INSTITUTO SUPERIOR TÉCNICO
Universidade Técnica de Lisboa

Scalable and secure RFID data discovery

Miguel F. L. Pardal
(MSc in Computer Science and Engineering)

Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
Computer Science and Engineering

Committee:

Supervised by:	Prof. José M. C. Alves Marques
	Prof. Sanjay E. Sarma
Committee:	Prof. Luís E. T. Rodrigues
	Dr. Christian Floerkemeier

July 7, 2009

Abstract

Radio-frequency identification (RFID) enables the *total visibility supply chain*, where trading partners collect data about physical goods in the supply chain and share it, as long as their own interests are safeguarded. The sharing restrictions can be stated in *discovery policies*, interpreted and enforced by *discovery services* that lookup information about physical goods across organizational boundaries and disperse geographic regions.

This research proposal aims to study how discovery policies and context data can improve the *scalability* of secure discovery services.

Keywords & Palavras Chave

Keywords

- Business-to-business
- RFID Discovery
- Scalability
- Security

Palavras Chave

- Negócio-para-negócio
- Descoberta RFID
- Escalabilidade
- Segurança

Contents

1 Introduction **1**

1.1 Motivation . . . 1

1.1.1 RFID . . . 1

1.1.2 Supply chains . . . 1

1.1.3 EPC standards . . . 2

1.1.4 RFID data discovery . . . 2

1.2 Research question . . . 3

1.3 Summary . . . 3

2 Background **5**

2.1 RFID technology . . . 5

2.2 RFID-enabled information systems . . . 6

2.2.1 Information systems . . . 6

2.2.1.1 Naming . . . 7

2.2.2 RFID data . . . 7

2.2.2.1 Tag memory . . . 7

2.2.2.2 Observations . . . 8

2.2.2.3 Events . . . 8

2.2.3 RFID system layers . . . 8

2.3 The EPC framework . . . 10

2.3.1 Tags . . . 10

2.3.2 Readers . . . 10

2.3.3 Application Level Events . . . 10

2.3.4 EPC Information Services . . . 12

2.3.5 Object Name Service . . . 12

2.3.6 EPCIS discovery . . . 12

2.3.7 EPCIS discovery draft proposal . . . 14

2.3.7.1 Participants . . . 14
2.3.7.2 Assertions . . . 14
2.3.7.3 Messages . . . 15
2.4 Summary . . . 16

3 Problem **17**
3.1 Supply chain domain . . . 17
3.1.1 Total visibility supply chain . . . 17
3.1.2 RFID benefits for supply chains . . . 18
3.1.3 EPC supply chain . . . 18
3.2 Discovery for supply chains . . . 19
3.2.1 Discovery policies . . . 19
3.2.2 Requirements survey . . . 20
3.2.2.1 Business drivers . . . 20
3.2.2.2 Data attributes . . . 21
3.2.2.3 Data distribution . . . 21
3.2.2.4 Performance and availability . . . 21
3.2.2.5 Management . . . 21
3.2.3 Core requirements . . . 21
3.2.3.1 Security . . . 22
3.2.3.2 Scalability . . . 22
3.3 Summary . . . 23

4 Research proposal **25**
4.1 Evaluation approach . . . 25
4.2 Product recall scenario . . . 25
4.2.1 Motivation . . . 26
4.3 Baseline . . . 26
4.3.1 EPCIS implementation . . . 26
4.3.2 Discovery implementation proposal . . . 27
4.4 Topline . . . 27
4.4.1 Blackboard . . . 27
4.4.1.1 Representation of assertions . . . 28

4.4.1.2 Representation of supply chains . . . 29
4.4.2 Distributed blackboard . . . 29
4.4.2.1 Event publication and subscription . . . 30
4.4.2.2 Locality . . . 30
4.4.2.3 Trust . . . 31
4.4.3 Massively distributed blackboard . . . 31
4.5 Summary . . . 32

5 Conclusions and future work **33**
5.1 Work plan . . . 33
5.1.1 Past . . . 33
5.1.2 Future . . . 33
5.2 Contributions . . . 33
5.2.1 So far . . . 34
5.2.2 Expected . . . 34
5.2.3 Future Work . . . 34

A Bibliography **35**

B GS1 Identification System **39**
B.1 Common identifier components . . . 39
B.2 Identifiers . . . 40

List of Figures

1.1 UHF RFID Tag (image courtesy of Alien Technologies). 1
1.2 RFID Reader (image courtesy of ThingMagic). 2

2.1 Data and energy transfer in RFID operation (Roussos [2006]). 5
2.2 Memory contents of a RFID identifier tag. 7
2.3 Observation of a RFID identifier tag. 8
2.4 RFID data flow through the system layers. 9
2.5 Overview of the EPC Architecture Framework. 11
2.6 ONS resolver data flow (based on EPCglobal [2008c]). 13
2.7 Discovery using the link traversal approach. 13
2.8 Discovery using the directory approach. 14
2.9 Discovery driven by assertions. 15

3.1 Graph representation of a transoceanic supply chain. 17
3.2 EPCglobal core services for subscribers. 18
3.3 EPC supply chain. 19
3.4 RFID data discovery query space. 20

4.1 Fosstrak EPCIS architecture (http://www.fosstrak.org). 27
4.2 Discovery services based on a Blackboard. 28
4.3 Discovery services based on a Distributed Blackboard. 29
4.4 Generalized trust schema. 31
4.5 Global-scale discovery services based on a Massively Distributed Blackboard. . . 32