ICOM: an integrated view on communicating business data

A white paper on GS1 and EPC integration

Issue 3, Approved, 05-Jan-2011

Document Summary

Document Item	Current Value
Document Title	ICOM (Integrated Communications): an integrated view on communicating business data – a white paper on GS1 and EPC integration
Date Last Modified	05-Jan-2011
Document Issue	Issue 3
Document Status	Approved
Document Description	Description of how types of business data and modes of communication are integrated in the GS1 system

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Log of Changes in Issue 3

Issue No.	Date of Change	Changed By	Summary of Change
3.0	15-Dec-2010		Document approved by Architecture group

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1. Introduction

1.1. Background

In its current state the GS1 System might appear to consist of overlapping standards and services. This is mainly due to the fact that standards have evolved over time as new technologies have emerged and user needs have changed. Notably the standards formerly developed under separate processes – the EPCglobal Standards Development Process for GS1 EPCglobal standards and the Global Standards Management Process (GSMP) for all other GS1 standards – are being integrated. As a starting point, the GS1 Architecture Group completed a comprehensive inventory of the GS1 Portfolio as the basis to assess gaps and to begin to understand the path to come to a fully integrated system of standards and supporting services. This resulting paper serves to identify overlaps and set the base for dialogue on possible ways forward. It intends to help to guide GS1 to where it should look to further streamline its standards offerings.

1.2. Summary

In this paper an integrated view of the GS1 Portfolio is presented with the inclusion of the GS1 EPCglobal standards as it relates to business data and how that data is communicated. With EPCglobal new technologies are added to the GS1 suite of standards, namely Radio Frequency Identification (*RFID*) and a distributed data repository concept (*EPCIS*), making use of the Electronic Product Code (*EPC*), which is a universal identifier that provides a unique identity for every physical object anywhere in the world. The GS1 identification keys for item instances can be used as EPC's.

Also, the concept of *visibility* is added. It is about knowing where things are in time and why in the supply chain; not just within your own four walls, but across all parties within your supply (demand) chain. GS1 eCom standards already provide levels of visibility throughout the supply chain: eCom messages such as the despatch advice can be used to convey such information. However, with the addition of GS1 EPCglobal standards (notably EPCIS), enhanced visibility is achieved by revealing the whereabouts and states of trade item instances and other physical objects. This granular level of 'Visibility' supports current and future supply chain best practices, such as enhanced Traceability, Product Recall and Pedigree. From an application point of view this probably is the most important addition to the GS1 standards.

1.3. Objectives

The core objective of this document is to achieve, for the GS1 Member Organizations and their member companies, a common understanding of the GS1 set of standards (including GS1 EPCglobal standards) regarding the:

■ types of business data

■ types of exchange of data through electronic communication and how these relate to the data types

■ commonalities and complementary nature of the respective standards

1.4. Scope

The initial focus of this paper is on trade items and instances of items; for example in shipments. Specifics about parties and relationships are not within the current scope except as they relate to trade items, but could be considered at a later time to expand the discussion. The functional aspects of GS1 standards and the types of data communicated in conformance with the standards is a major component of this document.

The discussion of technology within this paper is considered 'out of scope'. The conclusions contain some comments on the technologies used for the exchange of GS1 standard data.

2. GS1 Standards for Identification

2.1. Introduction

In supply chains, business agreements are made between people who buy and sell, thus determining the commercial conditions of their trade. The GS1 standards are intended to facilitate the execution of such agreements, often in repetitive transactions: many orders a day are followed by many deliveries, invoices and payments using electronic messaging. These transactions are executed using information systems, linked through communication systems. The trade items are identified by unique codes and details about them. At first the *meaning* of the codes needs to be communicated; this is the process of *master data alignment*. Here *identical items*, which are part of *a particular product* or *object class*, have the *same code*; in other words, there is no distinction between item *instances.*

Master data alignment is based upon the use of standardized electronic messages. In addition to this, **GDSN** (Global Data Synchronisation Network) offers a standardized "choreography" on how the exchange of such standardized master data can take place using certified data pools.

With a common understanding of the meaning of the codes, they can then be used in ordering, delivering, invoicing and paying (the "order-to-cash" process). This enables monitoring of where trade items are, for example when unloading a truck or at the point of sale in a shop. This can be done with or without distinguishing between item instances (the latter e.g. when scanning a bar code at a retail point of sale; the former when scanning a serial shipping container code of a pallet on a truck).

2.2. Identification Keys

Identification is at the core of GS1 standards. *GS1 Identification Keys* when used to identify objects, can distinguish between object classes and object instances:

- The Global Trade Item Number (GTIN) is used to identify object *classes*, that is to distinguish between objects (trade items) with different characteristics

- To identify object *instances* several options are available, depending on the type of object::
  - Concatenate a serial number to the item number; this is named a SGTIN (Serialized GTIN);
  - Serial Shipping Container Code (SSCC).for shipments / logistic units;
  - Global Shipment Identification Number (GSIN) for logical groupings of logistic units;
  - Global Individual Asset Identifier (GIAI) for assets;
  - Global Returnable Asset Identifier (GRAI) for returnable transport carriers.

Additionally *batches* and *lots* can be distinguished. These are item sets (or groupings) consisting of several interchangeable instances of the same item. Item instances, which have the same GTIN and batch / lot number, cannot be distinguished from each other; this numbering is used when it is not required to differentiate between each instance individually. Batch / lot numbers can be utilized to help process a product recall. Though the level of detail is limited because no distinction is made between all item instances, in practice this can often be sufficient. Items in a set may share common production characteristics (e.g. production run) or usability characteristics (e.g. best before date). Batch / lot numbers are not regarded as separate GS1 identification keys, but are used as attributes with GTINs.

2.3. Independence from Data Carrier

There should be no ambiguity around identification of an item when it is identified for product labeling or for communication in electronic commerce transactions:

■ Use the same number in communication (electronic or otherwise) and physically on the actual item

■ On the item, use the same number in different ways of representation (bar code, RFID tag or otherwise)

By using the same identification keys, information systems do not have to translate numbers from one numbering scheme to another.

Note: In bar codes different types of keys and additional data can be represented. "Application Identifiers" (AI's) are used to indicate which type of identification key and which type of additional key or attribute is used. These AI's are not to be confused with identification keys; they merely indicate how the data are to be interpreted. Examples are batch/lot numbers (to identify certain 'groupings' (see above)).

3. Visibility: Extending Supply Chain Management

3.1. Introduction

Visibility of physical events involving items essentially requires serialized identifiers, meaning they uniquely identify the *item instances*. This has clear roots and ramifications in the GS1 System itself. It should be noted that instance identifiers for individual objects (EPCs) can be physically carried on an item instance by a bar code, for example using GS1 DataBar, or by an RFID tag, for example a GS1 Gen 2 RFID Tag, or both. Visibility offers significant opportunities for extending and improving the control of supply chains in terms of traceability. This supports discovery of detail both upward (e.g. pedigree) and downward (e.g. product recall) in the supply chain and hence is significant in providing an appropriate response to the growing demand from business, consumers and governments.

3.2. Visibility with eCom

Business processes enable the trading of trade items between seller and buyer. GS1 standards provide electronic means of initiating and completing these commerce transactions and the business processes they support. GS1 **eCom** standards provide messages that initiate or acknowledge a business transaction. In cases where a business transaction coincides with a physical event, the eCom message may provide a certain degree of physical visibility.

For example, a seller or shipper sends a notice (despatch advice) to indicate that a product is being shipped to the buyer. When the buyer receives the goods he acknowledges the receipt of the shipment. To provide more detailed data about how the process proceeds at intermediate steps, additional messages are needed, and these are provided by EPCglobal standards as described in the next section.

3.3. Visibility with EPCglobal

EPCglobal standards extend this picture in the following ways:

■ The paramount use of **serialized** identification allows for visibility at a much greater level of detail: in principle the movements of *all* item instances can be monitored. It depends on the type of business whether this is required or not..

Visibility data are observations of what, when, where, and why of any item instance. It consists of:

- the identification key of the item instance (the "what")
- the time (the "when")
- the location of the event (the "where")
- details about the business process context in which the observation took place (the "why")

Capture of this data relies on strategically placed 'readers' where the 'read points' are foreseen to be spread over many locations in a supply chain, providing more detailed visibility of the whereabouts of trade items.

These data are not necessarily connected to any business transaction. The data can be retrieved and processed when required, thus providing complementary visibility to the data available from eCom business transaction data.

Note: For a more detailed description of visibility events, please see the annex.

- The GS1 **EPC Network** standards provide for **discovery** and sharing of visibility data across complex supply chains, to provide physical visibility information, as mentioned above. These standards rely on the EPC form of serialized GS1 identification keys to make visibility data discoverable and retrievable on the network.

  These standards include **EPCIS** (Electronic Product Code Information Services), which is the GS1 EPCglobal standard that defines the structure and meaning of physical visibility data and interfaces for sharing EPC related information between trading partners, as well as the EPC Core Business Vocabulary (CBV) standard, the Object Name Service (ONS) standard, and the EPC Discovery Services standard (still in development).

- **RFID** as a data carrier makes it economically and ergonomically feasible to collect physical visibility data in situations where bar code data capture is impractical, especially including situations where there is no line of sight to the individual objects (e.g. items packed within a sealed case or aircraft safety equipment located behind a panel).

Note: The above first three benefits can also be obtained from bar coded data, provided that serialized bar codes are used.

3.4. Comparison of EPCglobal and eCom

There are two main differences between EPCglobal standards and eCom standards.

First, the purpose of EPCIS data is to record what actually happened in the physical world, whereas the purpose of eCom data is to record the completion of business transactions. In some instances these coincide, but it is also possible to have a business transaction with no physical activity and conversely it is possible to have a physical visibility event in the absence of any business transaction.

This can be illustrated by the following examples:

- When one party invoices another, this is a business transaction but there is no direct accompanying movement or handling of physical goods. eCom business transaction standards are appropriate here (specifically, the Invoice message), but there is no use of physical visibility standards (EPCIS).
- When a product moves from the store room of a retail store to the sales area, there is no business transaction but it is an important opportunity for capturing physical visibility data. The physical visibility event captured at this point in time (e.g, via an RFID reader stationed at the doorway) provides the crucial information that the product is now available for sale where a consumer can purchase it. In this example, the EPCIS standard for physical visibility data is in scope, but eCom business transaction standards play no role.

■ When goods are shipped or received, there is both a business transaction (the legal and/or payment obligations associated with shipping or receiving) and physical visibility (the observation that the goods have in fact moved through the loading dock door). In such an example, both eCom business transaction data and EPCIS physical visilbity data may be used together, each cross-referencing the other.

This illustrates the complementary role of business transaction data and physical visibility data even when they occur simultaneously. For example, a despatch advice "tells" the receiver which trade items are expected to be delivered. Today this is trade item information at the class item level. Also, a receiving advice "tells" the shipper that the trade items have arrived.

Although it is inferred, there is no guarantee that the creation of these advices was synchronised with the product being loaded onto or unloaded from a truck. Alternatively, the use of the EPCIS standard that supports the data captured from the read of an EPC in a carrier on each product by a 'reader' attached to the back of the truck as the product was loaded or unloaded, is a more direct verification of the product's location. Depending on the way the applicable business process is organized by the shipper, the receipt of a despatch advice by the buyer is either an acknowledgement of an *intention* that the product will ship or is intended to be shipped in the near term, or a confirmation that it has actually been shipped. On the other hand, an EPCIS event about goods being shipped can physically confirm that the product is actually en route via the scanning of each physical object as it is being loaded onto the truck. So even in this example where both types of data occur together, there is (depending on the way the sending of the despatch advice is triggered) in principle no overlap or duplication, but rather complementary assertions which taken together are stronger than either is by itself.

While the use of business transaction (eCom) data is well established in the supply chain, physical visibility data is relatively new. Much of the promise of physical visibility data stems from the power of observations of an item as it is routed past interior data capture points where there is no business transaction at all. These can carry great meaning for supply chain partners, as in the example above where it becomes possible for the first time to know exactly when a retail product is accessible to a consumer. Trading partners that embrace and find innovative uses for physical visibility data will see the cost of readers, tags, and the associated 'event' data as providing a ROI that exceeds what can be ascertained by the mere 'acknowledgement' of a commerce transaction provided by business transaction data. These early adopters of new standards will drive down the cost over time and drive up the value of adoption based on their value statements

The **second** difference between EPCIS and eCom is that **eCom** business transaction data is most often sent unilaterally from one party to another (a "**push process**"), whereas **EPCIS** data about physical visibility may either be pushed or stored in data repositories to be retrieved when required (a "**pull process**"). The "pull" mode allows many more events to be easily registered without generating big volumes of messages. Thus it is possible to offer observational confirmation that the goods were physically shipped or received, while also additional details can be provided about intermediate observations that take place during business transactions, such as goods moving through loading docks, truck yards, highways, intra-warehouse movements, etc.

In summary, the combination of EPCglobal standards with other elements of GS1 standards portfolio provides a new level of visibility for supply chain data. EPC standards focus on providing detailed physical visibility information, by having both the records of completed business transactions and the physical observations at the transaction points and in between, which can be accessed when required. Observations of what, when, where, and why trade items or other assets of interest are physically handled complement the business transaction information available from eCom data.

3.5. Using Radio Frequency Compared to Bar Codes

In principle, physical visibility data can be captured using any data carrier, such as bar codes, RFID tags and even manual data entry. In practice, RFID is an especially attractive technology for capturing physical visibility data because of its ability to capture data from many assets at once, without optical line-of-sight, and in many cases without human intervention.

This allows physical visibility data to be obtained passively, without re-engineering of physical handling processes used throughout the supply chain. It should always be remembered, however, that the capture and use of physical visibility data does not *require* the use of RFID. Hence the benefits to business processes of enhanced visibility data are the same whether or not RFID was used as the data carrier; however the feasibility and the costs of acquiring such data can be quite different, depending on the particular business case.
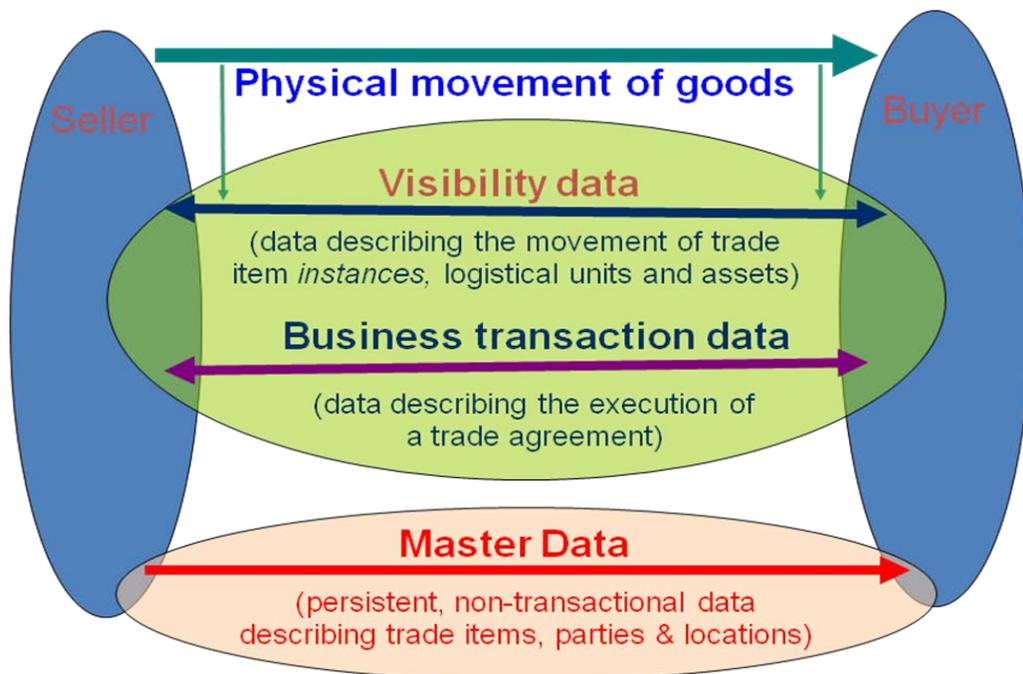
Examples:

■ All books within a bookstore or library are tagged with EPC enabled RFID tags, providing real-time knowledge of location and inventory of titles (books in a store tend to "get lost" because of customers placing books back on the wrong shelf). This is not practical using bar codes.

■ All suits ordered through a clothing store have been tagged using serialized bar codes or RFID tags to follow the product life cycle from order, creation, and delivery to customer (including returns). RFID greatly facilitates frequent stock-taking to know exactly which garment is where; serialization makes it possible to check if returned goods have been sold in the same store and at what price. RFID tags are not required to this end, however.

4. Categories of GS1 Data

In this chapter the different types of data which can be distinguished in the GS1 System, are discussed in some more detail than in the previous sections.

Looking across the GS1 standards, the data that is conveyed can be categorized into three types, as they relate to the layers of communication described above:

■ **Master data** that describes the trade items, parties and locations, all of which are identified by GS1 identification keys.

■ **Transaction data** that consist of trade transactions, confirming the execution of a previously made business agreement, from order to final settlement, also making use of keys.

■ **Visibility data** provide details about physical activity in the supply chain of products and other assets, identified by keys, detailing where these objects are in time, and why; not just within one company's four walls, but throughout the supply chain.

4.1. Master Data

'Master data' defines the attributes of trade items that are used to establish a catalogue. It can establish the details about buyers and sellers as the 'parties' transacting business within the supply chain. It also sets up the details of locations within the supply chain that are necessary for invoicing, billing and logistics.

GS1 provides message standards for master data both in EANCOM (PRICAT (Price Catalogue) and in GS1 XML (CIN (Catalogue Item Notification)).

Note: GDSN, which means Global Data Synchronisation Network, is about both the "choreography" of exchanging master data, using data pools and the GS1 Global Registry, and the data content (the "master data" itself). From a content point of view master data can be communicated both according to GDSN and in a bilateral way (non-GDSN); however, GS1 advocates the use of GDSN, since using data pools contributes greatly to achieve optimal quality of master data. See also chapter 5.

4.2. Transaction Data

Standards for electronic supply chain transactions ("order to cash") are provided by GS1 in EANCOM and GS1 XML schema formats. Use of electronic commerce in the supply chain ultimately simplifies the processes involved and reduces costs. They support business processes such as order to cash and logistics.

Transactions always take place within the framework of a business agreement (contract) between two parties. They confirm the commitment to execute the agreement: sending an electronic order messages implies that the sender wants to receive the ordered goods according to the conditions agreed in the contract and will pay for them.

4.3. Visibility Data

Visibility is about knowing where trade item instances are at a point in time and in what business context they were observed, to achieve better control of supply chains. For a further description, please see sections 3.1 to 3.4.
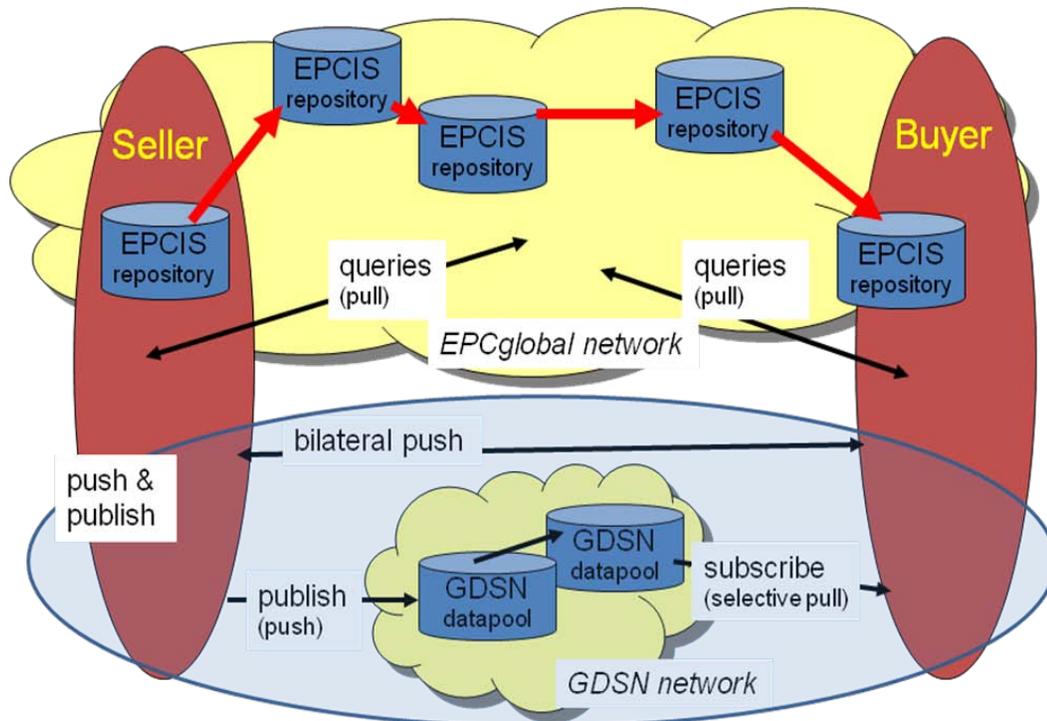
5. Modes of Communication

In this chapter the different ways of communicating data which can be distinguished in the GS1 system, are discussed in more detail than in the previous sections.

5.1. Push & Push /Pull and Pull (query)

The communication methods may be broadly classified in two groups:

- "*Push*" methods, where one party unilaterally transfers data to another in the absence of a prior request. Push methods may be further classified as:
  - ☐ Bilateral party-to-party push, where one party transfers data directly to another party
  - ☐ Publish/subscribe, where one party transfers data to a data pool, which in turn pushes the data to other parties who have previously expressed interest in that data by registering a subscription ("selective push")
- "*Pull*" or "query" methods, where one party makes a request for specific data to another party, who in turn responds with the desired data

It should be noted that both the "pull" method and the "publish/subscribe" method rely on some sort of intermediate repository for data. In the case of "pull" methods, it is this repository that is queried to satisfy each request. In the case of publish/subscribe methods, the repository serves as a holding area as published data is routed to each subscriber, and to service subscriptions which are registered after the initial publication of data.

The following sections describe which of these methods are employed by GS1 standards for each of the three types of data in the GS1 System.

5.2.   Master Data

■   The Global Data Synchronisation Network (GDSN) provides the publish/subscribe method for transferring master data. Depending on the data pool either the GS1 XML CIN or the EANCOM PRICAT message format is used. The repository in this case is provided by a GDSN certified data pool.

■   Master data may also be "pushed" bi-laterally based on the use of GS1 XML CIN or EANCOM PRICAT messages.

■   The EPCIS Master Data Query anticipates a future ability to transfer master data by a "pull"-style query. This is expected to be useful for highly granular master data, such as very detailed physical location master data that may be important for exception processing using detailed physical visibility data.

5.3.   Transaction Data

■   Bi-lateral "push" based on GS1 eCom XML or EANCOM is the most common way to exchange data

5.4. Visibility data

- EPCIS data may be transferred via a "pull"-style query using the EPCIS query interface. In this case, a trading partner's own EPCIS database acts as the repository to service queries, or the trading partner may outsource this to a service provider.

- EPCIS data may also be transferred via a bi-lateral "push" using EPCIS XML (delivered via AS2).

- The EPCIS query interface also provides for the registration of subscriptions, making a publish/subscribe style of data transfer possible as well.

5.5. Choosing a communication mode

As discussed, there are relationships between the data type and the communication layers. This is due to both the evolution of user needs and the standards created over time and to the related changes in technology that are available to enable the standards. The chart below illustrates relationships between data types and communication methods:

Data Type	Data Standard	Available Communication Methods		
		Bi-lateral "push"	Publish/subscribe	"Pull" ("query")
Master Data	GDS	X	X	[future]
Business Transaction	eCom	X		
Physical Visibility	eCom	X		
	EPCIS	X	X	X

Data types are often used in combination to meet a particular business need. For example; traceability can be supported through captured physical event data (EPCIS) used together with business transaction data from bilateral messages (eCom). Likewise, different communication methods are used according to the requirements of the business. For example, master data is most commonly distributed through publish/subscribe because of the one-to-many relationship between the source of master data and its recipients. However, these can also be pushed bilaterally. Business transaction data is nearly always "pushed" bi-laterally because it reflects the execution of a bilateral agreement between two parties. Physical visibility data is transferred via a "pull"-style query when it is used as-needed for exception processing (thereby minimizing the overall volume of communication); it may be also be pushed bi-laterally or by subscription when parties agree to share visibility data "all the time."

Just as the different communication mechanisms supported by GS1 standards provide for the most efficient communication of business data to meet a given business requirement, so too do the different data types help to provide the right data depending on the business process. master data, business transaction data, and physical visibility data complement each other and each serves a particular need.

6. Conclusions

GS1 has three identified types of business data that are exchanged between trading partners using three mechanisms for information flow. Although EPCglobal standards were initially developed apart from other GS1 standards, they are in fact highly complementary and amenable to integrated use. The available types of data are complementary and, by offering them in conjunction, a full suite of standards is available, which can be tailored to specific business needs. Providing this 'option' to the GS1 members ensures that every size of supply chain company can be serviced by GS1, protecting their legacy investments and offering guidance on adoption of the remaining standards based on newer technologies developed out of user needs as always.

The legacy investment in the bilateral model of data communication is likely to remain in place while it continues to support the business needs of the supply chain partners. As organizations see the value of GDSN and EPC as well as new business processes that are supported in XML [in addition to bilateral EDI] they are likely to implement these when they can substantiate the investment into the supporting technologies to solve their needs. For GS1 partners, these options remain important and provide the flexibility they desire based on cost and internal strategies that influence their decisions on implementation of standards.

Annex:
More about Visibility Events

Visibility data is a new data type that complements business transaction data. Visibility Data consists of "events," where each event is a record of something that happened in the physical world. The EPCIS standard defines a data model for visibility data in which each event has four dimensions of information:

- the unique identifier of the item instance (the "what")

- the time (the "when")

- the location of the event (the "where")

- details about the business process context in which the observation took place (the "why")

The "why" dimension of a visibility event is what distinguishes it from a raw sensor input such as a raw RFID read or bar code scan. The "why" dimension makes a physical visibility event meaningful to a business application, and makes it possible for a business application to understand it without being aware of the details of exactly how the event was captured by bar code or RFID data capture infrastructure (or even which of those data carriers was used). The "why" dimension may include three types of information:

- An identifier of what business step was taking place at the time of the event

- The status of the items involved; in other words, what is true of the items from a business perspective subsequent to the event.

- Links to business transaction information

Each of these is described below.

It is usually important to include an indication of business step in the "why" dimension of a physical visibility event. These business steps enhance the observation by providing a business context to the event, making it possible for a business application to understand how the event fits into an overall business process. The EPC Core Business Vocabulary standard defines many standard values that may be used for this purpose, including "shipping," "receiving," "holding," "inspecting," and others.

Over time, the status of an item may change. For example, the item was moved from the stock room of a retail store to the sales area, so the item went from "inaccessible to consumer" to "accessible to consumer" status. This status change may be indicated as part of the "why" dimension of a physical visibility event. If a particular physical observation does not imply a status change, no such status value need be included. As with business steps, the EPC Core Business Vocabulary defines many standard values that may be used for this purpose. There is an extension mechanism that allows users to define their own business steps and status values, if applicable.

Finally, the "why" dimension of a physical visibility event may include a link to an eCom transaction, such as an Invoice, Despatch Advice, etc. This helps business applications to correlate and process the physical visibility data with the business transaction data. For example, if goods are received into a warehouse, there may be a physical visibility event that records the physical movement of goods in through the door, and that event may include links to the Purchase Order, Despatch Advice and Receipt Advice that are related to that receiving operation.

Physical visibility information is designed to be self-describing by means of the data in the "why" dimension, and can therefore be used by many different business applications. Such applications include:

- Compliance with specific regulatory requirements such as Electronic Pedigree, which shows an authenticated chain of custody

- Recall of products from the supply chain

- Execution of a physical inventory of products within an area such as a warehouse, a distribution center or a storage area within a retail outlet

These are of course only a few out of many, many such examples. The same physical visibility data might be used by a particular business as input to more than one of these applications simultaneously.

It should be noted that between observations there is implied visibility only: *one may assume the status of a certain good, but in reality, it may have gone 'out of sight.'* Hence, the more physical visibility data capture points, the more events, and the better the overall visibility detail captured and available for business use cases. The required level of supply chain control determines how many data capture points and which locations are desirable. Additional considerations such as cost and business needs determine the extent to which each user will find value in multiple data capture points.

Every day the supply chain looks to data to answer the questions they have around product, a significant number of these are about specific instances of a product. The answers to these questions depend on tracking individual **serialized** items or assets as defined in the EPCglobal standards and Architectural Framework versus trade item class level products.