

RFID in the Automotive Industry – A Standards Based Approach Towards On-Tag Data Sharing in Cross-Company Logistics

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Abstract: Radio Frequency Identification (RFID) is expected to increase efficiency and transparency in the automotive supply chain. The lack of data standards in the automotive industry has been identified as one of the principal barriers for RFID adoption and diffusion in cross-company environments. At present the Automotive Industry Action Group (AIAG) is reviewing the existing AIAG B-11 Item Level RFID Standard to produce a standard that meets the identified needs of the automotive industry. In this paper we apply first results of the working group to a real life project environment. We extend existing standards and industry recommendation to derive an appropriate data structure for forward and reverse logistics and hereby contribute to the ongoing standardization discussion.

1 Introduction

Researchers and practitioners agree on the potential of Radio Frequency Identification (RFID) to increase supply chain efficiency and transparency [GS07]. In cross-company logistics collaborating companies need to agree on syntax and semantics for on-tag data organization in order to successfully share information along the supply chain. The EPC (Electronic Product Code) Network is based on a single unique identifier which is stored on the RFID tag while all object and process related data is kept on the network. In this paper we study the case of the pilot project LeoPARD (Volkswagen AG) and extend existing standards and industry recommendations from a process perspective to derive a data structure that enables both forward and reverse logistics. Our case study indicates that approaches covering forward and reverse logistics at the same time may require more than just a single unique identifier to be written to the RFID tag. Volkswagen specific information used in the paper was retrieved in extensive interviews with project members and by hands on project participation. We identify remaining standardization issues and recommend their consideration for the ongoing standardization process.

2 Data Standardization in the Automotive Industry

Standardization is considered to be one of the major implementation barriers for adoption of RFID in the automotive industry [SC09]. According to the OECD (Organisation for Economic Cooperation and Development) the ongoing discussion about the EPC standard is splitting the automotive industry into two camps [Oe07]. Sprafke, head of the RFID competence center at the Volkswagen AG, puts this position into perspective and states that the automotive industry is working with international partners to achieve a standard that meets the needs of the industry [Sp09]. However, at this stage the automotive industry humbles to adopt the EPC standard and clearly prefers ISO approaches [Sp08]. Most automotive companies already adopted existing standards and developed proprietary solutions to manage their assets. Changing the implemented identification standards and number ranges to EPC may come with extensive investments and endanger established and stable processes between the stakeholders in the supply chain. Moreover EPC charges for membership and assignment of company codes and number ranges. Volkswagen expects that suppliers asked to join EPC will shift the costs downstream in the supply chain [Sp09]. Although these statements require scientific validation they indicate strategic considerations in the Volkswagen context.

The arguments put forward in the standardization discussion are primarily based on different approaches towards data organization. In the past EPC represented a strictly centralized approach. Only a single unique identifier is stored on the RFID tags while all other object and process related data is kept centralized on the network (data-on-network) [JC08, p.15]. Harmon claims that a more generic approach is needed to turn EPC into a solution for cross-industry application [Ha06]. The International Organization for Standardization (ISO) takes a generic technology independent approach. Depending on application needs ISO standards support storage of additional user data to the RFID tag (data-on-tag). Both data-on-tag and data-on-network approaches come with specific advantages and disadvantages. According to Diekmann et al. [DMS07] the approaches are rather complementary than mutually exclusive. The choice on whether to implement data-on-tag or data-on-network concepts highly depends on existing IT-infrastructures and the processes which are to be supported.

In 2006 the Automotive Industry Action Group (AIAG), a non-profit consortium of automotive companies that are particularly involved in the development of common supply chain standards, proposed the standard B-11 (revision 1) for RFID item level tagging. AIAG-B11 supports a data-on-tag approach [Ai09]. The standard allows to store additional information such as a global location number, tire cure date and country of origin on the tag. In 2008 the German Association of the Automotive Industry (VDA) published the recommendations VDA 5501 – RFID for Returnable Transport Items, VDA 5510 – RFID for Parts/ Components and VDA 5020 – RFID for Vehicle Distribution. The documents argue from a process-driven perspective and reference ISO approaches for on-tag data organization.

The ongoing revision of the B-11 standard for RFID item level tagging (revision 8) proposes a format that permits both centralized and decentralized data storage approaches. B-11 is based on ISO 18000-6C/ EPC Gen2 and uses bit flags to distinguish

between EPC and ISO data (bit toggling) and to denote whether additional User Memory is used or not. The consortium recommends that tags should contain a Unique Item Identifier (UII) Memory Bank (min. 280 bits) for identification reasons and an additional User Memory (min. 512 bits) to store application specific data. The data syntax to be applied is ISO/IEC 15962 and ISO 1736x and based on data identifiers (DIs) which are specified within relevant ISO/IEC or EPC data syntax standards [Ai09, p. 2]. The essential benefit of the AIAG standard is that former controversy is resolved by considering both EPC and ISO approaches towards data organization. However, even though existing standards and recommendations build a solid foundation for RFID implementations collaborating companies still need to agree on RFID data structures to successfully provide essential information required throughout the process.

3 Case Study

In 2008/ 2009 Volkswagen and selected suppliers successfully conducted the pilot project LeoPARD (Logistic Process Acceleration through RFID) to support material logistics via RFID. More than 3.000 containers were equipped with passive EPC UHF Gen 2 tags (868 MHz). Mobile handheld scanners and forklifts were used to identify incoming materials and increase process efficiency in goods receipt.

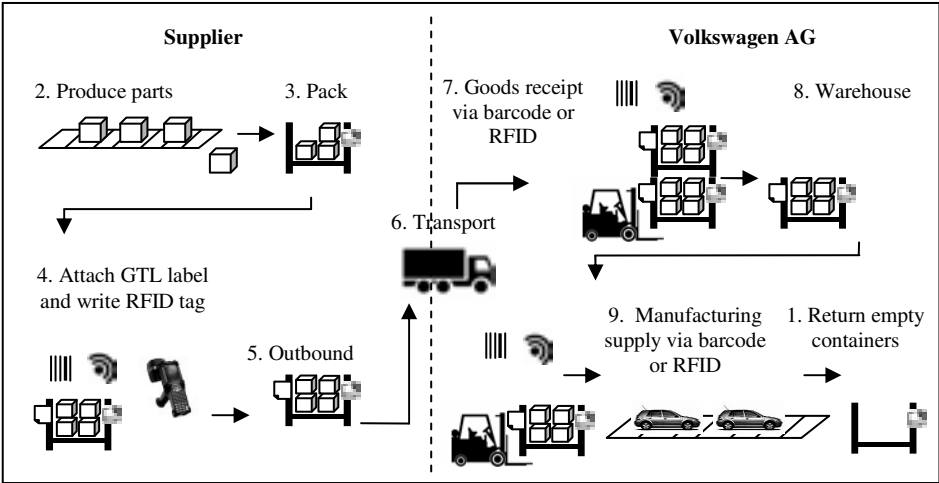


Fig. 1: Simplified RFID process at the Volkswagen AG

At this stage LeoPARD supports material logistics only. However, the process was designed to support reverse logistics in the long run. In the following we reference Fig. 1 to walk you through the LeoPARD process. We point out supplier's and customer's information needs and derive an appropriate data structure for RFID implementation.

The Volkswagen AG provides the supplier with returnable transport items (RTIs) (step 1). The RTIs are identified by *asset owner*, *asset type* and a unique *serial number*. The

requested parts are produced (step 2) and packed into previously delivered RTIs (step 3). The supplier labels the shipments according to delivery agreements (step 4). Global Transport Labels (GTLs) are attached to the RTIs. The GTL contains the so called License Plate. License Plates consist of a unique *supplier ID* and a *package item ID*. The combination of *supplier ID* and *package item ID* uniquely identifies the shipments. The supplier copies the License Plate information from the GTL to the RFID tags using hybrid handheld devices. Afterwards the supplier processes the outbound (step 5) and the materials are transported to the Volkswagen AG (step 6). In goods receipt the materials are received by either barcode or RFID information (step 7). The material is stocked (step 8) and eventually supplied to the manufacturing line (step 9). After the parts have been assembled the empty RTIs are buffered and returned to the supplier upon request.

4 Data Structure

LeoPARD is designed to enable forward and reverse logistics. The data structure to be derived needs to contain at least two unique identifiers: one to identify the RTI and the other one to identify content. In the previous section we identified *asset owner*, *asset type*, *RTI serial number*, *supplier*, and *package items* as relevant information to be written to the RFID tag. The Volkswagen AG implements the Data Universal Numbering Scheme (D-U-N-S) provided by the Dun & Bradstreet Corporation (D&B). D&B is a provider for credit information on businesses and corporations. The D-U-N-S service assigns a unique 9-digit numbering sequence to each registered corporate identity thus provides a unique identification for supply chain partners, i.e. asset owner and supplier. An internal numbering scheme is applied to assign RTI serial number and unique package item IDs.

The first identifier needs to contain an ID for the asset owner (D-U-N-S), asset type and a serial number to uniquely identify the RTI. The asset type is used to track outgoing and incoming RTIs by type. The serial number may be used to separate individual RTIs for maintenance reasons. Note that asset type and serial numbers are permanent. They never change throughout the process and may remain on the object for the RTI's complete life time cycle. The asset owner is not necessarily required but helps to clarify ownership and to distinguish between multiple RTIs in case one and the same serial number was assigned. The D-U-N-S ID for the asset owner is not static. It may be adjusted in case the legal situation of supply chain partners alternates or the assets are passed on to another business unit. Therefore it is clearly not the perfect solution to permanently identify assets. However, it is a feasible option to ensure unique identification.

The second identifier is used to identify material. It contains the supplier's company code (D&B) and a dynamic package item ID. The supplier ID may and package item IDs will change for each individual delivery.

In the following we take the identified information requirements and compose a data structure for RFID usage. VDA recommendation 5501 incorporates the idea of working with existing IDs and number ranges (e.g. D&B, internal numbering schemes) rather

than adopting EPC concepts. The recommendation references ISO/ IEC 15459 (Unique identifiers) and ISO/ IEC 15962/63 (RFID for Item Management/ RFID specific unique identifiers) for user data organization [Vd08]. Following the principle of on-tag data organization we reference AIAG-B11 to derive an appropriate data structure. AIAG-B11 divides RFID memory into two components: a permanent Unique Item Identifier (UII) and additional user memory for dynamic user information [Ai09].

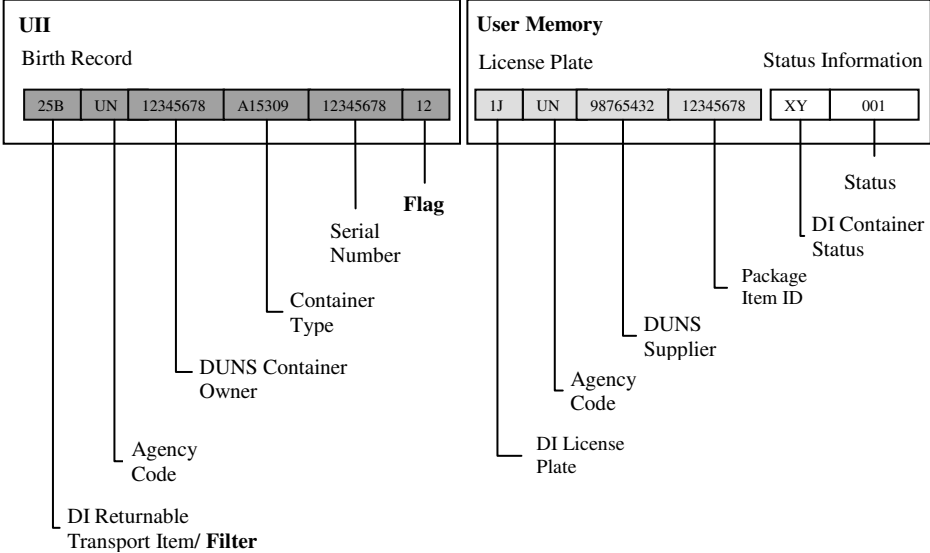


Fig. 2: Proposed Data Structure referencing AIAG B-11

The UII serves as a ‘birth record’ for both tag and item to which it is attached. With reference to reverse logistics it should contain the company code of the RTI owner, asset type and a serial number identifying both tag and returnable transport unit. The information may be locked as it is not changed throughout the process. Additionally we need a unique ID to identify forwarded materials. We suggest to adopt the bar-coded License Plate used in Global Transport Labels. It contains the unique supplier's company code and a dynamic package item ID. The License Plate ID exists for a limited period of time only and therefore must be written to the dynamic user memory. The major benefit of using the License Plate is that the same unique identifier is written to both barcode labels and RFID tags.

RFID has the potential to substitute conventional barcode technology [Wh07]; in some application areas barcoding will remain the more sufficient and effective solution and will not be replaced in near future [MM05][RW06]. Automotive companies will run both RFID and barcoding solutions for a considerable time period. Storing the License Plate to the RFID tag, conventional barcode may serve as a reliable backup solution for RFID implementations thus helps to achieve gradual RFID migration [Oe08]. With reference to the ongoing AIAG-B11 proceedings we propose to apply the data structure shown in Fig. 2. Both Birth Record and License Plate are stored on the RFID tag.

Experiences made during the rollout of LeoPARD indicate that an additional filter is required to enable fast filtering and pre-selection of basic logistic types. Such a filter could be used to focus on signals sent by a specific group of items rather than considering all signals in range [Ep08, p. 29]. For instance the filter may be used in goods receipt to distinguish between material carrying transport units and packaging aids (e.g. covers, separators). There are several possible solutions to solve this issue. We recommend to extend ISO/ IEC 15961/ 17364 Application Family Identifiers (AFI) to contain all relevant logistic entities. EPC Tag Data Standard (TDS) 1.4 contains dedicated UII capacity for filter values but the corresponding filter values have not been standardized yet.

The environment has strong impact on RFID reading effectiveness (e.g. metal, liquids). In some cases this issue can be solved by equipping a returnable transport unit with more than just one tag. Multiple tags on one single object potentially generate problems when writing to the tag. It is difficult if not impossible to address a set of tags that identify one and the same transport unit. In order to solve this problem we adopt a flag to distinguish between multiple tags attached to one object (e.g. 12 → first tag out of two). Alternatively companies may choose to add an identifying suffix to the serial number.

Damaged RTIs negatively influence process efficiency and therefore must be separated for maintenance reasons. Companies need to keep records of the RTI's repair status. VDA recommendation 5501 describes the need for storing repair status information but ISO has not defined an appropriate data identifier yet. Maintenance is relevant to all RTI owners no matter how in-house processes are run. As the repair status may take a limited amount of values (e.g. ok, to be repaired) we recommend to introduce a standardized data identifier including a predefined set of values. This way customers and suppliers can change the status of a transport unit and trigger maintenance activities.

5 Conclusions

In this paper we studied the case of project LeoPARD in order to derive a data structure that serves for both forward and reverse logistics. The derived data structure references contemporary RFID standards and industry specific recommendations. At the time of writing none of the existing approaches covers the proposed data structure up to 100 %. With reference to ongoing AIAG B-11 proceedings we recommend to improve B-11 by incorporating specific advantages of ISO and EPC rather than enabling pure co-existence. We suggest to apply an additional filter for fast filtering and a flag to distinguish between multiple tags attached to one single RTI. EPC implements filter capacity in EPC Tag Data Standards (TDS) 1.4. The AIAG should profit from EPCs experience and consider equivalent filter capabilities in B-11. Missing data identifiers should be added to the existing ISO standards. Information such as the repair status of returnable transport items matters to all stakeholders in the supply chain and therefore should be standardized.

In both barcode and RFID enabled processes we reference the GTL License Plate information. In large-scale RFID rollouts not all supply chain partners will be prepared to immediately shift to RFID technology. In forward logistics the bar-coded License Plate provides a reliable backup solution for RFID technology. The concept enables automotive companies to replace barcode step by step rather than running the risk of ‘big bang’ implementation. However, hybrid processes implementing both RFID and barcode technology will affect process efficiency. The impact of hybrid solutions on process efficiency and the overall business case remains subject to further research.

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