RFID-BASED REAL-TIME DECISION SUPPORT IN SUPPLY CHAINS

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ABSTRACT

For an effective global order management, the concepts of RFID and company-wide information brokerage offer promising technological background.

This paper will introduce the research project RAN (RFID-based Automotive Network) which develops a new way of collecting and sharing RFID based information in supply networks. This paves the way for new IT-systems, so called Logistic Assistant Systems (LAS), which use this new real-time process information for improving decision support. This article describes a simulation-based decision-support system based on real-time RFID event information from the supply chain.

Keywords: Supply chain management, supply chain simulation, simulation-based decision support systems, capable-to-promise planning, RFID

1. INTRODUCTION

Considering new challenges in global markets, companies are forced to plan their supply chains relating to more flexibility, effectiveness and cost reduction. High-value-added branches, like the automotive industry, are characterized by complex product configurations resulting in thousands of possible parts variants. Furthermore a high percentage of value creation is done by global supply networks with high order lead times, dynamic and risky transport relations and high transfer stocks.

Today one mayor problem in automotive supply networks is the lack of transparency, especially concerning in-transit stocks and the material flow. Often simple questions like "Where is my part no. 12345 now?", "How long does it take until shipment 67890 will be available in my warehouse?" or "How many parts of type A will be available next week?" cannot be answered. The problem is a very heterogeneous IT-infrastructure and insufficient communication between the supply chain partners. Furthermore simple basic information about the current status and geographic position of an object in a supply network is often nonexistent or unavailable for partners or logistic service providers.

The consequence is that shortage situations or delays in supply are often not detected. Either costly extra transports or expedited freight are initiated to avoid possible bottleneck situations or high inventory buffers are held. Both results in increased costs.

For an effective global order management, the concepts of RFID and company-wide information brokerage offer promising technological background. RFID and other AutoID technologies enable capturing a real-time picture of the supply chain operations. Each movement of goods, each operational step is documented by a RFID read point event. Thus, the current as-is state of the system is accessible at any time and the system state is updated with each object passing through a read point.

However, up to now companies apply RFID solutions mainly in closed-loop systems. A standardized industry-wide exchange of RFID/Auto-ID information between manufacturers, logistic service providers and suppliers has not been realized so far (Lange 2011). Some individual solutions exist, but the technology can not yet exploit its full potential for the management of supply chains due to missing standards and collaborative solutions. The automotive industry is a prominent example for this situation. Especially first tier suppliers suffer from this situation since they have to deal with multiple OEM-specific solutions.

This paper will introduce the objectives of the research project RFID-based Automotive Network (RAN) which develops a new way of collecting and sharing RFID based information in supply networks. This paves the way for new IT-systems, so called Logistic Assistant Systems (LAS), which use this new real-time process information for improving decision support. This article describes a simulation-based decision-support system based on real-time RFID event information from the supply chain.

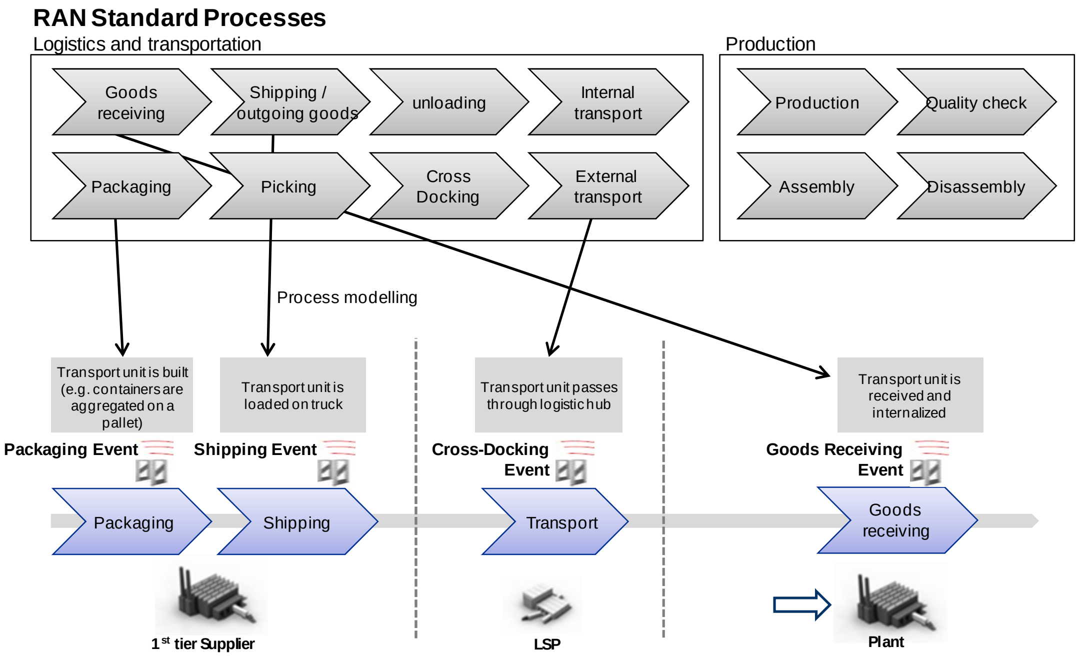

Figure 1: Example of process modeling using the set of RAN standard processes

2. RAN – RFID-BASED AUTOMOTIVE NETWORK

The research project "RAN – RFID-based Automotive Network" funded by the Federal Ministry for Economics and Technology (BMWi) has the objective to increase the transparency of information exchange in production and logistic networks of the automotive industry (FMET 2010) through the application of RFID. The consortium is composed of many partners involved in the production and logistics chain: Automotive OEMs (e.g. Daimler, BMW, Opel), suppliers (e.g. Bosch, Kaiper, Rehau) and logistic service providers (e.g. BLG) as well as RFID software providers and system integrators (e.g. IBM, SAP, Siemens) and leading research institutes (BIBA, IWB, FZI and IML).

The RAN project intends to standardize the technological infrastructure, the event data and informational systems so that event information can be shared across company boarders easily. The core elements of the RAN approach to achieve this are the following:

RFID-based RAN standard processes: So called RAN standard processes give a reference which RFID-events typical material flow processes can provide. These RFID-events represent the kind of information relevant to supply chain planning and event management systems. For typical supply chain operations, such as goods receiving process, outgoing goods process, transport, production, assembly and other common material flow processes, events are defined. Across several use cases with various automotive OEM, suppliers and logistic service providers it was analyzed which informational content these events must contain to support planning and event management in different supply chain scenarios, such as monitoring and control of KANBAN-call-offs for material, track & trace of reusable containers, available-to-promise planning in global supply chains, monitoring and control of vehicle distribution operations.

In Figure 1 the set of RAN standard processes is depicted. From this set of generic material flow processes the real supply chain process and its RFID deployment can be constructed. Supply chain partners agreeing on using the automotive RAN standard can rely on the availability of the defined RFID event information from a partner's process.

Data and event standardization: each event used in the RAN project scope is exactly defined. The target is a common industry-wide understanding of the process events for the users of the RAN process and event standard.

The EPCglobal EPCIS 1.0 (EPCglobal 2007) standard is adopted to specify the RIFD events. Where necessary, extensions to the existing EPCIS standard are made to meet the needs of the automotive industry. The EPCIS standard allows encoding the relevant information about the object identified and the circumstances of the capturing:

- What? Unique identifier of the object or the or the transaction
- When? Time log of the event
- Where? Read point plus business location
- Why? Business step (e.g. goods arriving, goods receiving) + Disposition (e.g. container empty, damaged etc.)

For the identification of logistic or production objects the Electronic Product Code EPC as well as the

ISO-standard is applied. Both standards ensure that information sharing between suppliers, customers and logistic service providers works reliably and the unique reference of a part or object to its manufacturer or owner is possible. Table 1 depicts the identification standards used for typical logistic items in the RAN project.

Table 1: Identification standards used in RAN

Object type	**ISO framework**	
	EPC	**ISO norm**
Freight containers	ISO 17363	
		15459-2
Returnable transport items	ISO 17364	
	GRAI	15459-5
Transport units	ISO 17365	
	SSCC	15459-1
Product packaging	ISO 17366	
	SGTIN/ GPIK	15459-4
Product tagging	ISO 17367	
	SGTIN/ GPIK	15459-4
Locations	SGLN	
Fixed Assets	GIAI	

RFID read point infrastructure and RFID-technology: read point hardware serves to read RFID tag information from logistic objects, e.g. incoming / outgoing objects, objects entering or leaving a process; edge- and middleware captures the object event and transfers it to connected applications or storage repositories. The goal is to define standard settings for typical automotive applications.

Standardized inter-operable IT infrastructure: Building on the standardized processes and data structures a so called InfoBroker infrastructure serves as a basis for effective exchange of object-related event data between companies. Distributed event repositories constitute the core of the InfoBroker (see Figure 2). Each repository is assigned to a defined organizational domain. It stores the event information generated within this domain in standardized form. Using query and subscription services companies can exchange event information between repositories and other periphery systems. Information exchange is controlled by rules for security and privacy of data. Each domain owner must authorize external partner to receive or retrieve information from his repository.

3. THE BENEFIT OF IMPROVED TRANSPARENCY

Transparency about the system's current state is clearly valuable for the management of logistic systems. But the visibility of logistic objects through read point events itself, the tracking and tracing of objects on their path through a logistic system, is only the bottom of the potential benefit an improved informational transparency can yield. The possible benefits new IT-systems can achieve on the basis of process event data is manyfold. The functionalities of these new IT-systems reach from the simple localization of logistics objects over event management and altering systems up to complex decision support systems. In order to systematize these IT-functionalities, a classification scheme of supply chain IT-systems building on real-time event information from the process level is introduced below. The classification scheme is shown in Figure 3. The complexity of the IT-system's functionality increases from level 1 to 6:

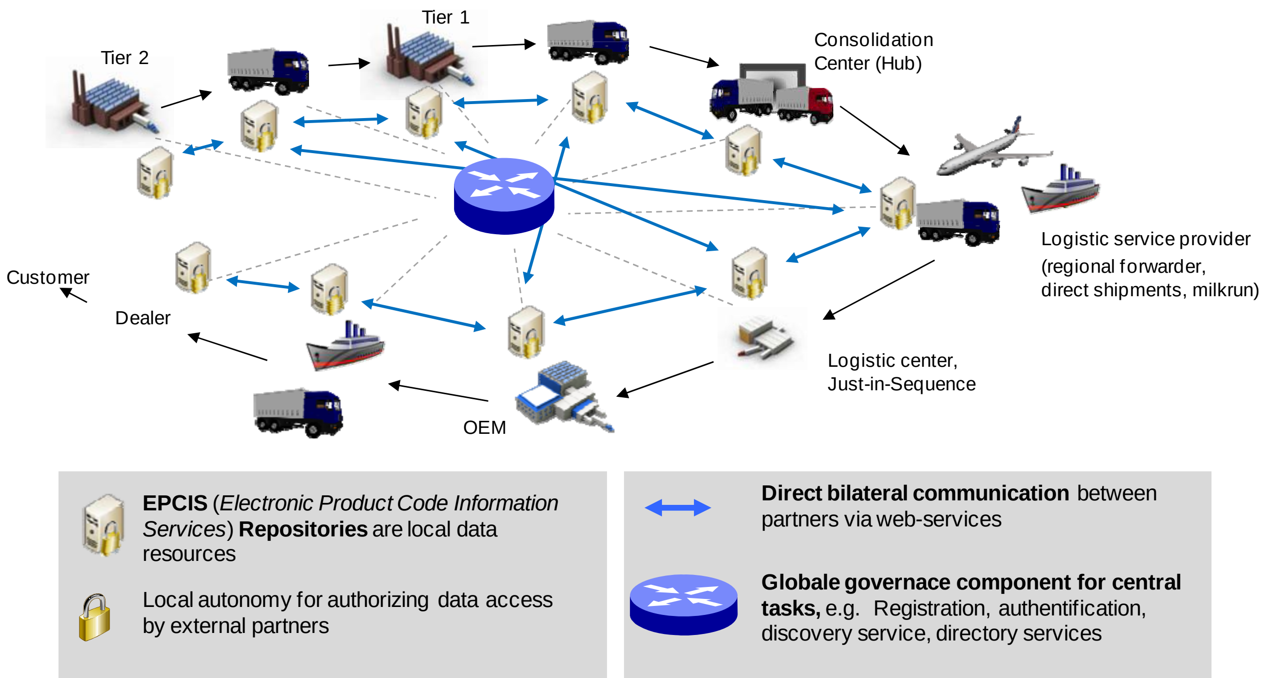

Figure 2: The RAN Infobroker concept

Level 1 system: representation of the actual current state; track and trace functionalities; locate-objects functionalities; reports on simple logistic key performance indicators (e.g. lead times, transit times; inventory)

Level 2 system: integration of to-be-state information like ETA, order and shipment number, advice note or production data

Level 3 system: comparison target vs. actual state; identification of deviations; visualization of deviations target vs. actual; monitoring functionalities

Level 4 system: identification of consequences; event management functionalities; detection of process deviations; integration of rules for alerting-functionalities; forward projection of the current state (simulation); analysis of the impact of process deviation on targets or desired future states; identification of critical process deviations

Level 5 system: evaluation of decision alternatives; configuration of solution measures and testing; application of decision support methods: simulation, optimization, cost-benefit calculation etc.

Level 6 system: integrated control of the supply chain; execution of processes; automatic problem solving processes; decisions or solution measures are instantly generated and initiated via established links to operative systems.

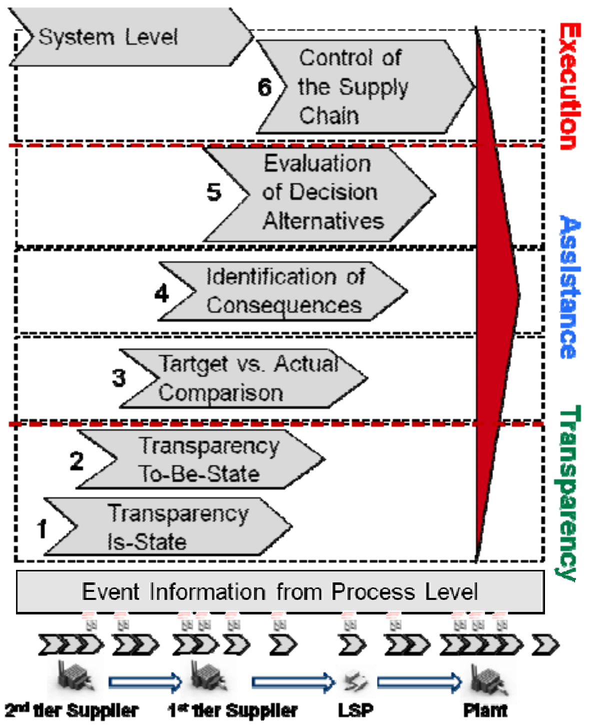

Figure 3: Levels of complexity of IT-applications based on real-time process event information

Within the RAN project IT-systems on all levels are being developed. This article will introduce the concept for a level 3 to 5 logistic IT-system based on real-time process event information.

4. LOGISTIC ASSISTANCE SYSTEMS (LAS)

Logistic Assistance Systems (LAS) are designed to assist logistic experts in planning and execution by offering transparency about all relevant supply chain information and integrating specific decision support methods and planning approaches into one combined approach. Besides that the idea of LAS is to provide a simple planning and software system based on the RAN infrastructure, which can be adapted to new supply chains or planning situations with low effort. It can be easily integrated into a company's organization. Therefore LAS integrate events from the RAN infrastructure and planning data to consolidate all relevant information along the supply chain. Furthermore, LAS comprise monitoring and event management functionality to allow for effective supply chain planning and execution applying current and high quality data. Thus, the LAS concept rests upon extended collaboration, consistent supply chain information, process transparency and planning functionality.

The following sections will show the application of the LAS approach in a RAN use case dealing with monitoring and available-to-promise planning in global supply chains.

Consequently we divide this LAS concept into three blocks: Data acquisition and transparency, decision support and collaborative planning. These blocks allow dynamic and collaborative supply chain planning and will be introduced in the following sections.

Data Acquisition and Transparency: LAS need to consolidate all relevant information for a specified planning task. To achieve data acquisition and data transparency LAS integrate functionalities of SCM concepts like SCMo. SCMo is a collaborative multi-level SCM concept founded on software support for processing information between network partners (Odette 2009). The basic functionality is the exchange of production demands and inventory levels among business partners in a supply network to gain extended transparency and avoid time lags in information flow. Recent developments in SCMo applications integrate Supply Chain KPI Frameworks (Key Performance Indicators) and the assortment of graphical tools (e. g. predefined charts, cockpits or dashboards) for information presentation (Bäck and Gössler 2006). Exemplary KPIs that are applied in SCMo applications are forecasting accuracy and days of inventory (Hellingrath et al. 2008).

Consequently, SCMo systems provide functionalities for monitoring the current status of a supply chain (level 1 and 2). Nevertheless, they lack methods for forecasting and planning, i.e. optimization and simulation. On the operational level the concept of Supply Chain Event Management (SCEM) aims to support the execution of agreed plans by automatic identification of unacceptable deviations and suggestion of alternative solutions (level 3 to 5). Therefore a SCEM system supports online data acquisition via tracking & tracing. It raises alerts if there are significant deviations between plan and current data. LAS need to combine functionalities of both SCM concepts but stick to a simple approach: This system concept focuses on information transparency for decision makers without implementing a complex system requiring organizational changes. Therefore LAS provide standardized interfaces to the RAN InfoBroker Architecture as well as tracking & tracing devices (e.g. XML specifications). This functionality is connected with the material flow level and extracts all relevant events including event interpretation and data aggregation. The key factor here is, that all relevant, task oriented information is collected and presented to the decision maker and critical deviations are directly illustrated on a dash board. The user interface is designed clear and simple; the technological background of this functionality is designed flexible in order to be prepared for dynamically changing environments and supply chain structures. Figure 4 shows typical data sources, which are relevant to enable sufficient information transparency in global supply networks.

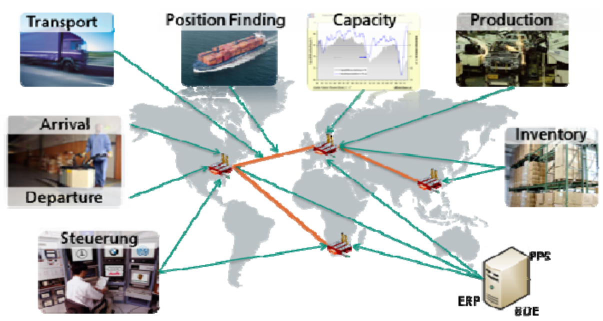

Figure 4: Forms of Data Acquisition and Consolidation

Decision Support (DSP): Decision Support (DSP) for LAS means that depending on the given logistic task the software system supports the human decision process in all its steps: decision preparation, option selection, decision execution and control. Depending on the focused planning task itself, LAS integrate different types of decision support concepts and systems: LAS realizations typically integrate a simulation based concept to enable available-to-promise (ATP) and capable-to-promise (CTP) planning in complex supply networks. Therefore, the DSP module comprises a simulation component, which allows scenario-based analysis of different demand, inventory and capacity situations within the supply network. Based on the current transport and inventory situation (warehouse and transport stock based on online data from the RAN InfoBroker) and a precise model of the supply network, LAS allow the simulation of future system's behavior.

The simulation model is initialized with the current state situation and enables the simulation of existing transports and material flows to the final warehouses or production sites. In combination with given demands it is possible to calculate deviations between the future availability of material and the future demand. Furthermore the feasibility of a change of plan (demand change or later estimated time of arrival of a ship) can be checked against reliably and thus be optimized ("what-ifanalysis"). Finally detected deviations of transports due to ETA and geographical position of a ship can be integrated into the simulation and possible delays as well as subsequent problems can be detected in time.

This so-called dynamic ATP allows for exact calculation if future demand could be fulfilled by then available inventory (see figure 5). This supports the user to control the chosen decision execution and its impact on the subsequent process (Toth and Wagenitz 2009).

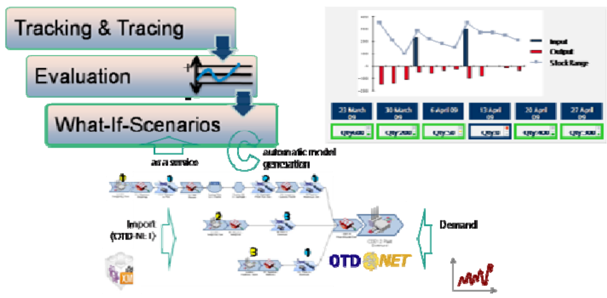

Figure 5: Simulation based ATP functionality and stock range calculation

The general idea of the DSP module is to offer flexible planning support by integrating different functionalities, i.e. simulation or optimization, as services into the architecture. Especially service oriented architecture and easy configuration of LAS is a current research topic in this context.

Collaborative planning: For collaborative planning LAS combine data from all relevant network partners. Thus, information from all supply chain tiers may be used for information processing and decision support. Supporting the planning process, manual changes in data need to be tracked and documented by users. In addition to that it is necessary to integrate individual views by a dedicated role-based user management. This way proprietary information can be revealed to selected user groups, network partners or organizational departments. To support an enhanced communication process for collaborative planning workflows and message systems must be applied (Bockholt et al. 2009, Deiseroth et al. 2008).

To sum up: By providing decision support and collaborative planning profound decisions can be made.

But only if relevant and current supply chain information is given. With RAN and RFID-based LAS an early identification of possible bottleneck situations, supply shortages or surplus stocks is possible which yields cost and service benefits. Decision makers may intervene in an early stage to ward off cost-intensive additional processes. Especially for global order management LAS provide company-spanning and consequently holistic collaboration to stay competitive within rapid changing markets.

5. CONCLUSION

This paper explains the motivation and objectives of the research project "RAN RFID-based automotive network" (FMET 2010), which aims at improving the transparency in logistic networks through real-time process event information. Furthermore Logistic Assistance Systems (LAS) are introduced to show, how this highly actual information can be applied to improve supply network planning and execution in different levels. Finally, the LAS approach was described within a successful implementation of a global supply chain use case.

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