

Sloan Information Period (SIP) RF.450 Information Infrastructure Needed for Effective Utilization of RFID AutoID technologies

Part 2 – RFID Information Infrastructure

Subject RF.450 @ E51-145 on Monday , Oct 24, 2005 at 2:30-5:30 PM

Abstract:

This is an exploratory research SIP activity. A high degree of interaction and student participation and discussion is expected.

In order to maximize the effective use of RFID, existing intra- and inter-organizational business processes must be re-thought and re-structured, and an appropriate Information Technology (IT) infrastructure must be established both across organizations and between organizations.

Prof Stuart Madnick, <smadnick@mit.edu>, Room: E53-321, Ext: 3-6671.

Outline

Some of Sloan's Research issues (4:05-5:25)

- RFID IT Infrastructure
- Challenges to “Data Synchronization”
- Role of MIT's Context Mediation Technology in addressing the “Data Synchronization” challenge
- Discussion

Challenges

- Changing Environment
 - Standards
- Technology
 - Big IC suppliers are just entering
 - Middleware role not defined clearly
- Cost
 - Important mostly to EPC
 - Sub 1 cent tags are 5-10 years out?
- Culture
- Environment
- **Information Infrastructure**

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RFID and EPC



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EPCglobal Standard

- <http://www.epcglobalinc.org>

“EPCglobal is leading the development of industry-driven standards for the Electronic Product Code (EPC) Network to support the use of Radio Frequency Identification (RFID) in today’s fast-moving information rich trading networks. “

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EPCglobal Background

- Joint venture between EAN International and the Uniform Code Council (UCC)
- Auto-ID Center/ MIT Successor
<http://archive.epcglobalinc.org/index.asp>
- Vendor Neutral
- Consensus-based
- Not-for-profit standards organization

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Auto-ID Center Founding Concept

Radio frequency identification (RFID) is a simple concept with enormous implications.

Put a tag - a microchip with an antenna - on a can of Coke or a car axle, and suddenly a computer can "see" it.

Put tags on every can of Coke and every car axle, and suddenly the world changes.

- No more inventory counts.
- No more lost or misdirected shipments.
- No more guessing how much material is in the supply chain - or how much product is on the store shelves."

- <http://archive.epcglobalinc.org/aboutthecenter>

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What's in a EPC Tag?

Header	Filter	Partition	Company Prefix	Item Reference	Serial Number
00110000	7	5	0614141	100734	2
8 bits	3 bits	3 bits	24 bits	20 bits	38 bits

- **Header:** identifies the type of code used (00110000 (binary) identifies a SGTIN-96)
- **Filter:** currently not used
- **Partition:** describes the split between Company Prefix and Item Reference (5 means 24:20 for company and item)
- **Company Prefix:** Company Code (assigned by EPCGlobal & country organizations)
- **Item Reference:** UPC product code
- **Serial Number:** Serialized within the company and product codes

With 96 bits, there are 2^{96} combinations or approximately 10^{30} combinations. 268 million companies can each categorize 16 million different products and each product may contain over 687 billion individual items !!

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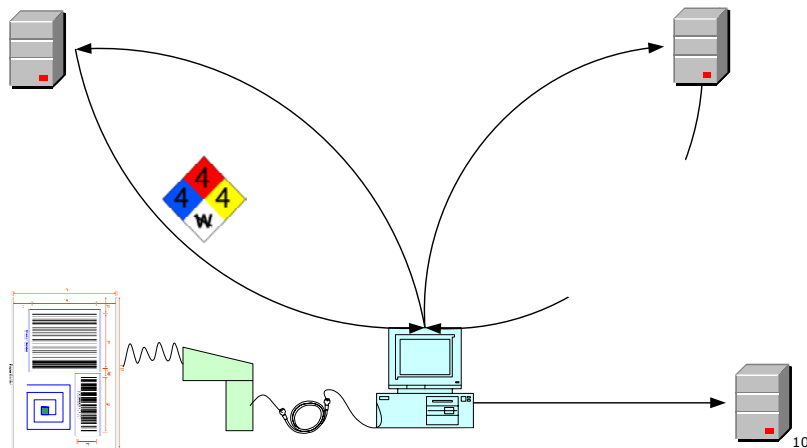
5 Parts of the EPC Global RFID Infrastructure

- Tag & Readers
 - EPC
 - **Object Name Server (ONS)**
 - **Physical Markup Language (PML)**
 - “Savant” – EPC distributed operating system / middleware
 - **... and everything else**
- Note: all of these are evolving and moving targets

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RFID Infrastructure - Example

(PML)



ONS – Object Naming Service

□ Redirection Service

- acts as telephone book in reverse
- based upon Domain Name Service (DNS)



■ Interesting temporal issues:

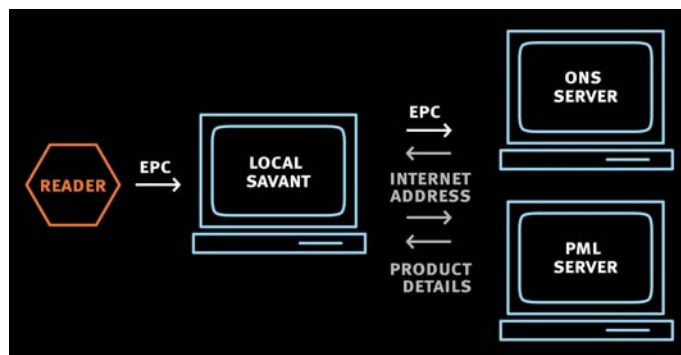
- How handle changes over time (e.g., Gillette merges with P&G)
- If company prefix changes, there may be tags with both old and new prefixes.

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PML – Physical Markup Language

□ Language for describing physical objects

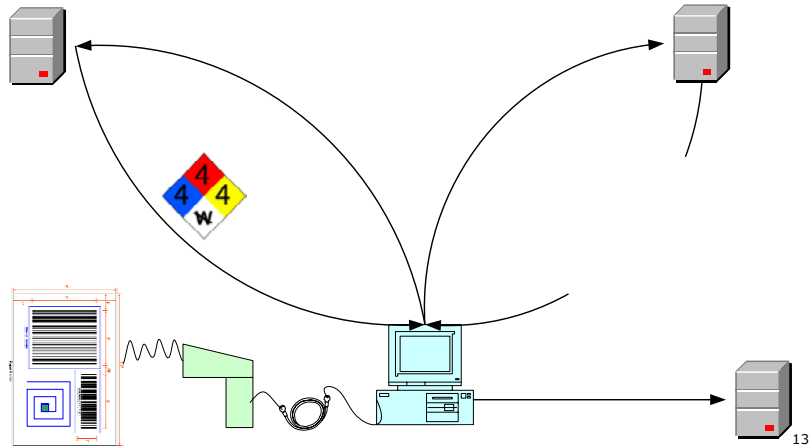
- classification and categorization



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RFID Infrastructure – Revisited Much more than tags & readers!

(PML)



International Workshop on
BUSINESS AND INFORMATION

Improving UccNet-compliant B2B Supply-Chain Applications On a Context Interchange Framework

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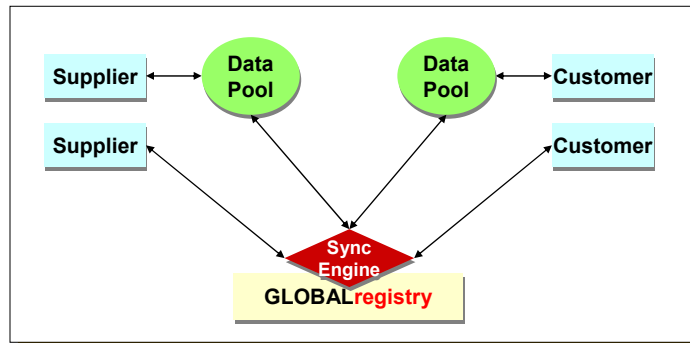
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XYZ Inc.
Informa
Service

What is UccNet?

Predecessor to EPCGlobal

- UccNet is a non-profit, interest-neutral, international, standard-based B2B data exchange platform and hosted by the Uniform Code Council (UCC).



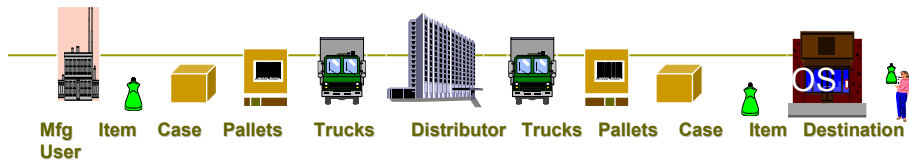
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UccNet Is An Emerging B2B Standard in The Retail Industry



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UccNet Goal: Solve Data Synchronization Problem



A study conducted by A.T. Kearney 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 \$40 - \$400 US dollars to reconcile
 - An average of four to six weeks is required to introduce a new product.
- The above are due to the **data synchronization and inconsistency problem in a many-to-many B2B supply chain environment**

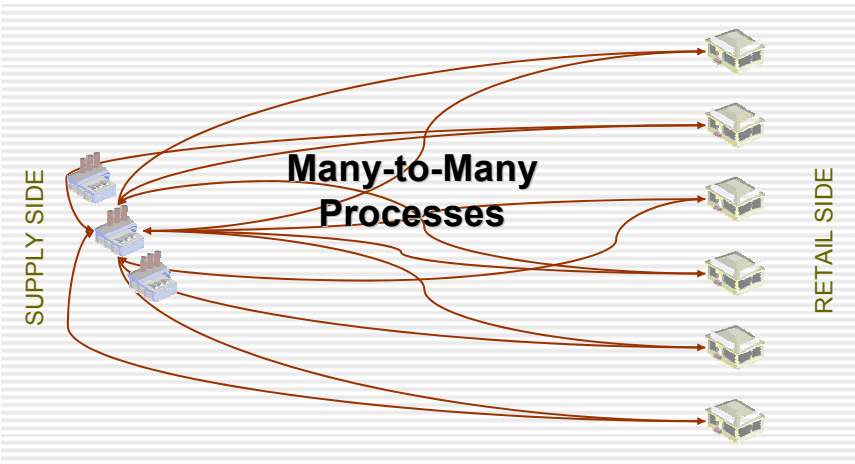
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UccNet's Data Synchronization Functions

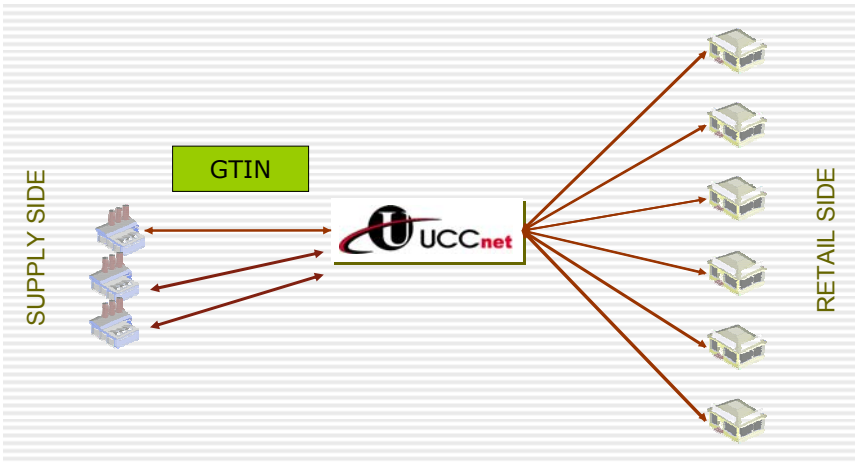
- Connectivity
 - From many-to-many to many-to-1-to-many
- Coding Standardization
 - **GLN** (Global Location Number) for identifying individual corporate entity
 - **GTIN** (Global Trade Item Number) for identifying individual product item

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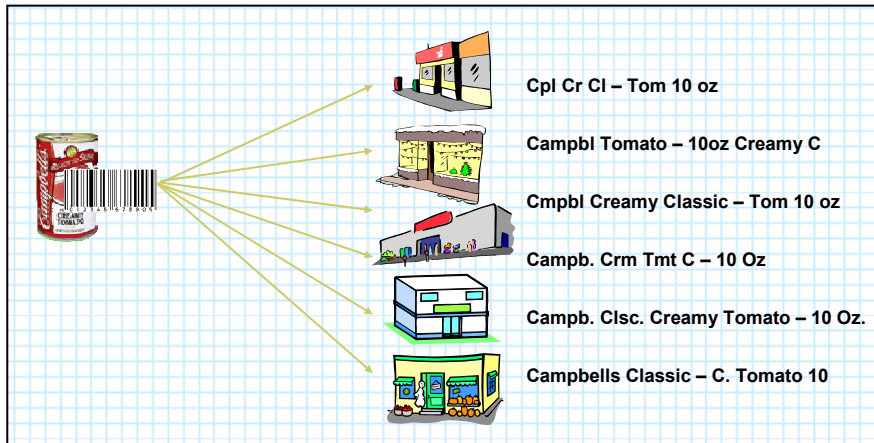
Lack of Data Connectivity - Before



UccNet Data Connectivity - After

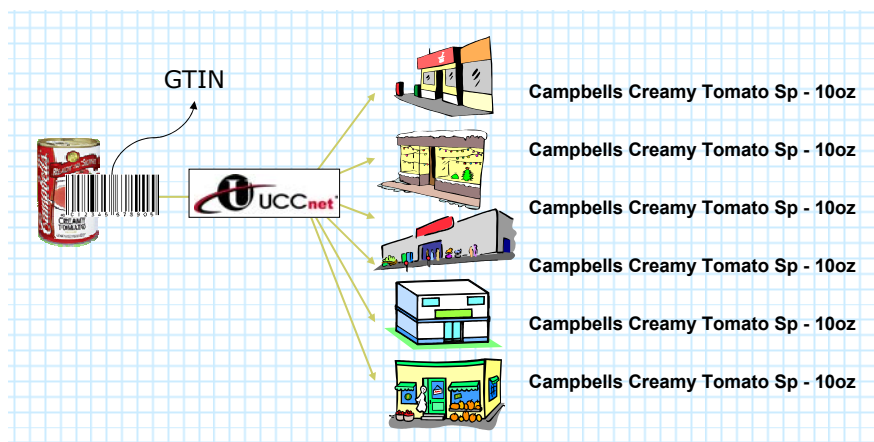


Lack of Code Standardarization - Before



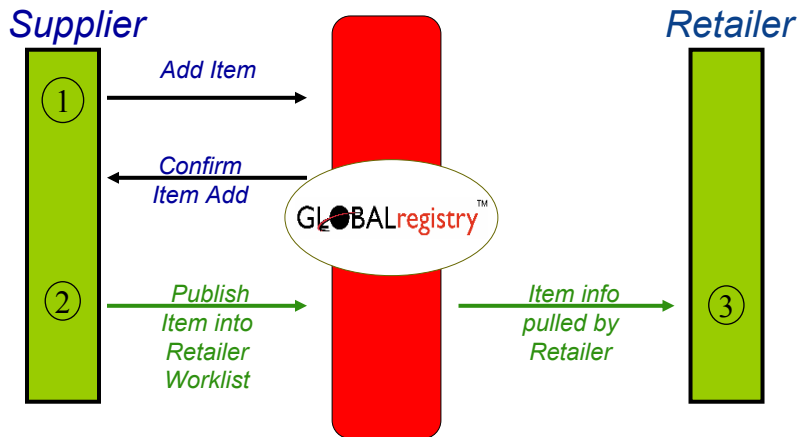
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UccNet Code Standardarization - After



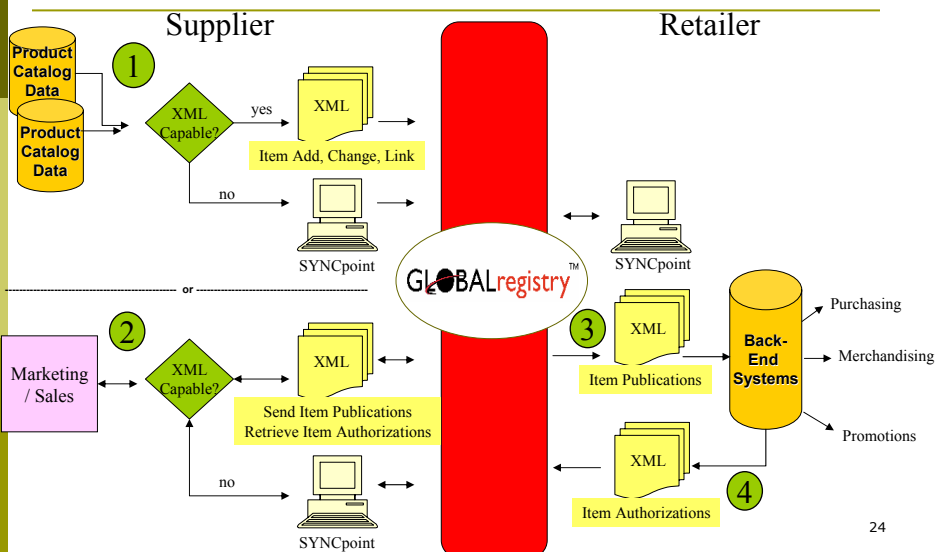
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UccNet Is A Centralized e-Catalog Service For Exchanging Product Item Information



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UccNet's Architecture



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Types of Information in Global Registry

Five types of Information - 162 Attributes

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

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Semantic Integration and Context

- From data integration point of view, UccNet only solves **syntactic integration** issues (schema and coding), but not **semantic integration** issues
- “*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
 - Example - 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

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Context Issues in Uccnet

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

Data interpreted or used in the wrong way is often worse than without data at all

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A Case Study on Context Issue in UccNet

- ❑ Company ABC 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.
- ❑ ABC's buyers include many US's major retailers such as Wal-mart, Home Depot, Staples, Target, and once received the best supplier award from Wal-mart.
- ❑ ABC is a member of the local EAN meaning that it publishes its offered product items in a product database *LocalRegistry*

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Some Global Supply-Chain Problem areas

- 1. Measurement systems
- 2. Regulations: Safety & Substituability
- 3. Cultural systems
- 4. Logistical systems
- 5. Trading terms

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Scenario 1: Core Attribute Context Discrepancy: **Measurement**

- Context discrepancy subject to different measurement systems used in China and the US.
 - *GlobalRegistry's* attributes “height”, “width” and “length” are assumed to take “**inch**” while *LocalRegistry's* counterpart attribute are assumed to take “**cm**”.
 - *GlobalRegistry's* 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**”.

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Scenario 2: Category-specific Attribute Context Discrepancy: **Regulations**

- Context discrepancy subject to different safety regulations - substitutability used in China and US.
 - *GlobalRegistry's* attribute “ReplaceItem” indicates the GTIN of an item that a product is replacing.
 - 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.

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Scenario 3: Manufacturing-specific Attribute Context Discrepancy: **Cultural systems**

- Context discrepancy subject to different cultural systems used in China and US.
 - *GlobalRegistry's* attribute “PackageType” is used in the apparel industry indicating whether the item is of the size: ‘S’, ‘M’, ‘L’, and ‘XL’.
 - 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.

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Scenario 4: Logistics-specific Attribute Context Discrepancy: **Logistic systems**

- Context discrepancy subject to different logistic systems used in China and 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.
 - 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 cause troubles for a LSP in the US adopting the latter pallet standard (e.g., Wal-mart cross-docking distribution strategy).

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Scenario 5: Transaction-specific Attribute Context Discrepancy: **Trading Terms**

- Context discrepancy subject to different trading terms used in China and US.
 - “SuggestedRetailPrice” and “ArrivalDate” 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 DDU and DDP trading terms.

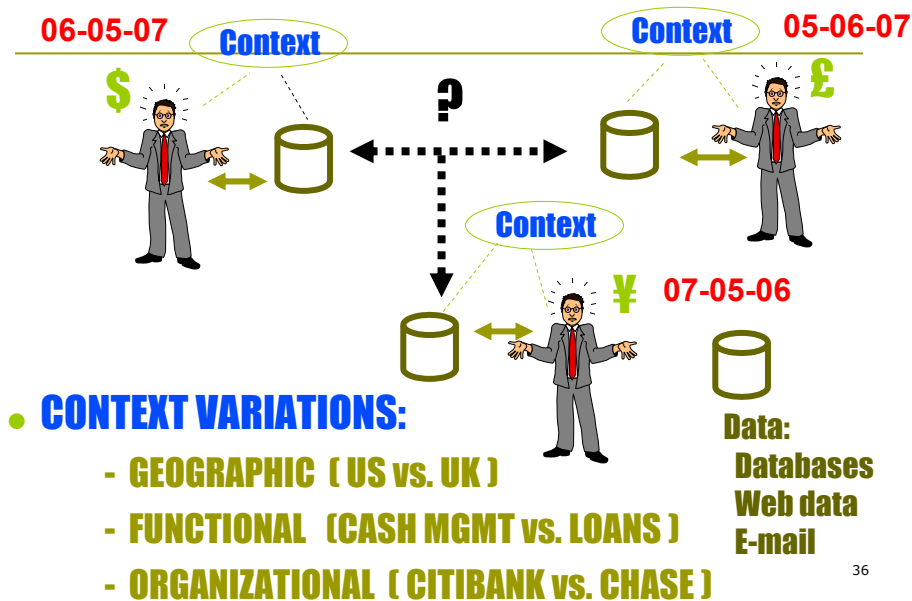
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Context Mediation Technology

- Local context is defined in *Context axioms*
- *Domain model* describes the ontology of “things” and relationship of “things” in the ontology
- *Conversion library* contains rules of transformations
- *Context mediator* performs context conversion based on the above three mechanisms
- *Wrapper* is an interface for data sources of heterogeneous structures

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Role Of Context



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Types of Context

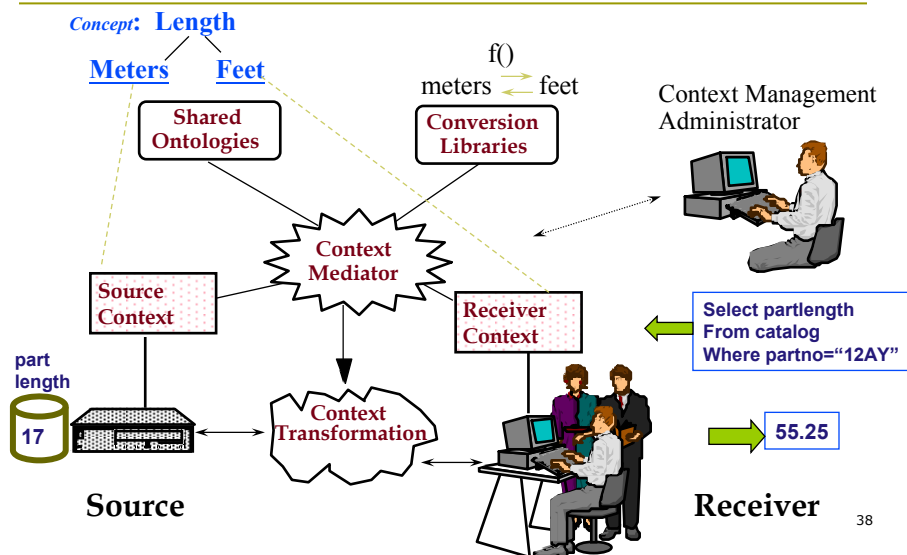
Representational Ontological

Temporal

	Example	Temporal
Representational	Currency: \$ vs € Scale factor: 1 vs 1000	Francs before 2000, € thereafter
Ontological	Revenue: Includes vs excludes interest	Revenue: Excludes interest before 1994 but incl. thereafter

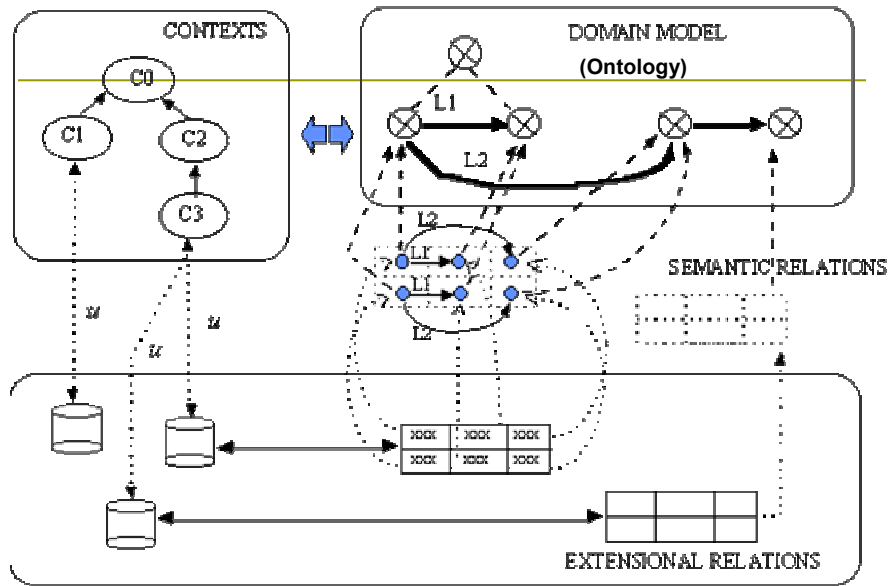
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Architecture of The Context Interchange Framework



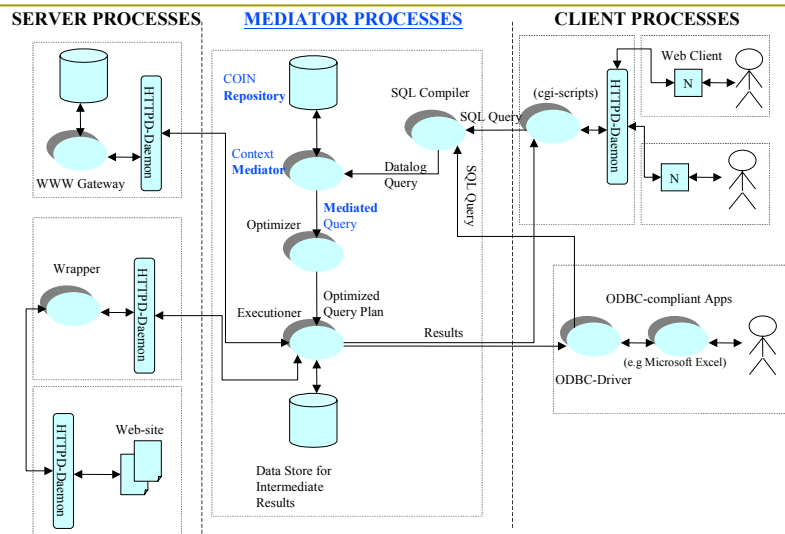
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COIN Conceptual Model



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COIN System Architecture



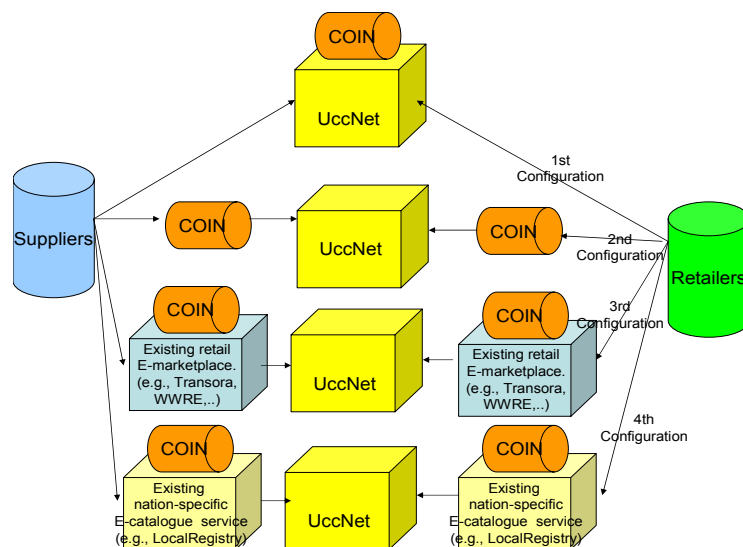
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Features of The Context Interchange Framework

- ❑ Concept-wise, COIN assumes a source-mediator-receiver model
- ❑ Architecture-wise, COIN is a “middleware” information service
- ❑ Representation-wise, COIN’s library of conversion functions and elevation axioms has sufficient expressive power to model the relationship between the “context” and the “described data”

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Approaches to Incorporating Context in UccNet Framework



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The 1999 Overture

Unit-of-measure mixup tied to loss of \$125 Million Mars Orbiter

“NASA’s Mars Climate Orbiter was lost because engineers did not make a simple conversion from English units to metric, an embarrassing lapse that sent the \$125 million craft off course. . . .

. . . The navigators (JPL) assumed metric units of force per second, or newtons. In fact, the numbers were in pounds of force per second as supplied by Lockheed Martin (the contractor).”

Source: Kathy Sawyer, *Boston Globe*, October 1, 1999, page 1.

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The 1805 Overture

In 1805, the Austrian and Russian Emperors agreed to join forces against Napoleon. The Russians promised that their forces would be in the field in Bavaria by **Oct. 20**.

The Austrian staff planned its campaign based on that date in the **Gregorian calendar**. Russia, however, still used the ancient **Julian calendar**, which lagged 10 days behind.

The calendar difference allowed Napoleon to surround Austrian General Mack's army at Ulm and force its surrender on Oct. 21, well before the Russian forces could reach him, ultimately setting the stage for Austerlitz.

Source: David Chandler, *The Campaigns of Napoleon*, New York: MacMillan 1966, pg. 390.

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Conclusions

- UccNet and EPCglobal are important and prevalent RFID and B2B standards
- UccNet and EPCglobal are evolving
- But in order for RFID to be fully effective, a carefully designed information infrastructure is important

- Our proposition is that without context discrepancy issues being solved, the value of RFID can be limited.