A Concept for Improving the Security and Efficiency of Multimodal Supply Chains

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ABSTRACT
Multimodal supply chains are characterized by multiple changes of transport modes and vehicles. Hence the risks for theft, untimely delivery and freight quality deterioration increase. There is hence a growing need to manage the security and efficiency of consignments from door to door. This paper describes the results of the Finnish national SCIE (Supply Chain Security and Integrity) project, which had as main objective the development of a holistic framework for the management of the security and efficiency of supply chains. A profound risk analysis was performed to find key vulnerabilities of the service and suitable monitoring technology. The security service was developed to deal with the vast amount of actors in the multimodal supply chain, accurate transport plan data reception and the identification of exceptional situations. The service concept was tested by monitoring and analysing steel product shipments from Finland to Central Europe. Advanced intelligent monitoring devices were attached to the consignments. These devices gathered and transmitted in real-time environmental, transport stress and location information. The paper will give an overview of the framework, service concept and the analysed results of a multimodal shipment from Finland to Italy.

Keywords: Location Technology, Monitoring Technology, Multimodal Transport, Supply Chain Security, Tracking and Tracing

BACKGROUND
The frequency of security incidents as well as their consequences is increasing. The total loss of value caused by theft of cargo and freight vehicles is about 8.2 Billion each year in Europe, or about 6.7 Euro per loaded trip (van den Engel & Prummel, 2007). The management of supply chain security is a topic which is hence high on the agenda of logistics operators and governmental agencies (Salmela et al., 2010; Urciuoli, 2010; Voss et al., 2009). In order to manage the security in supply chains and logistics, technologies and knowledge for building monitoring and emergency systems capabilities should be implemented. The constant changes
of processes, business practices and economic power in the global business environment have generated the need for the security management approach to enterprise resiliency (Ritter et al., 2007).

Logistics is the part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers’ requirements (Ballo, 2004). Due to the complexity of modern logistics networks, the availability of fast and accurate information exchange plays a key role in improving efficiency (Yu et al., 2001; Nilsson & Waidringer, 2010).

Tracking and tracing services assist both in improving the efficiency and security of supply chains. Increased supply chain visibility offers possibilities for reducing transportation and expedition costs and for increasing the on-time delivery level, and also assists in transportation planning (Goel, 2010).

There are many tracking and tracing services on the market, but they mainly concentrate on a single mode of transport, such as road vehicles, or transport units, such as containers (Meyer-Larsen, 2009). In multimodal supply chains, transport modes, vehicles and the responsible organizations for the transport of the goods change during the supply chain. This poses risks on both security and the timely delivery of the goods. The transport changes put also additional challenges on the tracking of shipments for the organizations responsible for the door-to-door shipment. Another issue related to tracking and tracing services is that often there are no mechanisms defined in order to identify and react on exceptional situations.

The objective of the Finnish SCIE (Supply Chain Integrity and Efficiency) project was to develop a holistic service framework for the management of the security and efficiency of multimodal consignments. The service’s aim is also to decrease the bureaucracy and documentation for the security management, and to be easily tailored to the needs of the customers. The service will be established in an alarm centre, where it will complete existing security services offered to the supply chain stakeholders. The service will be transport mode independent.

The value of the increased security measures and monitoring of the supply chain can be found e.g., in improved product safety and supply chain processes, in increased supply chain visibility and delivery speed as well as in resilience improvements, which include better anticipation and reaction to the undesired occurrences in the supply chain (Peleg-Gillai et al., 2006). The paper will give an overview of the supply chain critical stages vulnerability and risk assessments, consignments tracing devices requirements, service concept framework and analyse the results of a multimodal shipment in Europe.

**CRITICAL STAGES IN MULTIMODAL SUPPLY CHAINS**

There are obvious phases and stages along the supply chain that are more critical or carry more risks than others. Typically the most vulnerable phases in multimodal supply chains are slowing, stopping and parking en route on the road transport, moving through dangerous geographical areas, loading and unloading, change of transport vehicles or transport modes and static points along the routes (warehouses, terminals, ports, borders, etc.) (FreightWatch, 2011; Europol, 2009). Craddock and Stansfield (2005) have assessed incidents that can take place during a container journey. These threats have been generalized for consignments (parcels, transport units) and are presented in Table 1.

In many existing supply chain security applications the transport vehicle is monitored and exceptions and deviations are reported on real time basis. However, without effective response measures that allow to normalize the situation or at least minimize the damage without unnecessary delays, the overall impact remains limited.
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