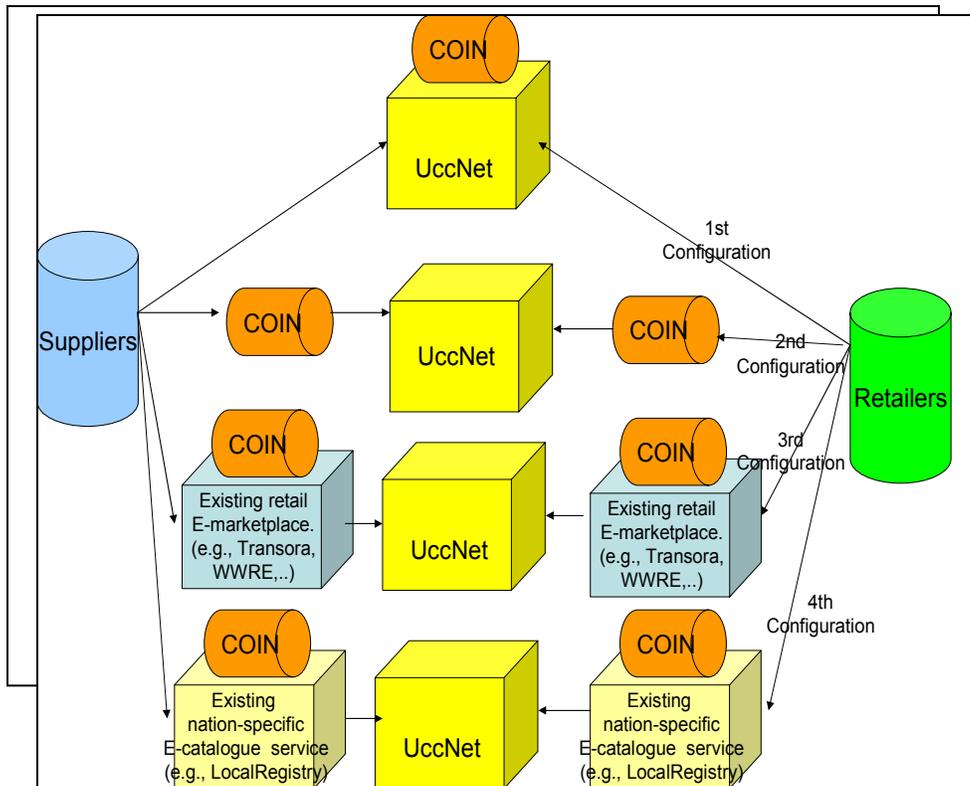


Figure 6. Four Alternative Configurations to Incorporating COIN into UccNet

In the 1st configuration, COIN is incorporated as part of UccNet where the technical components of COIN must integrate nicely with the existing ones of UccNet (e.g., the reasoning engine of COIN must interoperate with UccNet's *SyncEngine*). In the 2nd configuration, COIN is not part of UccNet but more as a "gateway" service to supplier/retailers. Under this configuration, COIN must be equipped with very powerful interfacing capabilities to allow easy connection with the internal ERP systems of suppliers/receivers. The current technical components within COIN system would need minimal adaptation work. In the 3rd and 4th configurations, we would expect COIN to be part of the existing trading platforms hosts that are orienting/expanding themselves to become intermediary services to UccNet for suppliers/retailers. While in the 3rd configuration, we list certain e-marketplaces hosted by private owners in the retail industry, we illustrate in the 4th configuration some platform hosted by local non-profit agency owners (e.g., Taiwan/China EAN).

5. CONCLUSIONS

UccNet's potential impact to the retail industry shall be profound. Many US retailers are requesting their international suppliers for compliance by the year-end of either 2004 or 2005. Many of the major IT software providers and consulting firms specialized in supply chain management are also preparing packaged services/solutions for this imminent demand. This momentum is further fueled by the legal imperative of Sunrise 2005 where all retailers' point-of-sale systems formerly scanning 12-digit UPC are required to be capable of scanning EAN-13-digit code by the date of January 1, 2005. The relationship of UccNet with Sunrise 2005 is that since GTIN (14-digit number) subsumes EAN-13 code, all organizations complying to UccNet will also be Sunrise-2005-compliant but not vice versa. With those numbering standards being forthcoming, UCC is thus able to transcend the interest of individual retailer and host a non-profit B2B standard data platform.

With the importance of Uccnet being acknowledged, it is the argument of this position paper to show that context discrepancy is naturally inherent in the international trading applications where UccNet is intended to be used. Without the context interchange issues being addressed for semantic integration, the data synchronization center as dictated by UccNet would be bad news rather than good news for subscribers when they hand over their in-house integration decision and work to EAN-UCC.

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