GS1 New Zealand

The Efficacy of Using the EPCglobal Network for Livestock Traceability: A Proof of Concept

Gary Hartley and Dr Erik Sundermann

June 2010

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Executive Summary

Radio Frequency Identification (RFID) systems have been used for a number of years in identification applications ranging from library books to pallets of kiwifruit. RFID tags have been used in animal applications since the late 1980's and the low frequency system was standardised in 1994-6. RFID rumen bolus and ear tag technologies are widely used for livestock management and inventory and are mandated in some parts of the world for animal traceability and biosecurity.

Ultra-high frequency (UHF) technologies were standardised more recently (circa 2003-2009) and have been widely adopted in many industries worldwide. The joint GS1 New Zealand / ANZCO Foods Proof of Concept (POC) described in the case study builds on the work completed by the New Zealand RFID Pathfinder Group Incorporated (Pathfinder) in 2008[1] and Rezare Systems (Rezare) in 2009[2] and 2010[3]. In both these trials, the scope was to assess the utility and efficacy of commercially available UHF RFID ear tags and readers when used in various simulated on-farm scenarios using various sized mobs of sheep, cattle and deer.

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Prompted by their constituents and by their own concerns about safety, government legislators in Europe and in the United States have been drafting laws requiring various degrees of traceability, especially in the food industry. These new regulatory requirements are creating more demand for traceability than ever before. Companies need systems that can provide end-to-end traceability, with accurate information and precise identification of the products and services, locations and actors involved.

The ability to track and trace goods and information and be able to quickly respond to market needs is the key to successfully and efficiently managing today's logistics supply chain. Manufacturers, processors, logistics providers and retailers are facing a multitude of new challenges including more stringent expectations for quality and safety from consumers and increased demand from regulators to respond quickly and efficiently to any question about any ingredient of any product. Increasingly, open, globally standardised systems that enable efficient and accurate traceability for food are being investigated to address these requirements. The EPCglobal Network is being used in many industries worldwide to provide robust traceability.

The EPCglobal Network is a secure means to connect servers containing information related to items identified by using globally unique numbers known as EPC (electronic product code) numbers. The servers, called EPC Information Servers or EPC-IS are linked via a set of standards based network services and the internet. The GS1 New Zealand POC sought to assess the utility of using the EPCglobal Network and the associated suite of EPC standards as a traceability system using commercially available UHF RFID ear tags and readers on a small herd of cattle.

The POC confirmed that the EPCglobal Network can be used effectively as a traceability system for the movement of cattle from an on-farm environment (where standard handling operations were performed for restrained or single file moving animals) to a suburban retail outlet.

1. The New Zealand RFID Pathfinder Group. The *Use of UHF RFID Ear Tags on Livestock.* 2008. www.rfid-pathfinder.org.nz
2. Rezare Systems Limited. *The Use of UHF RFID on Livestock*. www.rfid-pathfinder.org.nz. 2009.
3. Rezare Systems Limited. *The Use of UHF RFID on Livestock*. www.rfid-pathfinder.org.nz. 2010.

This POC report should be read in conjunction with the report published by Rezare Systems, a project partner involved in specific parts of this assignment. Rezare's report will outline specific details on the tags and readers used and performance outcomes.

We acknowledge with gratitude the substantial assistance of project partners ANZCO Foods Limited, Rezare Systems Limited, Invengo (China), GS1 Hong Kong and Sedna Systems (Hong Kong) who provided invaluable practical and technical assistance.

Introduction

In 2008 the Pathfinder Group undertook a trial of EPC Gen 2 UHF technologies for animal identification showing promising results. A follow up trail was undertaken by Rezare Systems Limited in 2009 using commercially available UHF ear tags sourced from China and a selection of off-the-shelf RFID readers and antennas. The Rezare trail established key findings, including:

- that commercially available Gen 2 UHF ear tags can be used effectively in a farm environment, performing standard animal handling operations for restrained or single file moving animals to the same standard as LF tags or better.
- that while the tags used performed suitably well in terms of readability on all species tested, the form factor (size and design in particular) was sub optimal for New Zealand industry requirements.
- organisations seeking (or developing) animal management and traceability solutions to consider applications of the technology
- including making provision for an EPC identifier field in database design.

In early 2010, Rezare secured funding from New Zealand Trade and Enterprise (NZTE) to extend their 2009 trials to focus on the utility of Gen 2 UHF ear tags when livestock (cattle and sheep) is transported from an on-farm environment to a meat processor. Earlier trials were confined to an on-farm assessment only. However, in collaboration with Rezare, (acknowledging conclusion # 2 of their 2010 report), GS1 and ANZCO Foods sought to examine the efficacy of using the EPCglobal Network in the project to demonstrate farm to retailer traceability. EPC identifiers were assigned for both animals and physical locations and nine (9) separate read points were identified in the supply chain from on-farm to retailer.

The proof of concept took place in April, 2010 at the CMP Canterbury Ashburton processing plant using a mob of ten (10) cows sourced from a proximate ANZCO farming unit.

Methodology

Our analysis focused on cattle only, with a sample size of ten (10) animals.

The proof of concept was designed to assess one primary outcome, namely to assess the efficacy and utility of using the EPCglobal Network (and associated standards) as a traceability system within a livestock supply chain. The process flow involved a nine (9) step process flow where RFID tags were read as either animal ear tags (SGTIN - on whole cattle, SSCC – on carcasses) or carton tags (SGTIN for finished product). Each tag read location was also assigned with a pre-allocated serialised location identifier (SGLN).

In preparation for the POC, GS1 New Zealand collaborated with GS1 Hong Kong to access and utilise their EPC-IS implementation - *EzTrack*. EPC Middleware was supplied and supported by Hong Kong based *Sedna Systems*. The process flow, having been identified was provided to all three POC stakeholders and included the following:

- Process Step
- Identifiers used (Whole animal, carcasses, cartons) Process Step (Location)
- Business Location
- Business Step

Fig: 1 - The Process Flow

Read Number	Process Step, Identifier and Hardware	Process Image
1	**Tagging the animal on farm** EPC Identifier (Cattle) – SGTIN EPC Identifier (Farm Tagging Station) – SGLN Reader – Tracient Padl UHF (Handheld) Tag Read Performance – 100% Business Step – Commissioning	
2	**Animal leaves farm on truck** EPC Identifier (Cattle) - SGTIN EPC Identifier (Farm Race) - SGLN Reader – Intermec (Fixed) Tag Read Performance – 100% Business Step – Loading	
3	**Animal arrives at processor holding yards** EPC Identifier (Cattle) - SGTIN EPC Identifier (Processor Race) – SGLN Reader – Motorola XR-450 (Fixed) Tag Read Performance – <100% Business Step – Receiving	
4	**Animal arrives at stun box** EPC Identifier (Cattle) - SGTIN EPC Identifier (Processor Stun Box) – SGLN Reader – Convergence Systems CS203 (Fixed) Tag Read Performance – 100% Business Step - Transforming	

5	**Carcass stored in Chiller Room** EPC Identifier (Carcass) - SSCC EPC Identifier (Processor Chiller Room) – SGLN Reader – Motorola XR-450 (Fixed) Tag Read Performance – 100% Business Step – Commissioning	
6	**Carcass moved to boning room** EPC Identifier (Carcass) - SSCC EPC Identifier (Processor Boning Room) – SGLN Reader – Motorola XR-450 (Fixed) Tag Read Performance – 100% Business Step – Transforming	
7	**Finished cuts packed into cartons** EPC Identifier (Cartoned meat) - SGTIN EPC Identifier (Processor Packing Line) – SGLN Reader – Motorola XR-450 (Fixed) Tag Read Performance – 100% Business Step – Commissioning	
8	**Loading cartons in shipping container** EPC Identifier (Cartoned meat) - SGTIN EPC Identifier (Processor Dock Door) – SGLN Reader – Motorola XR-450 (Fixed) Tag Read Performance – 100% Business Step - Shipping	
9	**Cartons received at retailer** EPC Identifier (Cartoned meat) - SGTIN EPC Identifier (Retailer Dock Door) – SGLN Reader – Tracient Padl (Handheld) Tag Read Performance – 100% Business Step - Receiving	

Traceability using the EPC-IS

The following screen illustrations outline the information captured in the EPC-IS from tag data from one 'Parent Animal EPC'. The Information captured includes the **unique identifier used** (SGTIN, SSCC), at a given business step, the event **location** (SGLN), the **business step** (Commission, Delete etc) and the **event time**.

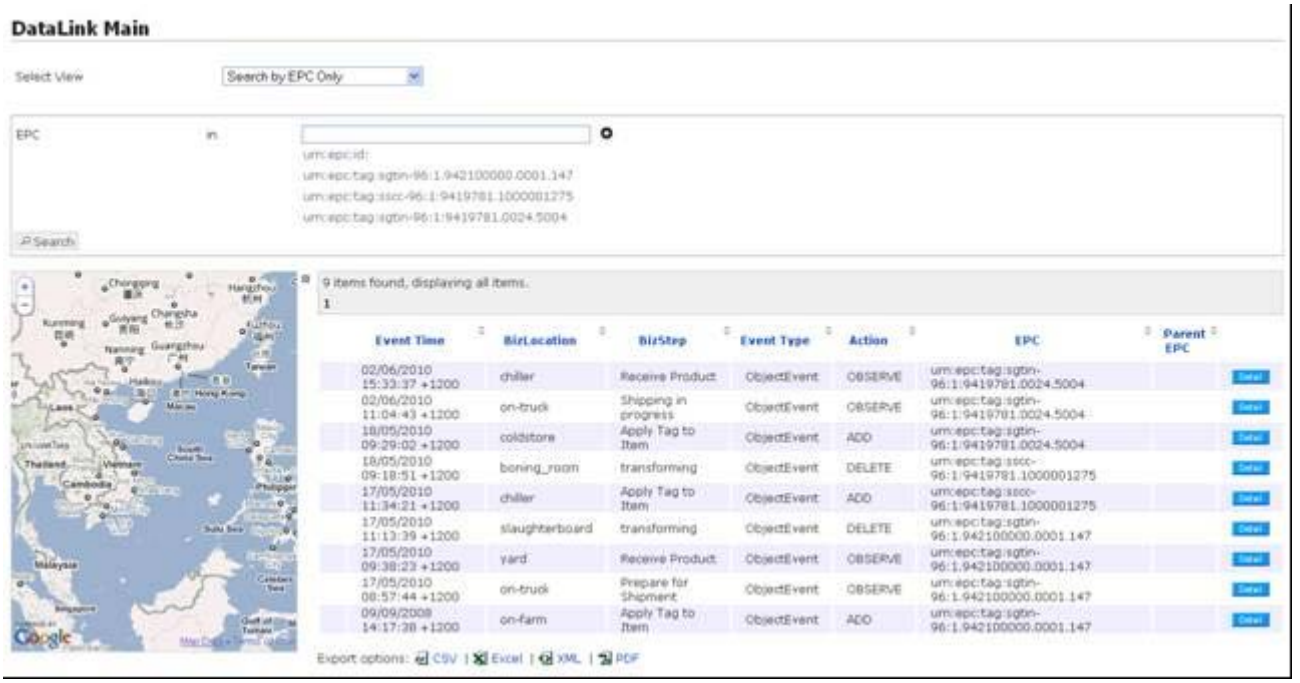
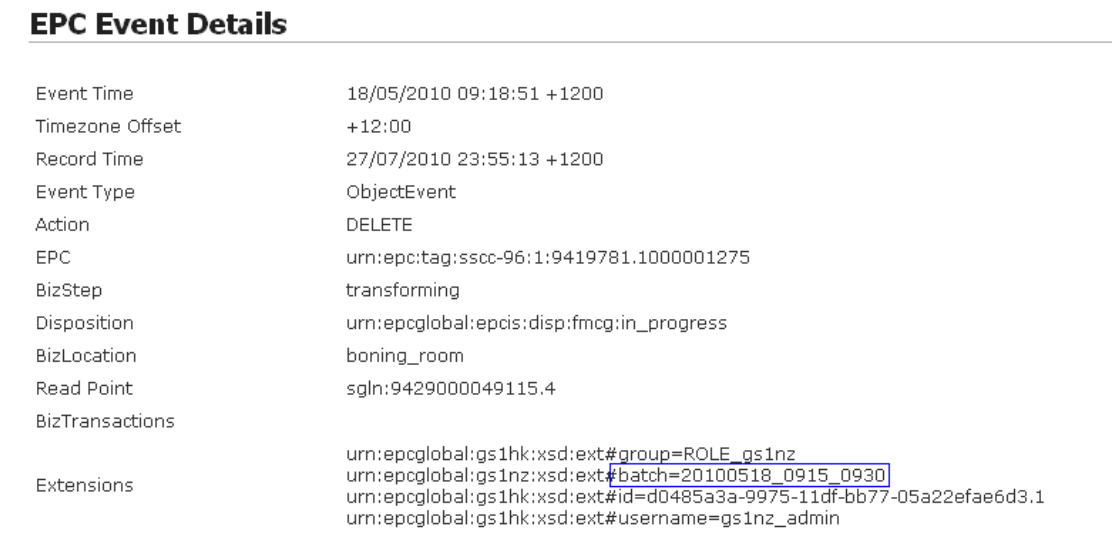


Fig: 2 – Screen capture of EPC reads at identified business steps, locations and observation time 's'. The three (3) EPC numbers correspond to a carton, a carcass and an animal. The chain of traceability that links these 3 objects together will be illustrated through the next 3 screenshots from finished carton to carcass to animal (ie: backward traceability).

EPC Event Details

Event Time	18/05/2010 09:29:02 +1200
Timezone Offset	+12:00
Record Time	27/07/2010 23:58:22 +1200
Event Type	ObjectEvent
Action	ADD
EPC	urn:epc:tag:sgtin-96:1:9419781.0024.5004
BizStep	urn:epcglobal:epcis:bizstep:fmcg:commissioning
Disposition	urn:epcglobal:epcis:disp:fmcg:active
BizLocation	coldstore
Read Point	sgln:9429000049115.5
BizTransactions	
Extensions	urn:epcglobal:gs1hk:xsd:ext#group=ROLE_gs1nz urn:epcglobal:gs1nz:xsd:ext#batch=20100518_0915_0930 urn:epcglobal:gs1hk:xsd:ext#id=40d1678b-9976-11df-bb77-05a22efae6d3.1 urn:epcglobal:gs1hk:xsd:ext#username=gs1nz_admin

Fig: 3 – Identification of a **Carton of Cuts** (SGTIN) going into the **Cold Store** (SGLN – Read Point) at specified time. This event corresponds to the creation of the carton; the highlighted extension field specifies that this carton was part of a (virtual) batch, i.e. all cartons that were produced in a 15 minute window (on the 18th May 2010, between 9:15 and 9:30).



EPC Event Details

Event Time	18/05/2010 09:18:51 +1200
Timezone Offset	+12:00
Record Time	27/07/2010 23:55:13 +1200
Event Type	ObjectEvent
Action	DELETE
EPC	urn:epc:tag:sscc-96:1:9419781.1000001275
BizStep	transforming
Disposition	urn:epcglobal:epcis:disp:fmcg:in_progress
BizLocation	boning_room
Read Point	sgln:9429000049115.4
BizTransactions	
Extensions	urn:epcglobal:gs1hk:xsd:ext#group=ROLE_gs1nz urn:epcglobal:gs1nz:xsd:ext#batch=20100518_0915_0930 urn:epcglobal:gs1hk:xsd:ext#id=d0485a3a-9975-11df-bb77-05a22efae6d3.1 urn:epcglobal:gs1hk:xsd:ext#username=gs1nz_admin

Fig: 4 – Identification of a **Carcass** (SSCC-96) going into the **Boning Room** (SGLN – Read Point) at specified time. This event occurs just prior to cutting the carcass into pieces inside the boning room; the highlighted extension field specifies that this carton was part of the same (virtual) batch as the carton, and that therefore meat inside the carton could have come from this carcass.

EPC Event Details

Event Time	17/05/2010 11:34:21 +1200
Timezone Offset	+12:00
Record Time	27/07/2010 23:50:50 +1200
Event Type	ObjectEvent
Action	ADD
EPC	urn:epc:tag:sscc-96:1:9419781.1000001275
BizStep	urn:epcglobal:epcis:bizstep:fmcg:commissioning
Disposition	urn:epcglobal:epcis:disp:fmcg:active
BizLocation	chiller
Read Point	sgln:9429000049115.3
BizTransactions	
Extensions	urn:epcglobal:gs1nz:xsd:ext#source=urn:epc:tag:sgtin-96:1.942100000.0001.147 urn:epcglobal:gs1hk:xsd:ext#group=ROLE_gs1nz urn:epcglobal:gs1hk:xsd:ext#id=339748c0-9975-11df-bb77-05a22efae6d3.1 urn:epcglobal:gs1hk:xsd:ext#username=gs1nz_admin

Fig: 5 – Identification of a **Carcass** (SSCC-96) going into **Chiller Room** (SGLN – Read Point) at specified time. This event corresponds to the creation (i.e. labeling) of the carcass; the highlighted extension field points to the source (i.e. the animal ID) of the carcass.

Conclusions and Recommendations

- Within the context of farming related applications for UHF RFID, research and field trails in New Zealand especially, have focused on the efficacy of using EPC Gen 2 UHF RFID ear tags with livestock in on-farm or farming environments. The results of these trails have been published widely. To the author's knowledge, there has been little if any investigation into the efficacy of using the EPCglobal Network and the EPC-IS component of the Network in particular as a tool to enhance supply chain visibility and establish traceability.

- While this POC did not focus on tag performance, it is important to note that the tags used in this study performed well thereby allowing for the accurate reading and recording of tag data.

- All tag data was successfully captured and recorded at each read/event point and successfully transmitted in XML format using commercially available EPC middleware (Sedna Systems) to GS1 Hong Kong's EPC-IS server.

- The tag data was not transmitted to the EPC-IS server in real-time but was batch uploaded within a few hours of the reads/ events. Batch uploading would not compromise traceability. Because each EPC identifier used in the POC (SGTIN, SGLN, SSCC) is able to be queried and reported on using the EPC-IS (and is time stamped) - traceability is accomplished.

- While the POC focused on the use of the EPC-IS in a primary/rural related setting, the authors are confident that the EPC-IS can be successfully in other applications.

- The authors encourage further research in other sectors and environments to corroborate the findings of this proof of concept.

Glossary and Definitions

- **EPC – Electronic Product Code**

  The **Electronic Product Code** (**EPC**) is a family of coding schemes created as an eventual successor to the barcode. The EPC was created as a low-cost method of tracking goods using radio-frequency identification technology. It is designed to meet the needs of various industries, while guaranteeing uniqueness for all EPC-compliant tags. EPC tags were designed to identify each item manufactured, as opposed to just the manufacturer and class of products, as bar codes do today. The EPC accommodates existing coding schemes and defines new schemes where necessary.

- **EPCglobal Network**

  A global standard system that combines radio frequency identification (RFID) technology, existing communications network infrastructure and the Electronic Product Code (a number for uniquely identifying an item). The network manages dynamic information that is specific to variable for individual products. This includes data regarding the movement of an object throughout the product life cycle.

- **EPC-IS – The Electronic Product Code Information Service**

  The (EPCIS) is a standard designed to enable EPC-related data sharing within and across enterprises. This data sharing is aimed to enable all network participants a common view of object information. At the EPCIS each company designated who has access to its dynamic information.

- **SGLN - Serialised Global Location Number**

  The Global Location Number (GLN) is part of the GS1 systems of standards. It is a simple tool used to identify a location and can identify locations uniquely where required. The GS1 Identification Key used to identify physical locations or legal entities. The key comprises a GS1 Company Prefix, Location Reference, and Check Digit. GLN's can be serialised to provide for multiple locations within an entity ie: a department within a processing plant.

- **SGTIN - Serialised Global Trade Item Number**

  The Global Trade Item Number GTIN is an "umbrella" term used to describe the entire family of GS1 data structures for **trade items** (products and services) identification.

- **SSCC - Serialised Shipping Container Number**

  The **Serial Shipping Container Code** (SSCC) is an eighteen digit number used to identify logistics units. The SSCC is encoded in a barcode, generally GS1-128, an EPC RFID tag and used in electronic commerce transactions. The SSCC comprises an extension digit, a GS1 company prefix, a serial reference, and a check digit.

The EPCglobal Network

The **EPCglobal Network** is a computer network used to share product data between trading partners. It was created by EPCglobal. The basis for the information flow in the network is the Electronic Product Code (EPC) of each product which is stored on an RFID tag. The network manages dynamic information that is specific to variable for individual products. This includes data regarding the movement of an object throughout the product life cycle. The EPCglobal Network consists of the following components:

- Object Naming Service (ONS)
- EPC Discovery Services
- EPC Information Services (EPCIS)
- EPC Security Services

The **ONS** is a service that enables the discovery of object information on the basis of an EPC. With the Electronic Product Code a matched URL or IP-address is searched within a data base and sent back to the requester when found. Under the URL further information about the object which is associated with the EPC can be found. The ONS is comparable to the Domain Name System which is used in the internet to translate names into IP addresses.

The **Discovery Services** are an instrument to find EPC Information Services within the network. They can be compared to search engines of the internet. They offer trading partners the ability to find all parties who had possession of a given product and to share RFID events about that product.

The **(EPCIS)** is a standard designed to enable EPC-related data sharing within and across enterprises. This data sharing is aimed to enable all network participants a common view of object information. At the EPCIS each company designated who has access to its dynamic information.

The **EPC Security Services** are tools which allow a secured access to the information of the EPCglobal network in accordance to the access rights of the participants.

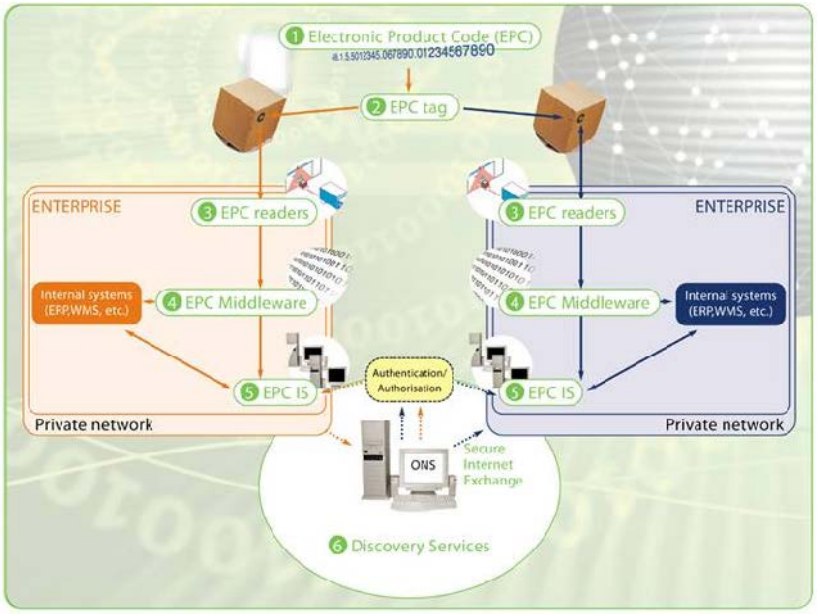


Fig: 6 – The EPCglobal Network Architecture

Acknowledgements

GS1 New Zealand would like to acknowledge to generous support provided by the following organisations in undertaking this proof of concept.

GS1 New Zealand
P O Box 11110
Wellington I New Zealand
T 64 4 494 1050
F 64 4 494 1051
info@gs1nz.org
www.gs1nz.org