A Supply Chain Tracking Model Using Auto-ID Observations

Thomas Kelepouris, Institute for Manufacturing, University of Cambridge, Cambridge, UK
Duncan McFarlane, Institute for Manufacturing, University of Cambridge, Cambridge, UK
Vaggelis Giannikas, Institute for Manufacturing, University of Cambridge, Cambridge, UK

ABSTRACT

Order location information is undoubtedly one of the most critical pieces of supply chain information. Yet supply chain visibility generally remains a challenge as observations of order progress are often irregular and collected manually. The emergence of Automated Identification (Auto-ID) technologies like Radio Frequency Identification (RFID) is improving the effectiveness of supply chain tracking systems. The authors propose a model that describes how Auto-ID observations across a supply chain and historical observation data can be combined to produce an ongoing order location estimation over time. The model is based on probabilistic reasoning principles and the resulting location estimation can be used to support operational decisions as well as to assess the quality and value of tracking information. The authors provide explicit instructions as to how to use the proposed model and using an illustrative example, they demonstrate how the model can produce ongoing location estimates based on RFID read events.

Keywords: Auto-ID, Model, Order, Radio Frequency Identification, Supply Chain, Tracking Information, Visibility

INTRODUCTION

Order location information is the cornerstone for effective decision making in many supply chain operations. Amongst others, ordering and scheduling decisions are directly based on either a current or future estimate of the location of goods moving through the supply chain. This estimate is typically generated based on a series of observations at specific locations across the supply chain (usually called checkpoints) as the products move through the chain. This set of observations along with an appropriate model enables estimation of the current or future location of products. We will refer to the overall process of determining the ongoing location of an order in a supply chain as supply chain order tracking (Jansen-Vullers, van Dorp, & Beulens, 2003). Figure 1 provides a representation of this definition, in which observation information is used to drive a location estimation process. The final location estimate is used by managers of industrial operations to answer questions like “Where is the order that I am expecting?” or “Will my order arrive by noon tomorrow?” The answers to these questions are used to make critical decisions regarding inventory manage-
ment and resource allocation throughout the supply chain. The emergence of automated identification (Auto-ID) technologies, such as radio frequency identification (RFID) over the last ten years, has created a great potential for the improvement of information quality generated from tracking systems and, as a result, for an improvement of the effectiveness of decisions that use this information. In particular,

i. RFID technology offers automated object detection enabling the installation of more frequent scan-points throughout the supply chain at a relatively low cost compared, for example, to barcode (Hodges & McFarlane, 2004).

ii. The automated nature of data capture together with the potential density of data collection points can significantly improve the completeness and the timeliness of the location information delivered.

iii. Automated network data sharing, for example through the Electronic Product Code (EPC) Network (EPCglobal, 2005), enables supply chain partners to build up the location history of a specific item by retrieving data from across the supply chain using standardized interfaces.

Given the data characteristics offered by Auto-ID technologies, order location estimation using probabilistic techniques has more chances of delivering realistic estimates than ever before. This paper proposes a model that takes advantage of the potential offered by Auto-ID technologies in order to deliver enhanced order location estimates.

Although Auto-ID technologies are expected to deliver frequent high quality tracking information (Bose & Pal, 2005), the benefits offered need to be carefully balanced with its costs. At the same time the large amount of data that new technologies can generate make it difficult to determine the business value of the applications that use them (Bose & Lam, 2008). As a result, the need to accurately quantify the expected benefits from Auto-ID based tracking systems has raised significant research interest from both academics and practitioners (Whitaker, Mithas, & Krishnan, 2007; Delen, Hardgrave, & Sharda, 2007; Dutta, Lee, & Whang, 2007; Ozelkan & Galambosi, 2008). In order to quantify the impact of these new supply chain tracking systems, subject to different possible system configurations and accuracy levels, it is necessary to formally describe tracking information and the resulting location estimate. Figure 2 describes the rationale and scope of this paper. The output
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