Response to: National Animal Identification and Tracing
Enhancing New Zealand’s animal identification and tracing systems

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Executive Summary

GS1 New Zealand is the member organisation of GS1, the world’s largest standards organisation involved in the identification of items, entities and products and their traceability in global supply chains. Globally, GS1 has almost 2 million corporate members; in New Zealand our membership totals 4800 companies, organisations and individuals. GS1 New Zealand is a non-profit, Incorporated Society owned and governed by its members and thus has a non-commercial interest in this topic.

GS1 New Zealand’s base premise in this submission is that the discussion document issued by NAIT only is concerned with the identification & traceability of animals to the processing plant rather than viewing animal identification as a key part of an continuous supply chain that starts with an animal and ends with the consumer, often on the other side of the world.

Increasingly, in an era of food scares and increasing demands by trading partners for traceability information, authentication and risk mitigation, such a NZ-centric view focusing on only a portion of the supply chain is limiting and possibly out-of-step with the demands of NZ Inc’s global customers.

A holistic, supply-chain centric view, if accepted, has implications for what NAIT proposes in the discussion document.

GS1 submits that New Zealand’s livestock industry’s ability to serve its global customers would be enhanced by a commitment to globally-standardised, interoperable identification and traceability systems based on globally-standardised RFID hardware, software and identification keys. Additionally, there is high utility in utilising, for livestock identification, data structures and RFID components (software, hardware) that are consistent and able to be ‘understood’ by downstream supply chain partners such as processors, exporters, transportation providers, importers and retailers.

We submit that it is essential for ‘New Zealand Inc’ to use global tools for a global requirement. New Zealand Inc; cannot and must not ignore the stringent requirement for global interoperability and traceability, and must not adopt technologies, numbering structures and network systems that will be orphaned or superseded by new and emerging opportunities.

Our submission promotes that the NAIT solution:

- Use interoperable, non-sector based globally standardised unique identifiers that transcend all industry sectors and is capable of linking the whole supply chain from birth farm to retail outlet.
- Enables tracking, tracing and visibility of movements by individual animals and/or mobs and of relating movements to each other and to locations or entities.
- Utilises EPC UHF compliant RFID components and technologies in preference to LF technologies to ensure wider, faster, cheaper adoption with extended application opportunities beyond livestock Identification.
- Facilitates vendor competition to stimulate product innovation, market-driven pricing and to minimise or eliminate the possibility of vendor capture.
- Is future-proofed as much as is practically foreseeable to take advantage of innovation in emerging RFID UHF and other technologies.
Requirements of a Robust Animal Identification & Traceability System

A robust animal identification/traceability system should rely on three components:

- A **numbering system** (i.e. identifiers encoded on in/on a data carrier) with global uniqueness and global interoperability throughout all supply chains irrespective of sector or industry.
- A **data carrier** (within the context of this submission, a RFID tag) that is globally standardised and fit-for-purpose.
- An **information system** (containing any amount of relevant information on the tagged animal, its location, its providence etc.).

Ideally these components should be *separate* but *interoperable*, allowing the greatest flexibility by all supply chain users. This ensures that the identifier can be encoded into a range of different vendor’s data carriers; different data carriers can ‘talk’ to a range of different vendor’s standards-compliant readers and a range of different softwares can be used as they read standard identifier information so that the identification can be read by RFID readers connected with whatever body administers the identification protocols. The standards adopted should support all links of the ‘farm to fork’ supply chain and be supported by competing commercial vendors each of whom conforms to a neutrally administered suite of global standards.

Historically, animal identification and associated information systems in use internationally have been designed and implemented at a sectoral level (cattle, deer, pigs) *within* a nation state to match the requirements of in-country and predominantly on-farm participants (or the industry’s regulator). These systems (e.g. Australia’s) were implemented with a brief (and supporting data structures/standards) focused on identifying the animal on-farm and to the processor. The fact that identification systems/standards used from the processor down the supply chain to the market were different and not consistent was not a concern. In effect, the supply chain was viewed as being in two halves, with the link between the two being the processor.

As supply chains become increasingly more interconnected and global, the need for supply chain interoperability and visibility has become a key business driver. It has been realised that sector-based or even in-country numbering and identification systems, infrastructure and data networks thwart interoperability, compromise information integrity leading to unnecessary risk and redundancy in data networks, while eroding the opportunities offered to users by economies of scale, supply and demand and hence competitive price advantages.

Whilst such sector-based systems may indeed deliver customised solutions to a particular industry’s need, such systems provide significant barriers to the facilitation of interoperability between industry sectors and/or nations. In addition, vendors of sector specific systems and infrastructure clearly have strongly vested interests in keeping components of their solution sector proprietary. Supplier ‘lock-in’ or capture is a predictable, often costly, result especially for all trading partners.

Food safety scares and consumer concerns about the origins of their food have driven both regulators and in-market players (esp. retailers) to ramp up traceability requirements on their suppliers – often requiring detailed information to be delivered to them in parallel with the product. The scenario of the smiling faces of the Kiwi farmers who grew the apples bought in Waitrose, or the animal ID printed on pack of
lamb chops or beef steak sold in a Korean retailer is no longer speculative but a reality.

Figure 1 illustrates that effective traceability relies on robust interoperable data exchange between all trading partners in the supply chain and not confined to discrete sectors within a supply chain. Implicitly, barriers to interoperability stifle opportunity while introducing unnecessary risk and cost through data inaccuracies and supply chain inefficiencies.

Fig: 1 Effective traceability systems use global, non-sectoral, interoperable UID standards.

Demands for Traceability

From 2005 both the EU and US regulators have required traceability systems for all food & feed sold or moved in their jurisdictions.

European Union Regulation 178/2002 effective 1 January 2005 requires all food products in the EU to be traceable back to the supplier and provides that “…where an “incident or crisis” occurs all food in the “batch, lot or consignment (shall be presumed to be) also unsafe unless following a detailed assessment there is no evidence that the rest of the batch lot or consignment is unsafe” (Article 14). Similar provisions exist in section 306 of the US Bioterrorism Act 2002.

The importance of these provisions cannot be overstated. They mean that if a single “incident or crisis” occurred involving a carton or carcass of New Zealand meat then all meat from the processor concerned, and possibly from the whole country, may be excluded from the market involved unless it is possible to affirmatively prove that all other meat comes from sources that can be proved to be safe from whatever had caused the “incident or crisis.” A robust traceability system that could be linked to locations is the only way this could be achieved.
It is clear that the trend internationally is towards full traceability for animals, feed and food. GS1 would suggest that to consider what is happening with live animals only – as is currently the scope of NAIT, risks disregard developments in the post-slaughter and customer’s supply chain that will inevitably impact the abattoir and upstream.

CIES – (Comité International d’Entreprises à Succursales), the independent global Food Business Forum is a global leader on international traceability specifically in relation to food and food products moving through global supply chains. CIES recommend that the “application of EAN.UCC [GS1] standards is a **prerequisite** for the alignment of global traceability systems”. CIES further recommend that companies that implement collaborative best practices and standards should encourage their partners to do the same thing.

The GS1 system is a mature, open and truly global system, operated on a non-commercial, by-industry-for-industry basis and provides:

- **Numbering systems and standards** – guaranteeing global uniqueness and sector interoperability for animals, products, assets, locations and services.
- **Data carrier standards** – providing the means to transport identification numbers and facilitate automatic data capture throughout all supply chains (ie: EPC/RFID tags).
- **Infrastructural components** – providing standardised solutions for master item data capture, global item information repositories and a comprehensive suite of globally ubiquitous and standardised RFID hardware and software standards (incl: RFID readers, RFID tags, middleware etc).

For RFID, GS1’s suite of standards is based on the **Electronic Product Code** (EPC). EPC is widely recognised as the only globally standardised RFID solution for the future of interconnected supply chains irrespective of industry sector. This is why all the largest players in global trade are standardising on the EPC standards – Wal*Mart, Tesco, Metro AG, US Department of Defence, Proctor & Gamble, Nestle, Boeing etc. EPCglobal standards have become the world’s most widely used and implemented UHF RFID standards.
About GS1

GS1 New Zealand Inc; is the New Zealand member organisation of GS1, the international body that develops, promulgates and administers the global set of standards for identification and automatic data capture (ie: bar code and /or RFID). GS1 is a non-commercial organisation administered by elected boards representing user groups that transcends all major industries.

EPCglobal is a subsidiary of GS1 and leads the development of industry-driven standards for the Electronic Product Code™ (EPC) to support the use of Radio Frequency Identification (RFID) in today's fast-moving, information rich, trading networks.

EPCglobal is a subscriber-driven organisation comprised of industry leaders and organisations focused on creating global standards for the EPCglobal Network.

Within the context of this submission, the GS1 Standards discussed cover two separate but related areas:

- **Unique identification** of units using RFID data standards (namely, the Electronic Product Code – EPC), to capture UID’s of individual animals or mobs, locations, assets etc.
- **Standards for RFID data carriers and network infrastructure** – standardised EPC compliant UHF RFID hardware and software that enable the automatic reading and interpretation of common, interoperable supply chain information.
NAIT’s Proposed Standards

NAIT, in common with most countries that have introduced systems for tracking livestock, is proposing using long established ISO standards for animal identification. These standards, with their origins in the 1980s, are focussed on simply ‘getting’ an ID number off a RFID tag and were not designed with a supply chain (network) in mind.

We submit that these existing standards are not readily interoperable with the very well developed and proven system (GS1) that is already used for meat products between the abattoir and the retail outlet. Using one set of data standards and technologies on farm and another set post-slaughter introduces unnecessary complexity, risk expense and potential unreliability to the entire farm-to-plate system. There could also be a not insignificant impact on biosecurity and market access systems.

Our submission addresses these issues in three key areas as follows:

1. NAIT’s Proposed Data Standards
2. NAIT’s Proposed RFID Standards
3. Global Exchange of Traceability Data

The ‘NAIT Data’ Standards


A number of serious issues with these standards\(^3,4\) have been identified:

1. Inability to ensure unique ID codes.
2. Lack of manufacturers’ accountability despite audit requirements.
3. No minimum transponder performance is stipulated.

The proposed NAIT unique animal identification numbers are based on the International Committee for Animal Recording (ICAR) system. Clause 3.3 of the NAIT RFID Standard’s Specifications outlines that transponders included in a NAIT RFID device shall be encoded with the relevant manufacturer’s code granted by the International Committee on Animal Recording (ICAR). Whilst such systems may indeed deliver customised solutions to a particular industry’s needs, such systems provide significant barriers to the facilitation of interoperability between industry sectors and/or nations. In addition, vendors of sector specific systems clearly have strongly vested interests in keeping components of their solution proprietary. Supplier lock-in and capture is often the predictable, costly result for end-users in particular.

NZ/ISO 11785:2001 does not guarantee animal uniqueness\(^5\). The standard and associated protocols only provide a mechanism whereby countries and regulatory organisations, such as ICAR, can manage number uniqueness using a combination of country and manufacturer codes and database management - but not a guarantee.

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\(^2\) Provision Permanent Radio Frequency Identification Device Standard V: 5.5, March 2008

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An Alternative

CIES in “Implementing Traceability in the Food Chain” describes the potential impact of the implementation of a traceability system and provides recommendations. The recommendations highlight the components of such a system, the pitfalls when designing and implementing such a system and above all how to ensure that systems can be aligned along the food supply chain.

CIES identifies an underlying need to define the specific information elements that each sector of the food business must agree upon when designing functional robust traceability systems. At the heart of their recommendations is the requirement to share standardised information and identifiers between the different sectors in order to achieve supply chain traceability. CIES recommend that the application of GS1 standards is a prerequisite for the alignment of global traceability systems. CIES further recommend that companies that implement collaborative best practices and standards should encourage their partners to do the same thing.

GS1 New Zealand recommends that NAIT’s core identification data are based on globally unique identifiers that interoperate with all industry sectors and supply chains – and not just within a narrow segment of the livestock sector. Two identifiers are recommended:

1. **Global Location Numbers** (GLN) - As the name implies, the GLN is the GS1 identification key for locations. The GLN can be used to identify physical locations and legal entities where there is a need to retrieve pre-defined information to improve the efficiency of communication with the supply-chain.

   GLN’s have recently been assigned to every farm business in the United States and it is expected that approximately 5.5 million GLN’s will be assigned to U.S farms and farm supply businesses. The use of GLN’s will enable the U.S agriculture industry to establish a standardised means to identify farm locations and expand the use of electronic commerce to improve supply chain operations. The assignment of the GLN to each farm community is seen to establish and enable the groundwork for more detailed and visible tracking and traceability with the farming industry. The GLN can be utilised for tracking animal movement between locations as each location will have an assigned GLN. Coordinating the GLN with the unique animal identification provides for animal movement detection and recording.

2. **Global Trade Item Number** (GTIN) - As the name implies, the GTIN helps automate the trading process – basically buying and selling. GTINs are therefore assigned to any item that may be priced, or ordered, or invoiced at any point in any supply chain. The GTIN is then used to retrieve pre-defined information about the item. The key benefit is that information about the item can be retrieved about the product from the GTIN whether it is read in a GS1 Bar Code symbol, exchanged via an eCommerce message or when used on an EPC RFID tag.

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7 CIES – (Comité International d’Entreprises à Succursales), the independent global food business network.
8 Refer: Appendix 2, Page 21 - The Global Location Number (GLN) details.
10 Refer: Appendix 2, Page 21 - The Global Trade Item Number (GTIN) details.
The NAIT Proposed RFID Standards

Within the context of RFID, NAIT’s preference for animal tracing also concentrates on the ISO standards NZ/ISO11784:2001 and NZ/ISO11785:2001. These NZ standards are, in turn, based on ISO 11784 & ISO 11785:1996. There is nothing in these standards that renders them the only ones or necessarily the best ones to consider. Indeed, there appears to be widespread and well documented international concern over the efficacy of these standards for traceability of food and food products in particular.\(^{11,12}\)

Since these two ISO standards were written, another suite of RFID standards based on Ultra High Frequency (UHF) RFID and the \textit{Electronic Product Code} (EPC) has been developed. These standards are being specified for use in the FMCG industry especially and is currently being used by several global level players including Wal*Mart, Tesco, Proctor and Gamble, Boeing, US Department of Defense and others. As business cases and ROI are being identified within non FMCG sectors however, implementations are becoming increasingly more prevalent both nationally and internationally.

EPC compliant UHF RFID technology performs exceptionally well with livestock. The New Zealand RFID Pathfinder Group Incorporated\(^{13}\) (Pathfinder) has recently conducted research using EPC UHF RFID compliant readers, tags and software on deer, cattle and sheep in New Zealand. Using NAIT compliant (ie: size and retention) RFID ear tags, the results confirmed conclusively that the EPC compliant UHF RFID technology works with exceptional performance on livestock and offers the livestock industry many other benefits over the NAIT proposed low frequency (LF) solution.\(^{14}\)

The Pathfinder report identifies a number of key benefits that would accrue to the New Zealand livestock sector when utilising EPC UHF RFID technology over LF RFID including:

- Wider, longer read performance.
- Faster read performance.
- Less infrastructure is required with lower implementation cost.
- Ability to read many tags simultaneously or singularly as required.
- Performs better in RFID ‘noisy’ environments (ie: electric motors etc) than LF options.
- Standardised EPC RFID protocols providing end-to-end supply chain interoperability irrespective of industry sector or country.
- Accommodates globally standardised identifiers for use in any supply chain world-wide irrespective of industry sector or country.
- World-wide ubiquitous use providing economies of scale translating into significant price advantages over LF options.\(^{15}\)
- Continuous innovation and R&D investment at a global level into new and improved UHF performance and applications.
- Animal agnostic – will function at an exceptionally high performance on cattle, deer, sheep and others.

\(^{12}\) Refer Appendix 1, Page 17 – The Standards in Relation to Livestock.
\(^{13}\) The New Zealand RFID Pathfinder Group Incorporated – www.rfid-pathfinder.org.nz
\(^{15}\) Refer: Appendix 1, Page 20 – The Decreasing costs of UHF Technologies.

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Global Exchange of Traceability Data from NAIT’s Proposed Standards

As outlined above, NAIT largely considers that exchange of data outside NZ to supply chain participants, the buyers of produce or end consumers is out of scope.

However, as discussed above, this seems out of step with most industries are moving to build supply chain visibility and automated traceability systems – providing value for them and their customers. Below GS1 outlines what it believes is a viable alternative, available now and used across many sectors, that provides for standardised data moving through standardised hardware & software components.

**A Viable Alternative: Using Open, Global, RFID standards and infrastructure**

GS1 New Zealand contends that at the highest level the objective should be to establish a system that enables identification of animals - individually or by mob - and of locations and entities that enables the coordination of each against the other. Interested user groups will then be able to access and utilise common data as necessary for their purposes, which may differ from those of other users. This can be achieved through a framework that enables immediate, automatic identification and sharing of information on items in the supply chain and across supply chains. In this way, all organisations become more effective by enabling true visibility of information about items in the supply chain.

**An Interoperable Global RFID Network**

The term "Internet of Things" has come to describe a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical or animate objects. Technologies like RFID, short-range wireless communications, real-time localization and sensor networks are now becoming increasingly common, bringing the 'Internet of Things' into commercial use. They foreshadow an exciting future that closely interlinks the physical world and cyberspace - a development that is not only relevant to researchers, but to corporations, industry sectors and individuals alike.

Using a combination of open standards based technologies and harnessing the power of current information systems would provide NAIT with immediate, automatic and accurate identification and location of any item in the supply chain of any company, in any industry, anywhere in the world at any time. A globally standardised, sector agnostic network based on an open infrastructure to drive efficiencies and visibility into global supply chains while providing open, global solutions for traceability, counterfeit, theft and product diversion appears to align closely with NAIT objectives.

The concept of a network based on an open infrastructure using RFID, existing information systems and internet based technologies is a design conceived by the Auto-ID Center, a global research team directed through the Massachusetts Institute of Technology (MIT) with labs around the world. MIT’s research effort was supported by more than 100 leading companies globally. Companies, regulators and consumers are the ultimate beneficiaries of such a network as it enables organisations to be more efficient, flexible and responsive to the needs of regulators, consumers and trading partners.

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17 See Appendix 3, Page 26 - The Auto-ID Labs

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The Auto-ID Center’s concept of the ‘Internet of Things’ is a global reality. The heart of the ‘Network’ is the Electronic Product Code, the EPC Information Services and the Object Naming Service (ONS) (similar to the DNS of the Internet).

- **The Electronic Product Code - EPC** is an identification scheme for universally identifying physical objects via Radio Frequency Identification (RFID) tags and other means. The standardized EPC data consists of an EPC (or EPC Identifier) that uniquely identifies an individual object, as well as an optional Filter Value when judged to be necessary to enable effective and efficient reading of the EPC compliant tags.

- **The Object Naming Service (ONS)** specifies how a Domain Name System is used to locate authoritative metadata and services associated with the unique identifiers of item moving through a supply chain. The architecture is flexible to provide NAIT with its own managed, regulated and ‘fire-walled’ ONS ‘instance’. This means that NAIT would have the benefit of an existing, open, global, standardised network infrastructure managed by NAIT exclusively for NAIT and NAIT stakeholders.

- **EPC Information Services** is the standard that provides a common set of data elements, a common language for communication and a set of defined messages for trading partners to use for storing, accessing, and communicating data on objects moving in the supply chain. The key to these information services is the EPC held in the RFID tag on each object. EPC-IS middleware is standardised software technology that acts as the central nervous system of the EPCglobal Network. The EPC-IS middleware manages and moves information in a way that does not overload existing corporate and public networks.

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18 See Appendix 3, Page 26 - The Analogy Between The EPCglobal Network™ with the Internet’s Architecture.
Understanding the EPCglobal Network

The EPCglobal Network employs EPC and RFID technologies to deliver increased efficiency and accuracy through business automation. The network improves tracking, security, and collaboration by providing a standard framework for supply chain event information exchange. Because individual product units can be tracked precisely through the entire supply chain, the EPCglobal Network offers unprecedented opportunities for supply chain event management.

The EPCglobal Network manages RFID information in three key phases: Discovery, Storage, and Secure Access.

- **Discovery** - The ONS directs general requests for specific product information within the network. EPC Discovery Services manage partner specific EPC data, creating the ability to track and trace.

- **Storage** - EPC Information Services control the storage and retrieval of detailed product information on each unit as it travels through the supply chain.

- **Secure Access** - An EPC Security Framework authenticates user identities, controlling access, and ensuring sensitive information is delivered only to approved entities.
Building upon the EPC Tag Data Standard and the ISO/IEC/EPC standardised air interface protocols\textsuperscript{19}, the EPC network infrastructure consists of a number of roles and interfaces that are deployed within a company or organisation in order to process EPC RFID tags in an EPC-compliant way. The EPC Network\textsuperscript{20} specifications do not define the individual components, but rather roles and interfaces that must be implemented. These roles and interfaces are illustrated in the figure below.

Exchanging data over this open network allows everyone to access the information needed and to make decisions accordingly. No longer are important decisions about responding to supply chain exceptions made in the dark or left to trends and outdated information. This new ability for improved information sharing and decision making is the result of two fundamental capabilities that RFID brings to advanced supply chain management: “track” and “trace.”

- **Track** allows organisations to know where a product is at any given moment within the supply chain. Organisations have the ability to know when a product has been delivered to trading partners. Trading partners can better manage inventories and reduce the costs of maintaining large quantities of warehoused merchandise.

- **Trace** allows organisations to see exactly where a product has been throughout the entire supply chain process. Organisations get a big-picture view of how their items move through the supply chain, allowing them to determine where costly delays are taking place or where shrinkage may be occurring within the delivery process.

The fundamental information provided by track and trace regarding product location and movement can be applied to a wide array of business scenarios. Many leading supply chain organisations are beginning their exploration of the possibilities created by this new level of visibility into the supply chain. The result is that organisations are identifying a variety of real-world scenarios that can be addressed by the EPCglobal Network.

These include:

- **Chain of custody** - by identifying which trading partners were in possession of a shipment on its normal path, organisations can identify where losses are taking place, guiding important decisions on shipping and partner selection.

- **Proof of receipt** - the ability to track a product’s location enables a receiving organisation to establish proof of receipt as goods are scanned upon entering the building.

- **Inventory accuracy** - all trading partners can know exactly how much inventory they have at any given moment thereby streamlining the order process and re-order process.

- **Product conditions**—managing expired products and making product recalls/traceability become much easier and less costly as the exact products involved can be quickly identified and located. Additionally, physical conditions that impact product integrity, such as temperature, can be tracked and associated with individual products to ensure shipments are enjoying optimal conditions throughout the supply chain process.

\textsuperscript{19} ISO/IEC 18000-6:2004 - Information technology -- Radio frequency identification for item management -- Part 6: Parameters for air interface communications at 860 MHz to 960 MHz

\textsuperscript{20} See Appendix 3, Page 22 – Network Components
Conclusion

The GS1 System and suite of standards incorporating EPCglobal standards offers a full and proven range of global, sector agnostic, fully interoperable standards for identification, data capture and information networks. There are numerous demonstrable benefits for the New Zealand livestock industry in adopting GS1 standards.

The benefits in adopting EPC compliant UHF RFID technologies over LF will continue to increase as innovation in UHF technologies continues to evolve rapidly. LF technologies are considered to be stable and mature rendering any significant future technological innovation unlikely. There are a number of legitimate, very worthwhile potential uses for ISO 11784/85 transponders, however national animal registration databases relying on positive and unique identification is not one of them.

GS1 New Zealand Recommendations:

1. That NAIT adopt EPC compliant Ultra High Frequency (UHF) RFID technologies for livestock and abandon the proposed LF RFID solution and implicitly the use of NZ/ISO 11784:2001 standard outlined in the NAIT proposal.

2. That the sector specific animal identification numbering structure NZ/ISO 11785:2001 proposed by NAIT be abandoned in preference for the globally ubiquitous, supply chain agnostic standard offered by the GS1 EPCglobal suite of standards.

3. That the GS1 suite of identification standards specifically GTIN’s and GLN’s and the EPC be adopted to uniquely identify farms, entities, locations and assets.

4. That the NAIT proposed network infrastructure be reviewed against the GS1 suite of standards and networks outlined herein to determine the extent to which the standards could be integrated into NAIT architecture.

5. That GS1 New Zealand is included in the livestock industry dialogue on traceability and global RFID standards.
Appendix 1

The Standards in relation to Livestock

GS1 identification numbers and barcodes are already used on meat for retail and throughout the retail supply chain so their extension into the livestock environment would build on existing systems and competencies.

Means exist within the standards, because of their separation of data and data carriers to implement the system alongside legacy systems, either indefinitely or as part of a phased migration. This flexibility offers the additional benefit, where the use of any particular technology is not mandatory, that users can make their own decisions about technology – and therefore cost – while still complying with what may be mandated requirements for identification and traceability.

Different RFID Technologies

A number of frequencies are used for passive RFID: low frequency (LF), high frequency (HF) and ultra-high frequency (UHF). Each of these frequencies has different features and operating characteristics. We outline the two useable frequencies of relevance for livestock as follows:

**LF - low frequency** (125 and 134 kHz):
- Good penetration of water and body tissue.
- Reading range from a few centimetres to a few tens of centimetres (depending on transponder size and reader used).
- Susceptible to interference from electric motors.
- Transponders (tags) are typically more expensive (starting from around NZ$1).
- Low data transfer rates (the lower the frequency, the slower the communication).
- Most LF systems can only read one tag at a time and do not support simultaneous reading of multiple tags.
- 125 and 134.2 kHz are globally accepted frequencies – no restrictions.

**UHF - Ultra high frequency** (860 to 960 MHz):
- Relatively poor performance\(^\text{21}\) around water-based liquids (incl. body tissue).
- Excellent read distances (up to 5 metres).
- Tags are relatively cheap (starting around NZ$0.20).
- Very high data transfer rates.
- Readers can identify many tags simultaneously (typically hundreds of tags per second). High end systems can read thousands of tags.
- No single frequency across the globe; different regions have allocated different frequency bands in the 860–960 MHz band; region-specific restrictions With regard to maximum power level and communication protocol (frequency-hopping, LBT).

\(^{21}\) Advances in these technical challenges have been largely overcome in recent times.
NAIT’s Proposed ISO RFID Standards

These standards have been updated and expanded in ISO 14223/1 which regulates "advanced" transponders for animals, in an attempt to address the issues mentioned above (e.g. ID duplication) however there is doubt that these amendments have been functionally unsuccessful. 22 23

The Use of Ultra High Frequency (UHF) Technology for Livestock

The use of LF technology has a number of restrictions, mainly due to the limited read range and the inability to identify multiple tags simultaneously and difficulties in reading tags when animals are moving at high speed. This typically results in narrow read portals where animals need to be passed through one-at-a-time. Also, many breeders have voiced concerns over the costs of the tags and related other LF hardware.

Research undertaken by the University of Adelaide’s Auto-ID lab has been evaluating the use of UHF FRID in recent years using pigs. With increasing global standardisation of UHF technologies, the Auto-ID Labs investigated whether the use of UHF would allow production of low cost animal ID tags that would provide satisfactory performance. Satisfactory performance was defined as the ability to read tags and identify specific animals in a suitably confined area.

The Auto-ID researchers reported very favourable performance within the terms of their definition on the use of UHF ear tags on pigs. In summary, the report documented high confidence in the use of UHF on pigs for the future use in the livestock industry and commented that this is good news because the tags were easy and economical to construct. Since EPC Generation 2 chips are abundantly available, if RFID vendors manufacture tags based on the UHF prototype and standards, livestock producers should find it more economical to RFID-tag animals.

The Benefits of UHF over LF include:

- Allows for higher speed of animal movement
- Increased maximum reliable read range
- Increased maximum reliable read rate
- Identification of multiple animals simultaneously with standardized protocols
- Larger tag data storage capacity and thus more functionality if required
- Globally ubiquitous, transcends all industry supply chains
- Cost leadership and economies of scale

On analysis, these benefits mean that the use of UHF can reduce the complexity and/or the cost of existing read points (e.g. less antennas required to cover a wider area), but it can also enable new use cases for example the potential to use RFID across additional paddock gates for mustering in the field.

Features of the EPC UHF Gen 2 Tag Standard

The evolution of tag performance that has resulted in the EPC Generation 2 tag standard is the result of world-wide user defined business and tag performance requirements. The features are summarised as follows:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>EPC Gen2 Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Regulatory Compliance</td>
<td>Europe, North America, Japan, etc.</td>
</tr>
<tr>
<td>Operation in Noisy Environments</td>
<td>Multiple Sessions, Dense Reader Modes</td>
</tr>
<tr>
<td>Fast Operation</td>
<td>&gt; 1600 tags/sec USA, 600 tags/sec Europe</td>
</tr>
<tr>
<td>Privacy Protection</td>
<td>EPC code not broadcasted, 32-Bit Kill Password</td>
</tr>
<tr>
<td>Improved Accuracy</td>
<td>Elimination of “Ghost Reads”, Adaptive Protocols</td>
</tr>
<tr>
<td>Memory Write Capability</td>
<td>&gt; 7 tag/second write rate, Optional User Memory</td>
</tr>
<tr>
<td>Group Searches &amp; Filtering</td>
<td>Flexible Select Command</td>
</tr>
<tr>
<td>Low Cost</td>
<td>Multi-Vendor Availability</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Tolerates Identical EPC numbers &amp; Multiple EPCs</td>
</tr>
<tr>
<td>Certified products</td>
<td>Currently Available</td>
</tr>
</tbody>
</table>
The Decreasing Costs of UHF Technologies

- Globally, increasingly the prices of UHF EPC compliant RFID infrastructure are coming down. Because the standards for RFID tags and readers have been ratified, competition around the world among hardware manufactures is hotting up. Inevitably, the prices are being driven down. Currently, there are tag inlays available for under $0.12 (depending on volume) and there are RFID EPC compliant readers available now for under US$1000.00 – some 50% lower than in 2006.

- As more vendors enter the global RFID market and vendor consolidation continues globally, prices will continue to plummet for hardware. The same optimism cannot be expressed for the costs involved in LF technologies as the technology is mature and market static and any added value innovation is considered unlikely.

### Gen 2 Announcements
- $0.15 tag (RSI)
- $0.08 inlay (Avery)
- $0.09 inlay (Rafsec)
- $1000 reader (AWID)

### Gen 2 Certified Hardware
Examples:
- Alien Technology
- Applied Wireless Devices
- Impinj
- Intermec Technologies
- MaxID Group
- Symbol Technologies
- Thing Magic

---

![Graph: Downward trends in UHF hardware costs (tags and readers)](image)

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Appendix 2

The Global Location Number – GLN.

The GLN is constructed as follows:

<table>
<thead>
<tr>
<th>GS1 Company Prefix &gt;</th>
<th>&lt; Location</th>
<th>Check Digit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₁ N₂ N₃ N₄ N₅ N₆ N₇ N₈ N₉ N₁₀ N₁₁ N₁₂</td>
<td>N₁₃</td>
<td></td>
</tr>
</tbody>
</table>

GLN Extensions

Global Location Numbers may also use an optional extension component using the Application Identifier (254) to support is restricted for internal purposes. Although optional, when used AI (254) must be in conjunction with AI (414) Identification of a physical location and can be encoded using an EPC tag, a GS1-128 symbol or a GS1 DataBar symbol.

The Global Trade Item Number – GTIN.

The GTIN-13 data structure is constructed as follows:

<table>
<thead>
<tr>
<th>GS1 Company Prefix &gt;</th>
<th>&lt; Item Reference</th>
<th>Check Digit</th>
</tr>
</thead>
<tbody>
<tr>
<td>N₁ N₂ N₃ N₄ N₅ N₆ N₇ N₈ N₉ N₁₀ N₁₁ N₁₂</td>
<td>N₁₃</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3

The EPCglobal Network Suite of Standards

The EPCglobal Network Components

The EPCglobal Network consists of several components that are based on the Electronic Product Code (EPC), tags, readers, and software that helps all of the components communicate using a common “language.” The EPC sits on a tag comprised of a silicon chip connected to an antenna, which is physically attached to an item, a case of items, in an animal ear tag or a pallet of cases of items for example. The tag "communicates" its unique number to a RFID reader through radio waves. The reader then passes the number to a computer or local application system, known as the Object Name Service (ONS). The ONS ‘tells’ the computer systems where to locate information on the secure network about the object carrying an EPC, including, for example, when the item was first read, where it currently is and where it has been over a given period of time.

The Electronic Product Code (EPC) is a unique number that is used to identify a specific item in the supply chain. Much like a Global Trade Item Number (GTIN) or Vehicle Identification Number (VIN), the EPC is the key that unlocks the power of the information systems that are part of the EPCglobal Network.

EPC Information Services is the standard that provides a common set of data elements, a common language for communication and a set of defined messages for trading partners to use for storing, accessing, and communicating data on objects moving in the supply chain. The key to these information services is the EPC held in the RFID tag on each object. EPC-IS middleware is standardised software technology that acts as the central nervous system of the EPCglobal Network. The EPC-IS middleware manages and moves information in a way that does not overload existing corporate and public networks.

The EPCglobal Network is extendable and adaptable to provide for a dedicated secure, confidential ‘instance’ of the network architecture to be managed and regulated by a governing body (such as NAIT or its agents for example) to attain the traceability, biosecurity, market access and supply chain visibility objectives outlined in the NAIT discussion document.

Importantly, the network allows trading partners to exchange such information about the goods they ship among themselves. In that way, the EPCglobal Network™ makes organisations more effective by uncovering inefficiencies or reducing such eternal issues as counterfeiting, internal theft, and other drains on productivity and profitability. The EPCglobal Network provides end-to-end traceability and is being used and considered by a number of jurisdictions around the world for the potential this solution promises - (eg: US FDA, EU).

If a system is adopted that is capable of meeting the worst case scenario it need not be fully rolled out at the outset as long as it is scaleable. The EPCglobal Network can be developed incrementally.
With the international trend towards full traceability for live animals, GS1 recommends consideration be given to the needs of supply chain partners (both known and unknown) in the slaughter and post-slaughter supply chain as this will inevitably impact the abattoir and upstream and the ability to provide immediate responses to incidents and alerts.

European Union Regulation 178/2002 effective 1 January 2005 requires all food products in the EU to be traceable back to the supplier and provides that “…where an "incident or crisis" occurs all food in the “batch, lot or consignment (shall be presumed to be) also unsafe unless following a detailed assessment there is no evidence that the rest of the batch lot or consignment is unsafe” (Article 14).

Similar provisions exist in section 306 of the US Bioterrorism Act 2002. The importance of these provisions cannot be overstated. They mean that if a single “incident or crisis” occurred involving a carton or carcass of NZ meat then all meat from the processor concerned, and possibly from the whole country, may be excluded from the market involved unless it is possible to affirmatively prove that all other meat comes from sources that can be proved to be safe from whatever had caused the “incident or crisis.” A robust, fully interoperable traceability system that could be linked to locations is the only way this could be achieved.

GS1 is the largest player in the global retail environment and supply chain and has produced guidelines for the identification and bar coding of food products including meat, to address the European and US requirements. These guidelines assume that the traceability to the abattoir that they enable will also be possible between the abattoir and the farm, a channel in which the GS1 EPCglobal system, although applicable, is not generally used. If traceability upstream from the abattoir is not possible then traceability from retail to abattoir offers producers little protection. Rather it serves to the finger of suspicion at all of the producers whose animals were processed at the abattoir identified. Protection requires accurate identification in abattoir records, linked with full and useful data about animal’s movements and locations prior to slaughter, so that the individual source/s with the problems can be separated from those that are free of them.

**The Electronic Product Code - EPC**

The Electronic Product Code (EPC) is an identification scheme for universally identifying physical objects via Radio Frequency Identification (RFID) tags and other means. The standardized EPC data consists of an EPC (or EPC Identifier) that uniquely identifies an individual object, as well as an optional Filter Value when judged to be necessary to enable effective and efficient reading of the EPC compliant tags.

**ID System (RFID Tags and Readers)**

The ID System consists of EPC tags and EPC readers. EPC tags are RFID devices that consist of a microchip and an antenna attached to a substrate. The EPC is stored on this tag, which is applied to cases, pallets and/or items. EPC tags communicate their EPCs to EPC readers using Radio Frequency Identification. EPC readers communicate with EPC tags via radio waves and deliver information to local business information systems using EPC middleware.
EPC Middleware

EPC middleware manages real-time read events and information, provides alerts, and manages the basic read information for communication to EPC Information Services as well as a company’s other existing information systems. EPCglobal is developing a software interface standard for services enabling data exchange between an EPC reader or network of readers and information systems.

Discovery Services

A suite of services that enable users to find data related to a specific EPC and to request access to that data. Object Naming Service (ONS) is one component of Discovery Services.

EPC Information Services (EPC IS)

Enables users to exchange EPC-related data with trading partners through the EPCglobal Network. Leveraging this technology, the EPCglobal Network will enable trading partners to minimize shrinkage and shortages, accelerate order processing and increase responsiveness to consumer demand by enabling real-time information about goods in their supply chain. In addition, it will provide increased efficiency in handling physical goods during processes such as receiving, counting, sorting and shipping. Security is an important part of the EPCglobal Network. The EPCglobal Network uses industry recognized best practices to protect its data. In addition, the EPCglobal Network functions like an extranet with a federated data model. Data lives both behind a Subscriber company’s firewall and is only referenced by the data registry system at EPCglobal.
EPC Tag Data Standards

This standard defines standardised EPC tag data, including how it is encoded on the tag and how it is encoded for use in the information systems layers of the EPC Systems Network.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GTIN</td>
<td>Global Trade Item Number, (here, a serialized version)</td>
</tr>
<tr>
<td>SCC</td>
<td>Serial Shipping Container Code</td>
</tr>
<tr>
<td>GLN</td>
<td>Global Location Number</td>
</tr>
<tr>
<td>GRAI</td>
<td>Global Returnable Asset Identifier</td>
</tr>
<tr>
<td>GIAI</td>
<td>Global Individual Asset Identifier</td>
</tr>
<tr>
<td>GID</td>
<td>General Identifier</td>
</tr>
</tbody>
</table>

Application Level Events (ALE) Standard, Version 1.0

This standard specifies an interface through which clients may obtain filtered, consolidated Electronic Product Code™ (EPC) data from a variety of sources.

Object Naming Service (ONS) Standard, Version 1.0

This standard specifies how the Domain Name System is used to locate authoritative metadata and services associated with the SGTIN portion of a given Electronic Product Code™ (EPC). Its target audience is developers that will be implementing Object Naming Service (ONS) resolution systems for applications.

Reader Management Standard

This standard defines Version 1.0 of the wire protocol used by management software to monitor the operating status and health of EPCglobal compliant RFID Readers. This document complements the EPCglobal Reader Protocol Version 1.1 specification [RP1].

EPC IS Standard

EPCIS, by providing a standard set of interfaces for EPC data, enables a single way to capture and share information, while still allowing the flexibility for industry and organization-specific implementations. The specification supports powerful business cases and consumer benefits such as container tracking, product authentication, promotions management, baggage tracking, and electronic proof of delivery, chain of custody, returns management, and operations management.
The Analogy Between the EPCglobal Network with the Internet’s Architecture

<table>
<thead>
<tr>
<th>World Wide</th>
<th>EPCglobal Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNS</td>
<td>ONS Authoritative record of manufacturers that routes requests for product information</td>
</tr>
<tr>
<td>Web Sites</td>
<td>EPC Information Services Resource for specific information about a product, e.g. date of expiration</td>
</tr>
<tr>
<td>Search Engines</td>
<td>EPC Discovery Services A tool for finding EPC Information Services on the network</td>
</tr>
<tr>
<td>Security Services</td>
<td>EPC Trust Services Provide security and access control for EPC product data</td>
</tr>
</tbody>
</table>

The Auto-Id Labs

- Cambridge - UK
- MIT – USA
- Adelaide - Australia
- St. Gallen – Switzerland
- Fudan – China
- Keio – Japan
- ICU – South Korea
How GS1 Unique Identifiers (GTIN-13) Integrate into an EPC RFID Number

Because of the ubiquity of the GS1 System, the integration of identifiers between the traditional GS1 identifiers (i.e.: ‘barcode numbers’) and the RFID EPC tag data formats are required to be seamless. The diagram below illustrates below the mapping from ‘barcode’ number format to EPC formats.