



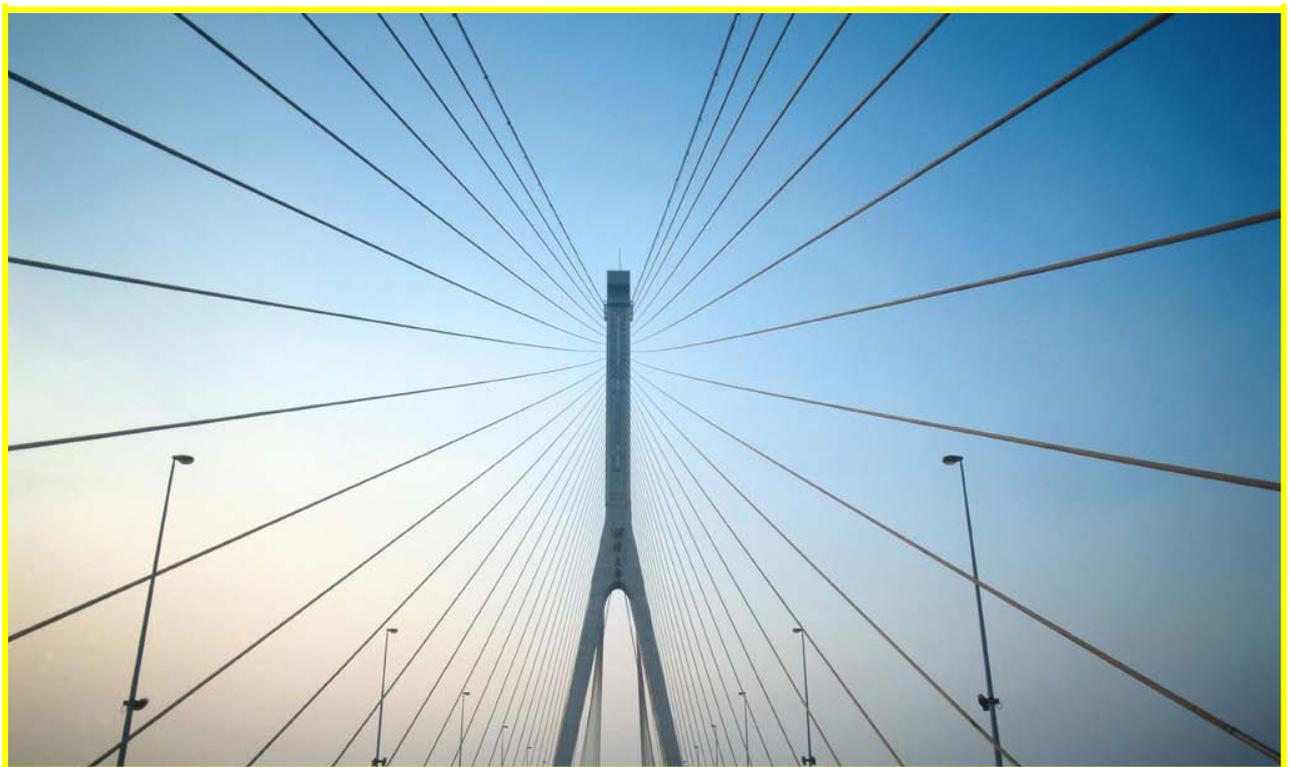
**Building Radio frequency IDentification for the Global Environment**

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## **Technical Guideline**

# **Implementation of solutions based on GS1 and EPCglobal standards for Asset Management**

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## About the BRIDGE Project:

BRIDGE (**B**uilding **R**adio frequency **I**dentification for the **G**lobal **E**nvironment) is a 13 million Euro RFID project running over 3 years and partly funded (€7,5 million) by the European Union. The objective of the BRIDGE project is to research, develop and implement tools to enable the deployment of EPCglobal applications in Europe. Thirty interdisciplinary partners from 12 countries (Europe and Asia) are working together on : Hardware development, Serial Look-up Service, Serial-Level Supply Chain Control, Security; Anti-counterfeiting, Drug Pedigree, Supply Chain Management, Manufacturing Process, Reusable Asset Management, Products in Service, Item Level Tagging for non-food items as well as Dissemination tools, Education material and Policy recommendations.

For more information on the BRIDGE project: [www.bridge-project.eu](http://www.bridge-project.eu)

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## This document:

*This document is a technical guideline that will provide solution providers information in order to develop GS1 and EPCglobal based solutions for companies who want to improve Asset Management. It will firstly remind the Asset Management context in the supply chain and secondly presents the solutions needed by companies in term of standards, functionalities, performances and configuration.*

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## 1 Purpose of the document

This document is a technical guideline that will provide solution providers information in order to develop GS1 and EPCglobal based solutions for companies who want to improve Asset Management. It will firstly remind the Asset Management context in the supply chain and secondly presents the solutions needed by companies in term of standards, functionalities, performances and configuration.

## 2 Context

In recent years, the need to improve Asset Management in the supply chain has greatly increased and will continue to grow in the future. There are many explanations for this need to improve Asset Management, such as costs savings, research of process efficiency, flow visibility improvement, respect of legal requirements, diminution of environmental impacts, etc.

Currently there is no common commitment among supply chain participants to guarantee a better asset control. Only some parties undertake actions and the level of non-commitment from other parties makes difficult or even impossible, to improve asset follow-up, even more since the supply chain is an open loop system. There are certain problems that commonly arrive from this situation such as, the number of asset lost (about 10% per year), oversized asset pools, non-transparency on rental costs, non-identification of the problems starters (asset damages, unauthorized reuse or loss), number of disputes and tensions between business partners, inefficiency in logistic processes and substantial number of counterfeited assets (often true with pallets).

Solutions based on GS1 and EPCglobal standards give companies a strong opportunity to tackle the difficulties listed above by improving the visibility on asset flow. Over the course of three years, the BRIDGE WP9 addressed this issue by: studying the market, analysing company needs, testing the technology and standards in a live context during a pilot phase, and proposing a recommendation for implementation. This document is the WP9's final work which was written to disseminate the collective findings of all the analyses done since the beginning of the project in June 2006. This document is associated with three other dissemination documents produced by the WP9 group:

- 9.6.2 Application Guideline. A document to help end-users to implement of solutions based on GS1-EPC standards for Asset Management
- 9.6.3 Costs/Benefits Analysis. A document to help end-users to address the profitability assessment of the implementation of solutions based on GS1-EPC standards for Asset Management
- 9.6.4 Training Tool Kit. A document to help companies to understand how solutions based on GS1-EPC standards can improve Asset Management

## 3 Who will use this document

This technical guideline is addressed essentially to solution providers but could be interesting also for every company in the supply chain who wants to improve its Asset Management by implementing solutions based on GS1 and EPCglobal standards.

## 4 Market needs

Whatever the model use (pooling or exchange), Asset Management current practices do not allow for much asset identification during the logistic processes, and thus give way to lots of errors and approximation. Companies do not have accurate visibility on their own internal asset flow and cannot therefore exchange relevant information with their trading partners in order to improve Asset Management.

In order to improve asset flow visibility and therefore Asset Management, companies have three main needs:

- First, there is a need of identification solutions. Assets can be “traced & tracked” in the supply chain if and only if they are identified with a code. This code is needed for identification so as not to confuse one asset from another during the logistic processes
- Secondly, there is a strong need of automated data capture solutions. Trading partners need to automate their processes in order to improve their productivity (i.e. reduce time per process) and their reliability (better process quality)
- Thirdly, there is a need of collection and filtering solutions. Companies need software to manage their reader pool, and consolidate the data before using them
- Finally, there is a need of data exchange solutions. Because the supply chain is an “open loop” world, Asset Management efficiency depends of multiple different companies. Therefore, there is also a need to exchange relevant information concerning assets between trading partners

## **5 What are the companies’s objectives**

On one hand, Asset Management specialists, such as Pool Operators and Pool Providers, want to:

- Adjust their pool size according to the actual demand and at the same time improve reactivity to customer demand
- Improve their processes such as asset delivery, collection and reconditioning
- Identify the problems starters and therefore improve their capacity to fight against asset damages, counterfeiting or unauthorized reuses
- Improve pricing competitiveness (rental, repair, transportation, etc)
- Invoice customers with better transparency and fairness
- Propose new services to their customers. For example, provide them with a means to track and trace goods by tracking and tracing the asset on which they are loaded

On the other hand, trading partners, such as manufacturers, retailers, carriers and logistics providers, want to:

- Improve asset accountability
- Reduce asset over stock
- Optimize exchanges with partners (delivery and collection of empties)
- Reduce number of disputes
- Reduce costs (rental, reconditioning, dispute...)
- Address the Supply Chain Management in doing Asset Management (track and trace the goods by tracking and tracing the assets)

A detailed analysis outlining the needs and benefits individualized for each company are available in the BRIDGE deliverable 9.5 entitled “Pilot Analysis and Recommendations Report”.

## 6 Standardized solutions

Reusable Assets circulate for several years between many companies in the supply chain which is an open loop system. Therefore, first of all, solutions have to be based on global standards in order to guarantee interoperability and durability.

GS1-EPCglobal is the leading global organisation dedicated to the design and implementation of global standards and solutions to improve the efficiency and visibility of supply and demand chains globally and across sectors ([www.gs1.org](http://www.gs1.org)). The GS1-EPC system of standards is the most widely used supply chain standards system in the world with more than 1 million of companies. Indeed, solution providers must develop solutions based on GS1-EPC standards:

- For identification of assets and goods
- For automated data capture
- For data collection and filtering (middleware)
- For data exchange

## 7 Codification and tagging solutions

The first solutions to provide concern the codification (i.e. the identification) of the assets and the goods loaded on and also the data carrier capable to encode this codification.

### 7.1 Codification management

#### 7.1.1 GRAI for Asset

In the GS1-EPC world, one standard already exists to identify a returnable asset, such as pallets, crates or rolls. This standard is the GRAI, the Global Returnable Asset Identifier. Its structure is composed of 3 parts:

- The Company Prefix. This code is attributed by GS1 to the company who will identify the asset (i.e. create the GRAI), such as pool providers, pool operators or other companies who will use assets in closed loop system
- The Asset Type. This code is created by the company who encode the GRAI. It gives the opportunity to sort assets by type, such as dimension, brand, composition (i.e. plastic, wood, metallic, etc)
- The Serial Number. This code is also created by the company who encode the GRAI. It gives the opportunity to track and trace one asset among all the other

Companies that will codify their assets need codification solutions that guarantee the GRAI uniqueness. This corresponds to guarantee:

- The non redundancy of the GRAI Serial Number. Indeed, most of the time, the companies who will create the GRAI will be pool providers and pool operators. Therefore, there will have many different locations of a same company where GRAI will be attributed. The encoding solution has therefore to manage GRAI creation among different location without redundancy. On one hand, this could be achieved by attributing slot of Serial Number per location of the company. For example, from 0 to 100 000 for Location N°1, from 100 001 to 200 000 for Location N°2, etc. On the other hand, this could be achieved by using at solutions connected in real time between the different locations in order to synchronize which codes are attributed and which are available
- The GRAI timeliness. Because a GRAI is attributed to an asset for its entire life, and because, an asset can live up to decades, the encoding solution has to guarantee that GRAI already attributed in the past cannot be reattributed before the asset end of life. This could be achieved by storing and managing in time in a data base the list of the GRAI attributed

## 7.1.2 SSCC for shipping unit

In the GS1 world, one standard already exists to identify a shipping unit (i.e. the goods loaded onto an asset). This standard is the SSCC, the Serial Shipping Container Code. Its structure is composed of two main parts:

- The Company Prefix. This code is attributed by GS1 to the company who will create the shipping unit and therefore the SCC, such as manufacturer, logistic provider, distribution center, etc
- The Serial Number. This code is attributed directly by the company who creates the shipping unit. It gives the opportunity to track and trace one shipping unit among all the other

SSCC codification solutions already exist in the companies. As for the GRAI encoding solutions, they have to guarantee the uniqueness of the SSCC created.

## 7.2 Tagging solutions

GS1-EPC standards capable of carrying a GRAI or a SSCC already exist in the form of GS1 128 barcodes or RFID EPC UHF Class1 Gen2 tag. The data carrier solutions have therefore to respect these standards in order to give companies the opportunity to use automated readers.

A GRAI in a GS1 128 barcode is structured as followed:

GS1 Company Prefix	Asset Type	Check Digit	Serial Number
0 N1 N2 N3 N4 N5 N6 N7 N8 N9 N10 N11 N12		N13	X1 variable to X16

A SSCC in a GS1 128 barcode is structured as followed:

Extension Digit	GS1 Company Prefix	Serial Reference	Check Digit
N1	N2 N3 N4 N5 N6 N7 N8 N9 N10 N11 N12 N13 N14 N15 N16 N17		N18

Structure of the GRAI and the SSCC encoded into a GS1 128 barcode are detailed in the GS1 General Specification document available on the GS1 Website (i.e. <http://www.gs1.org/barcodes/technical/genspecs>).

A GRAI in an EPC Gen2 tag is structured as followed:

Header	Filter Value	Partition Value	Company Prefix	Asset Type	Serial Number
8	3	3	20-40	24-4	38

A SSCC in an EPC Gen2 tag is structured as followed:

Header	Filter Value	Partition Value	Company Prefix	Serial Number	Unallocated
8	3	3	20-40	38-18	24

Structure of the GRAI and the SSCC encoded into a RFID tag are detailed in the Tag data Standard document available on the EPCglobal Website (i.e. <http://www.epcglobalinc.org/standards/tds/>).

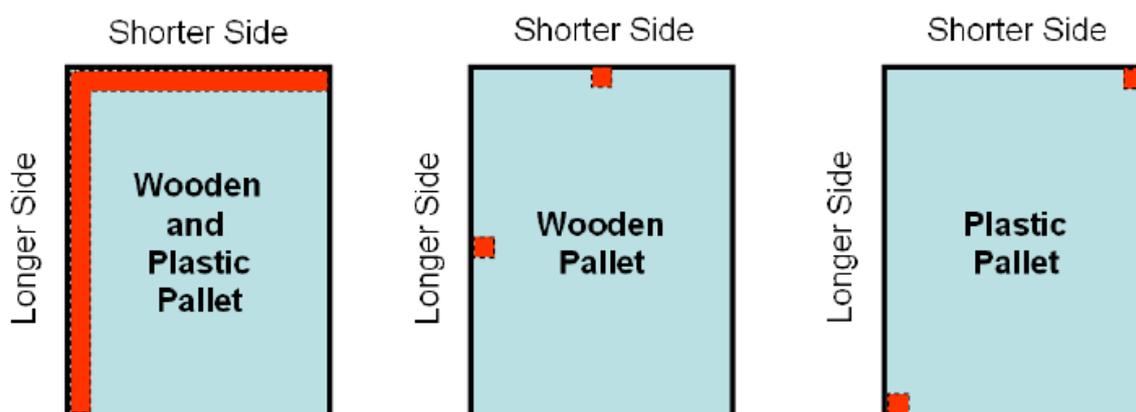
## 7.2.1 Data carrier fitment

Because the supply chain is an open loop system, and because data capture performance is the basis for Asset Management improvement, GS1 and EPCglobal is developing Asset tagging guidelines. The objective of this work is to create a set of requirement as follows:

- Recommendations of which GS1-EPC identification key have to be encoded into the data carrier of a pallet, crate, roll, etc. These recommendations define also what data are mandatory (e.g. GRAI, SSCC, both, etc), optional (e.g. batch number, expiration date, etc)
- Define the specifications (which data carriers, number of data carrier, orientation and placement onto the asset) in order to standardize asset tagging and guaranty better identification performance

Tagging solutions have therefore to respect these recommendations. For example, EPCglobal has already produced a guideline for pallet tagging. The minimum specifications for the integration of EPC/RFID tags into pallets are:

- Minimum of two pieces of RFID tags per pallet to ensure a minimum process security. GS1 128 barcode are not mandatory but optional.
  - Wooden pallets should have one RFID tag on the longer side and one tag on the shorter side of the pallet
  - Plastic pallets should have one RFID tag in the corner and another RFID tag in the opposite corner of the pallet



- 96 bits as a minimum of the EPC memory bank for each tag. The tags fixed onto a pallet have only to encode the same GRAI-96 bits (one and its duplication). SSCC or other data are not mandatory but optional and could be registered into the additional memory of the tag (if it exists)

## 7.2.2 Specificities for RFID tags fitment

Because RFID technology is not a plug and play technology, solution providers who will provide tagging solutions to companies will have to be aware of some physical difficulties in order to guarantee reading rate performances:

- **Absorption:** The kind of material placed between the reader antenna and the tag strongly determines the operating range of the tag. Only vacuum is passed by electromagnetic energy without absorption, so wood or plastic are absorbing materials
- **Reflection:** This phenomenon leads to interferences. Constructive interferences could lead to super read ranges, but at the opposite, destructive interferences could lead to “black holes” in the operational area of a RFID reader. For example reflection could be created by the presence of metallic materials in an asset (i.e. rolls) or by the forks of the forklift that lift the asset (i.e. pallets)
- **Detuning:** This phenomenon changes the frequency operation of the tag. For example, a tag studied to operate at 865 MHz could be detuned to 845 MHz because it is fixed or buried into wood or plastic.

Contrary to barcodes, RFID tags have to be selected with precision because reading rate performances deeply change from one tag model to another. Therefore, solution providers have to study which tag correspond the best to a specific asset tagging which will load specific product (i.e. vegetable, milk, metallic object, etc). EPCglobal has developed a “Static Test Method for Applied Tag Performance Testing” that describes how selecting the tag. This method available from the EPCglobal website (i.e. [www.epcglobalinc.org](http://www.epcglobalinc.org)) is composed of laboratory tests.

However, although the strict selection of the tag and its fitment is required, this will not suffice to guarantee asset’s accurate read performance at each steps of the supply chain. In an open loop system like the supply chain, several players will use different tag models, different tag locations, different asset configurations (e.g. goods loaded), different RFID readers, etc. In this context, following the recommendation could not always guarantee that each asset could be read by each actor. Therefore, asset tagging certification could be a solution indispensable. This certification could be done by accredited RFID labs that abide by a sort of “Asset Tagging Certification Test Methodology”. This methodology could be a variation of the Door Portal Simplified Field Strength Method (SFSM), developed by the TLRPP EPCglobal Working Group in order to certify the RFID portal (see the following chapter). In order to effectuate, this methodology requires two things: one, a list of worst case scenarios that could arise when asset are used in the supply chain (i.e. asset with metallic goods loaded on), and two, a minimum level of performance expected from the tags already fixed into assets that corresponds with the list of scenarios from above (i.e. read range, RSSI, etc). Therefore, during the certification tests, if the tags give a better performance than the minimum level required, the RFID assets is certified, and if it gives a subpar performance, it is not certified. In conclusion, end-users could ask for a system of tagging certification that can guarantee a minimum level of performances for all actors who want to track and trace assets with RFID tags in an open loop world.

### 7.2.3 Data carrier resistance

In order to resist the difficulties presented in a supply chain environment, data carriers solutions (i.e. barcode and RFID tags) proposed to companies require also the following capacity criteria:

- **Longevity:** Assets can survive multiple trips through the supply chain and are used for several years (up to decades)
- **Robustness:** Assets undergo frequent falling, bumping, kicking, transportation trembles, mechanized handling, and manual handling without particular notice
- **Temperature & humidity:** Assets can be used between -40°C and +140°C, and withstand a fluctuating humidity rate (up to 100%)
- **UV resistance:** Assets are frequently stocked outside during long periods (weeks) and suffer from UV radiation
- **Cleaning:** some Assets are frequently cleaned with high pressure water (up to 110 bars) and chemical detergents

## 8 Automated Data Capture solutions

Companies need two solutions: Barcode readers and RFID readers. However, due to the need of automation (i.e. bulk reading of multiple assets at the same time), RFID readers will be more adequate. Moreover, if a barcode seems to be used as a data backup with crates or rolls, it may not be used at all with pallet. Indeed, it will be difficult to fix durably a GS1 128 barcode into wooden pallets. It is therefore conclusive that Pallet Management may only be achievable with RFID and will not provide companies with leniency to choose, like we see in Crate or Rolls Management. Therefore, sometimes companies will have the choice between Barcode and RFID and sometimes not.

RFID readers need specificities in order to operate as wanted. They must:

- Respect the Air Interface called EPC Class1 Gen2

- Be synchronized with other readers in order to share the RFID frequency band in respect to the regulation rules in presence (i.e. ETSI 302 208 in Europe)
- Not generate bad identification such as missing read, ghost read, erroneous read, etc. Because of automation, bulk reading capacity and UHF electromagnetic specificities (reflexion and non-uniformity of the field), readers can sometimes identify object they do not have to, and generate wrong information for the IT system. In order to reduce the risk of bad readings, position of the RFID antenna, power delivered by the reader, implementation of silence space using absorbing material between different reading emplacement, use of sensor to start and stop the reading only when movements appear have to be studied very carefully. Moreover, readers should have software capacity to analyze the power return by the tag and the number of reading per tags read in order to eliminate what not correspond to the minimum needed (i.e. considered as a bad reading)
- Have connection with the company's information system. Whatever the type of reader used they need to be connected with the system in order to transmit the data collected (i.e. GRAI and other data possibly stored in the tag). The connection could be done by using wired or wireless infrastructures (i.e. Wi-Fi, GPRS, etc). However, there are two specificities that apply to connections with RFID readers. Firstly, because of automation, RFID readers need to be connected most of the time in real time with the IT system. Secondly, because of bulk reading capacity, the size of data collected by a RFID reader can be important and connection infrastructures have to therefore be sized enough in order to operate efficiently

### 8.1 Specific to RFID hand held reader

Hand held readers will be indispensable to achieve two processes:

- **Empties inventory:** inventory of assets unloaded such as pallets or crates stacked. For this process, hand held readers must have a sufficient read range, a low saturation rate and the capacity to read quickly multiple tags in the same time



*Inventory process*

- **Aggregation:** association between the goods and the asset during the preparation process in order to track and trace the goods by tracking and tracing the asset. Three actions are necessary to achieve this process: Action 1: Read the barcode of the goods to register the SSCC, Action 2: Read the RFID tag of the asset to register the GRAI and, Action 3: Create the link between the SSCC and the GRAI in a data base. Therefore, because most of the goods loaded onto assets will always be identified with barcode, hand held reader must have the capacity to read both barcodes and RFID tags (i.e. bi-technology)



**Remarque:** More than for the inventory and aggregation processes, companies will want to use hand held reader because they represent a less expensive solution than fixed reader. Indeed, hand held readers are cheaper moreover if current barcode readers already used in company are compatible with RFID. In this case, the implementation of just an RFID module and an RF antenna will limit the hardware costs.

## 8.2 Specific to RFID embedded readers

Readers embedded onto a vehicle such as a forklift are efficient solution for every process where assets are moved from one location to another such as, during truck load/unload or asset stacking onto racks.

Embedded readers must have the capacity to read one or multiple assets lifted by a forklift without identifying the assets not lift and situated next to the vehicle. Therefore, equilibrium must be found to ensure the maximum reading performance (i.e. read rate and read range) and a non-identification of wrong assets (assets not lift by the vehicle). This is achievable by configuring precisely the electromagnetic field of the RFID antenna fixed onto the forklift.

**Remarque:** Like hand held readers, companies will want to use embedded readers because they represent a cheaper solution than fixed reader. There are often less forklifts in a company than shipping gates and therefore the deployment of embedded reader is often less expensive than a deployment of several portal reader (one per each shipping gate).

## 8.3 Specific to RFID fixed readers

Readers fixed to specific location will be the solution the most wanted by companies in order to count the inbound/outbound asset movements. Most often the location of the readers will be shipping gates, but it could be also conveyor belts or rotational tables which film the shipping unit.

Fixed readers must:

- Be automated and therefore connected with movement sensors, traffic lights and monitoring equipment in order to help operator visual control
- Offer a high reading performance. Most of the time they will identify multiple assets loaded with goods and moved quickly through a gate (shipping or receiving processes). They could for example achieve bulk reading of multiple crates loaded onto a pallet, or multiple pallets staked together and lifted by the same forklift. In order to guarantee the better performance as possible, EPCglobal has developed a “Simplify Field Strength Method” in order to ensure that the electromagnetic field delivered by a reader deployed at a gate is sufficient. This method could be useful for solution providers in order to guarantee the performances of their RFID portal

## 9 Collection and filtering solutions (middleware)

Companies need software that sits between the readers and IT infrastructure. Since the RFID middleware is positioned directly in contact with the physical hardware, it can perform a vital data filtering and aggregation function, by helping to cut down on the data volume moving further up the pipe and closer to company systems. This solution have to inspect the data upon initial capture, and in applying business rules, must help to turn raw data into actual meaningful information that constitutes real events and transactions. Moreover middleware solutions have to help companies in the management of the reader pool in doing controls, configurations and upgrades of new firmware.

## 10 Data exchange solutions

Because the supply chain is an open loop world, companies need to exchange relevant data concerning the asset flow with interested parties such as pool players or trading partners. Two complementary solutions based on GS1-EPCglobal standards have to be developed:

- The first solution is EDI infrastructures. Initially, the EDI messages did not permit the exchange of GRAI codes. However, in recent months, GS1 has led the initiative to alter the existing messages in order to manage GRAI codes and therefore assets. Therefore, companies that have already implemented EDI infrastructures need an evolution of the current messages, and those that do not have yet implement it need full EDI solutions implementation. Three main EDI messages are useful for Asset Management among all the messages standardized: DESADV, RECADV, INVRPT
- The second solution is the EPCIS infrastructure. Information System have to evolve in order to create EPCIS events concerning the assets and the goods life (WHAT, WHERE, WHEN, WHY). These events have to be used by the internal application of the company and also store in an EPCIS Repository (a database) in order to give the opportunity to share them with trading partners. Two types of solutions have to be provide to companies that want to recover EPCIS events:
  - If the company knows the EPCIS Repository address of the partner that has the information required:
    - **Push solution:** the partner pushes the event as soon as it occurs
    - **Request/Response solution:** request the data from the partner and receive it directly from its EPCIS Repository
    - **Subscribe solution:** Subscribe to some kind of data list from the EPCIS Repository of the partner and automatically receive the data when events occur
  - If company does not know the EPCIS Repository of the partner that has the information required:
    - **Follow the chain solution:** ask a partner known who knows the address of the desired partner's EPCIS Repository that contains the information required. Receive the address of the EPCIS Repository and request it the data
    - **ONS solution:** look up mechanisms to bootstrap the supply chain. Find the EPCIS Repository of the source which is the company that encodes the EPC (e.g. GRAI or SSCC). ONS can be for example use by the company which is the asset final destination in order to retrieve the EPCIS repository of the pool operator and push a Quantity Event about the number of empties available for collection

In the future, another model named Discovery Service will be available. Solutions using the Discovery Service will permit companies to find the address of any partner's EPCIS Repository in the supply chain that has information about a specific product (e.g. a GRAI or a SSCC).