A Non-Invasive Software Architecture Style for RFID Data Provisioning

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ABSTRACT

Integrating real-time RFID data into autonomous and heterogeneous information systems across the business value chain presents a number of challenges. At an abstract architecture level, this paper identifies important requirements for RFID data provisioning and points of integration. A non-invasive architecture style is proposed to satisfy these requirements. It has the advantages of low entry barriers, low latency, high flexibility, and independent evolvability. The architecture style is used as a basis for evaluating three existing architectures for RFID data provisioning. Various architecture mismatches that could hinder the pace of RFID adoption are identified and discussed. A new asymmetric integration approach is suggested as an alternative to existing methods.

Keywords: Asymmetric Integration Approach, Data Provisioning, Event Driven Architecture, Non-Invasive Architecture, RFID Data

INTRODUCTION

To survive and thrive in today’s competitive global marketplace, an organization’s information system needs to address two paradigm shifts in the Internet age. The first shift is called business as service. It requires the smooth consumption and provision of services within the organization boundary and across the business value chain. The second shift is the near real-time response to business events. To sense, process, and respond in fast pace to internal and external changes (events) requires a near real-time information system. RFID application is such a widely adopted information system because it enables real-time global visibility of goods and assets.

Due to major improvements in RFID technology and rapidly declining costs, RFID applications are now approaching a critical mass (Want, 2006). However, business partners across supply chain may have different expectations...
of the RFID technology due to various reasons. For instance, the size, hence the complexity, of their businesses are different, resulting in different demand for RFID data. In addition, business partners may be in different stages of RFID adoption and thus have different RFID support capabilities. Also, their IT systems may be heterogeneous and have different constraints. Nonetheless, RFID data has to be collected and shared in near real-time for maximum efficiency because the full potential of RFID technology can be achieved only when all business partners across the value chain share the RFID data in a timely manner (Bornhovd, Lin, Haller, & Schaper, 2004). Data provisioning refers to the mechanisms for providing RFID data to multiple business applications from RFID data sources. As the fundamental enabler for RFID applications, data provisioning plays a critical role as well as poses many technical and managerial challenges that need to be resolved to ensure smooth global adoption of RFID technology. Integrating RFID data into existing applications that spread over the business value chain is an urgent research topic for both practitioners and academic researchers (Asif & Mandviwalla, 2005; Curtin, Kauffman, & Riggins, 2007). The integration is a challenging task because of the impedance-matching between them (Sarma, Systems, & MIT, 2004).

This research attempts to identify and address these challenges from a software architecture point of view. Specifically, the research questions are: 1) What are the requirements of RFID data provisioning in the context of global business value chain? 2) What is the appropriate software architecture style to meet those requirements? 3) Are there architecture mismatches in existing software architecture? This paper answers all three questions through a number of use cases and system evaluation. The proposed new software architecture style enables an asymmetric approach for integrating RFID data into existing business processes across business boundaries.

This rest of the paper is organized as follows. Section 2 describes the scope and methodology of this research. In section 3, architectural requirements are identified from general RFID use scenarios. Section 4 proposes an architecture style to satisfy these requirements. In Section 5, three existing architectures are evaluated using the proposed architecture style. Section 6 discusses the asymmetric RFID data integration approach. Section 7 concludes with directions for future research.

RESEARCH SCOPE AND METHODOLOGY

A typical RFID system is naturally a complex system that has many aspects (Sheng, Li, & Zeadally, 2008; Zhao & Gan, 2006). An RFID tag can store from a simple 96 bit EPC identifier to several Kilobytes of product and operational data. The RFID can be seen as a mass distributed database that store critical business information (Floerkemeier, Roduner, & Lampe, 2007). Data provisioning is the mechanism through which every business application can access RFID data. To define data provisioning clearly, we have to understand what RFID data is. The definition of the term turns out to be quite complex because of the diversity of RFID data and its usage. Nonetheless, we try to define it from a data flow perspective as depicted in Figure 1.

Starting from the bottom, the input to data provisioning is tag data which is data encoded in an RFID tag. Tag data includes a unique identifier and optional attributes describing the tagged object. Using tag data, data provisioning services can independently derive other data associated with tag data. The derived data can be context information (such as timestamp and the place where the tag is read) or computational/state data (such as the count of tagged objects in specific time intervals or the absence of a specified tag). The tag data and/or the derived data are both considered as RFID data. It is worth pointing out that according to our definition, any application data, such as an invoice number associated with a specific tag, if not already encoded in the tag, is not RFID data. Data provisioning cannot derive
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