SA-RFID: Situation-Aware RFID Architecture Analysis in Ubiquitous Computing

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Abstract

Sensors in ubiquitous computing provide a new opportunity to extend existing RFID capabilities to situation-awareness. This paper proposes several alternatives of the Situation-Aware Radio Frequency Identification (SA-RFID) system architecture and analyzes the pros and cons of each alternative.

1. Introduction

The Radio Frequency IDentification (RFID) system enables to identify objects by contactless (wireless) access using radio frequency, monitor object status, and process transactions without human's intervention. The RFID is widely used for various applications such as transportations, electronic cash, and logistics and so on [1,2].

In these days, sensor network technology in ubiquitous computing offers a new opportunity to extend existing RFID capabilities, for example, by collecting context-aware information from the sensors, analyzing and sharing the information through a sensor network, providing adaptive, situation-aware RFID services [3,4,5]. At our best knowledge, however, no situation-aware RFID system architecture is studied yet.

In this paper, four Situation-Aware RFID (SA-RFID) system architectures are proposed and investigated their characteristics in brief. Section 2 presents situation-awareness in the RFID systems, Section 3 proposes four SA-RFID architectures, and Section 4 concludes the paper.

2. SA-RFID Overview

SA-RFID supports situation-awareness and consists of four components (See Fig. 1). The RFID tag (RFID-T) holds object ID information. The RFID reader (RFID-R) reads the RFID tag information. SA-RFID-R can provide extended capabilities of acquiring context-aware data from sensors such as temperature, brightness, sound, and analyzing the data to understand situations. For example, a sudden stop (within 0.5 second) of a running car with 60-miles-per-hour speed (context-aware data) can be interpreted as an accident (situation-aware information). The analyzed situation triggers proper actions to provide situation-aware services.

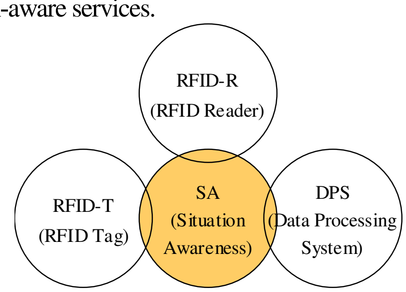

Figure 1. SA-RFID Concept

The data processing system (DPS) basically utilizes the information acquired by RFID-R. The DPS also contains the information pertaining to the use policies and determines suitable actions by inferring and judging the situation information.

For supporting the situation-awareness, the RFID system requires functions to collect situation information, define use policies with a profitable representation language, and infer for determining valid actions using the use policies and the situation information collected. We satisfy these requirements by applying the concept of the situation-awareness.

3. SA-RFID Architectures

Four SA-RFID architecture types (alternatives) are proposed based on two criteria: *whether Situation-Aware Sensors (SA-S) is required* and *where the situation-awareness is analyzed* (See Fig. 2). Type I and IV do not require SA-S and analyze situation-awareness in DSP (Type I) or in RFID-R (Type IV). Both Type II and III require SA-S, but their actions as results of the analysis of the situation-awareness are executed in SA-Sensor (Type II) or in the DPS (Type III).

As for Type I, which extends the DPS capabilities, the situation information is received directly from the sensors, and the DPS infers the situations and tag information acquired from the RFID-R, and executes the resulting actions in DPS. For Type II, the new component SA-Sensor is added and forwards to the DPS the situation information collected from the sensors. The SA-Sensor infers the situation information from the sensors, and sends the results to the DPS. The DPS obtains the tag information from the RFID-R and the actions from the SA-Sensor, and then executes the actions. Type III is similar to Type II, but the difference between them is that the SA-Sensor of Type III processes both of the inference and execution depending on the use policies. The SA-Sensor gets the tag information and sends it to the DPS with the action result. Finally, Type IV is an extended architecture that RFID-R performs the functions of the SA-Sensor. Therefore, RFID-R processes the inference and execution by collecting the situation information from the sensors.

As for Type I, existing architecture of RFID systems can be extended easily by generating SA-DPS with extension of DSP, but communication privacy problems might be occurred due to spatial heterogeneity between sensors and SA-DPS in a wide area network (WAN). Type II can trust and maintain situation information more correctly than Type I because tag information from RFID tags and situation information from sensor are corrected in the same space. However, extra cost is needed to use SA-Sensor. Type III can reduce error rate caused by remote communication, and improve the trust about transmission of information. However, it also needs extra cost and computation capability for inferring and executing situations. Finally, for Type IV, the complexity of architecture is the most simple, but RFID-R should have additional functions such as remote communication, communication with sensors and collection of situation information.

4. Conclusion

Four alternatives of the Situation-Aware RFID (SA-RFID) system architectures are proposed and their pros and cons are analyzed. It is expected that the proposed architectures overcome simple and restrained capabilities of the existing RFID system. In addition, they also provide far-reaching applications. Above all, it is feasible to utilize the various RFID tags based on the situation information and determine the diverse access methods.

This paper summarized characteristics of each architecture in brief. Therefore, evaluations should be approached in aspects of performance, each component load, and extension need of specific components, etc. These issues are remained as future work.

5. Acknowledgment

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6. References

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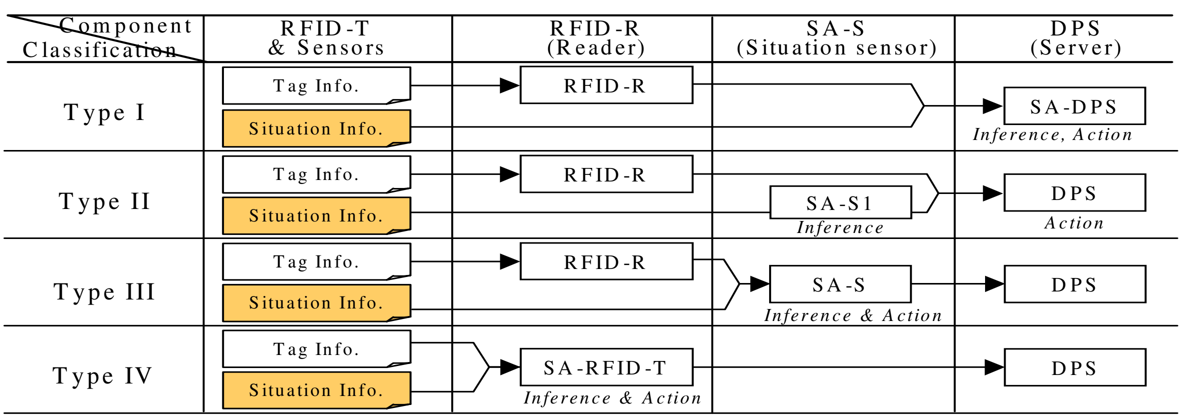

Figure 2. SA-RFID Architectures