final report

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Development of an Integrated Livestock (Beef) Management System

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Executive summary

A vertically integrated beef production/processing operation reviewed their data transfer and management systems across their businesses. The review of existing software management systems identified deficiencies with the business's ability to capture and transfer agribusiness data from its properties and feedlots to a central head office location for processing, analysis and reporting. The review identified that data was being captured through ad-hoc software packages some of which were redundant or not supported. Since the redundancy of on-farm data capture and broader supply chain management systems, the business's only feasible options for software systems to meet their specific operational requirements were to develop their own systems from initial design. This approach can be very inefficient, expensive, carries a high risk profile and open to system failure. Many of these challenges are common across the red meat supply chain, and this project aims to demonstrate a working solution that resolves these data integration challenges.

The primary objective of this project was to implement a fully integrated supply chain information management system for the business. This was achieved by upgrading the existing software system that is was in use. Through a collaborative development process with the Project Manager, the software provider and Integrity Systems Company's (ISC) Technology team, key learnings were incorporated into reference architectures and principles. The software provider delivered four new modules: Livestock Procurement Booking; Saleyard Data Interface; Feedlot Data Interface; and "iLivestock" Management Module. Once the new modules were developed, the system was successfully deployed and trialled at selected business pilot sites under live commercial production conditions. Following successful pilot trials, the whole Integrated Information Management System was successfully implementation across all business sites.

Outcomes from the project included:

a) Significant returns on investment can be achieved from successfully developing and implementing integrated information management systems
b) Identification of enabling technologies was critical to the success of the project including innovative solutions.
c) Viable options (private NextG towers) were identified to support connectivity (data and voice) to clusters of properties to assist with defraying capital costs. However, risks to success need to be seriously considered. Collaboration between property owners/managers is required to facilitate the main tower to be located in a suitable location.
d) Utilising a collaborative design and delivery model with a dedicated Project Manager working with the Integrity Systems Technology group, learnings feeding back into the Digital Supply Chain Strategy in way of practices, principles and reference architecture patterns to enable future success of projects of this type.
e) Benefits to Industry can be gained by Intellectual Property in the systems developed being retained by the software vendor allowing new functionality available to other customers/industry participants.

Recommendations include:

a) Collaborative approach to connectivity and communications
b) A collaborative and phased design approach
c) Further develop data collection protocols through their value chain to further ensure all data is collected consistently across all properties.
d) Translate the value from data collected and collection platform into other business processes.
e) Utilise data analytics to maximise value of insights obtained from data

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1 Background

A vertically integrated beef production/processing operation reviewed their data transfer and management systems across their businesses. In parallel to this project, the business undertook a separate project to investigate improving communications connectivity across their businesses, specifically those in remote and regional locations. This separate project focussing on connectivity provides an "enabling" platform to underpin the development of supply chain management systems.

The review of existing software management systems identified deficiencies with the business's ability to capture and transfer agribusiness data from its properties and feedlots to a central head office location for processing, analysis and reporting. The ability to capture, and efficiently and accurately upload data to the business's central head offices is critical for the integrity and compliance of the data showing livestock movements from property and feedlots to the business's processing facility as well as making timely and accurate business decisions. The review identified that data was being captured through ad-hoc software packages including a package recently made redundant and was unavailable for red meat supply chains to use. Since the redundancy of on-farm data capture and broader supply chain management systems, the business's only feasible options for software systems to meet their specific operational requirements were to develop their own systems from initial design. This can be very inefficient, expensive, carries a high risk profile and open to system failure. Many of these challenges are common across the red meat supply chain, and this project aims to demonstrate a working solution that resolves these data integration challenges.

2 Project objectives

The primary objective of this work is to implement a fully integrated supply chain information management system for the business. This was to be achieved by upgrading the existing Software provider 'Promptu' system that is currently in place.

Through a collaborative development process with the Project Manager, Software provider and Integrity Systems Company's (ISC) Technology team, key learnings were to be incorporated into reference architectures and principles.

Software provider will deliver four new modules:

- Livestock Procurement Booking
- Saleyard Data Interface
- Feedlot Data Interface
- iLivestock Management Module

Once the required new modules have been developed, the Project Manager will coordinate the deployment of the updated system at selected Business pilot sites for live commercial trials for a period of three months.

Once the trials have been conducted and analysed, the Project Manager will coordinate a full implementation across all Business sites.

The Project Manager will coordinate all activities, and document the findings in preliminary reports, and then a final report covering all aspects of the delivery of the project.

3 Methodology

Seven main phases were identified to achieve the overall project milestones. The relevant approaches to achieve these activities/milestones are outlined below. Note that due to the modular nature of the project milestones, Milestones 2-3c were able to occur concurrently with resourcing being the primary limiting factor.

3.1 Milestone 1 - Detailed Project Management Plan

The Project Manager assisted the business, with input from ISC and Software provider, to develop a detailed project management plan, which included a work schedule for the Integrated Information Management System.

A Project Management Group (PMG) was formed from key stakeholders in the business and MLA/ISC to provide ongoing project governance and oversight.

A preliminary milestone report of the project management plan was prepared by the Project Manager and submitted to and approved by the PMG as a phase gate to ensure key deliverables were met and key learnings are documented.

3.2 Milestone 2 - Design, build and evaluate the Livestock Procurement Booking Module

The Project Manager coordinated development of requirements, and managed the design, development and implementation of the Livestock Procurement module. The provider (Software provider) reviewed and modified the original booking system to align with the business's requirements identified above. This involved new and modified functionality being added to the Livestock Console to provide a new "Bookings" module, which included:

- Add, Modify and Delete Bookings
- Reschedule Booking
- Receipt/Receive Livestock Against a Booking
- Modify Receipt
- Finalised Booking

A preliminary milestone report for the Livestock Procurement Booking module was prepared by the Project Manager and submitted to and approved by the PMG as a phase gate to ensure key deliverables were met and key learnings are documented.

3.3 Milestone 3a - Design, build and evaluate the Saleyard Data Interface Module

The Project Manager will coordinate development of requirements, and manage design development and implementation of the Saleyard Data Interface module.

The provider (Software provider) will deliver the feature to import data into the booking system from the Saleyard systems participating in the supply chain. It will also involve determining the feature of "auto learning" any changes in format or data structure as it is importing to make the maintenance and operation of the process easy for users.

A preliminary milestone report for the Saleyard Data Interface module will be prepared by the Project Manager and submitted to and approved by the PMG as a phase gate to ensure key deliverables were met and key learnings are documented.

3.4 Milestone 3b - Design, build and evaluate the Feedlot Induction Data Interface Module

The Project Manager coordinated development of requirements, and management of design development and implementation of the Feedlot Induction Data Interface module.

The provider (Software provider) evaluated the importation of the Feedlot induction data into the booking system, which included:

- New feature to import feedlot induction information
- Data presented in a fixed Excel sheet
- Any CSV files to be converted into excel in the specific format before import

A preliminary milestone report for the Feedlot Induction Data Interface module was prepared by the Project Manager and submitted to and approved by the PMG as a phase gate to ensure key deliverables were met and key learnings are documented.

3.5 Milestone 3c - Design, build and evaluate the 'iLivestock' Livestock Management System Module

The Project Manager coordinated development of requirements, and management of the design, development and implementation of the iLivestock Module.

This module proposed to deliver the following functions:

- Purchased Backgrounders
- Bred Backgrounders (weaners)
- Purchased Breeders
- Check Weigh
- Breeder Fertility

This involved the design and evaluation of the Animal Management fields to provide filtering capability on Category, Purchased, Background (BG), Bred Background including:

- Alert
- Animal Standard Note
- Animal Status
- Breed
- Classification
- Dentition
- Fertility
- Lactation
- Last Processed Date

- Last Scanned/Seen
- Category
- Origin
- Paddock – Current
- Paddock – Previous
- Processing Session
- Property
- Sex
- Vendor
- Weight
- Year Brand
- A further evaluation of the ability to import and transfer required data at induction cattle to the feedlot with essential fields including but not limited to:
    - List of Paddocks and numbers in each paddock
    - List of Properties
    - List of Processing Sessions
    - Treatment Inventory
    - Import Data from CSV (Out of Property)
    - NLIS Movement
    - Decision Rules (Drafting Gates)

A preliminary milestone report for the iLivestock module was prepared by the Project Manager and submitted to and approved by the PMG as a phase gate to ensure key deliverables were met and key learnings are documented.

3.6 Milestone 4 - Deploy commercial pilot trials, capture data and testing

The Project Manager, in consultation with technical consultants, provided internal design services and run commercial pilot trials across all four modules as per the trial schedule. The Project Manager provided input into technical meetings, present results, findings and observations to PMG as required.

A preliminary milestone report was prepared by the Project Manager and submitted to and approved by the PMG as a phase gate to ensure key deliverables were met and key learnings are documented. The report included:

a. Assessment of the individual module delivery and the success of the final product integration
b. Assessment of the rollout across the integrated supply chain
c. Key learnings and opportunities for improvement

3.7 Milestone 5 - Final report & presentation of outcomes & recommendations to the business

The Project Manager prepared and submitted a final report to the PMG for approval as a phase gate to ensure key deliverables were met and key learnings are documented. The final report includes:

- Review of third-party business case and cost benefit analyses of connectivity
- Detailed specifications of data transfer across the business.
- Production trials, detailed specifications of connectivity infrastructure options.

- Outcomes of production trials
- Recommendations on connectivity and data transfer to the business.
- Value chain benefits of implementing a best practice integrated system
- A blueprint (e.g. practices, principles, reference architecture patterns) to successfully implement future projects of this type

The Project Manager assisted the business in preparing a company report and presentation to the business. The Project Manager will also provide an industry report approved by the business to include general description of business case and commercial considerations for property data transfer.

4 Results

4.1 Business case and cost benefit analyses of connectivity and infrastructure

The benefits to the business by having enhanced connectivity and data transfer capability and capacity are numerous including:

- More efficient and cost-effective reporting; live dashboarding; more timely reconciliation and business transactions;
- More timely and accurate costings;
- Reliable animal transaction data (including NLIS) and payments;
- Improved staff amenity in rural and remote locations leading to better staff availability and retention rates; and
- Importantly staff safety.

Improved connectivity per. se. may not necessarily provide direct benefits over and above coverage, reliability and performance improvements and potential cost reductions. Connectivity does however provide an "enabling" platform facilitating the implementation and harvesting of benefits from more accessible and better designed and performing decision support systems.

Details of an analysis of some of the animal, pasture and processor benefits are outlined in Section 4.4 Value chain benefits of implementing a best practice integrated system which forms the primary focus of this project.

The business reviewed the direct benefits associated with improving connectivity infrastructure and reduction in costs from transition from Satellite to NextG internet, when unlimited or high-volume downloads are required. This formed the basis for separate and parallel project, it is useful to report preliminary findings of this "enabling" connectivity project in this report. The unlimited download is required in these locations to enable the transfer of production data from the stations & feedlots to the centralised databases at head office.

Data connectivity and communication platforms in regional Australian can have limited bandwidth with costs of services in remote areas directly linked to download rates and volume. Table 1 below outlines three main options available to remote stations which have been considered through the business's analysis.

Table 1 Remote connectivity options and capacities

System	Download limit (GB/Month)	Download speed
Sky Muster*	20GB month	256/256 kbps
Leased Satellite	Unlimited	512 kbps
NextG	Unlimited	3G – 5 mbps 4G – 25 mbps

* At time of project commencement.

The cost benefit analysis of these system was to assess the minimum data requirements for the stations. The analysis provides a comparison in costs associated with the current system and a NextG solution

Table 2 below presents the monthly and annual costs of the two systems which meet the technical requirements of the stations. The satellite leasing option costs were spread across 3 stations in this

example and resulting in total monthly costs of $14,290 per month. The $200 / month for the NextG system is to enable unlimited download over the mobile network. This cost will vary between provider contracts and the number of locations requiring internet access. The NextG option also allows station staff to utilise their personal mobile devices within 50m from the receival tower.

Table 2 Costs associated with each service type available

Service	Monthly cost per station	Annual cost per station
Sky Muster	Deemed not appropriate due to limited capacity and technical constraints	
Leased Satellite*	$4,763	$57,161
NextG	$200	$2,400

* Cost assumes 3 company stations utilising the satellite

A significant risk and limitation to the reliance on NextG is that property locations may be outside the guaranteed coverage footprint of commercial NextG providers. The technical solution suggested utilises requires a tower to be placed within line-of-sight within 100kms of the homestead or desired location/infrastructure. The cost of surveys (potentially by helicopter) to identify a suitable location with NextG reception and hardware costs (including installation/commissioning) are demonstrated in Table 3 below.

Table 3 Capital costs associated with the installation of a NextG tower to transmit signal to the station homestead

Establishing NextG tower	Cost per tower site	Annualised capital cost
Identify Tower Location (One off cost)	$20,000	$2,000
Hardware (2 years life)	$9,500	$4,750
Total	**$29,500**	**$6,750**

An advantage of this solution is a main tower could be utilised by a cluster of properties around a central point reducing the cost to individual properties of installing these towers. Collaboration between property owners/managers is required to facilitate the main tower to be located in a suitable location.

The return on investment for the installation of the NextG tower to enable unlimited downloads is 0.56 years when compared to leasing satellite capacity. The annual benefit when the cost of identifying the NextG tower's location is annualised over 10 years is $48,011. The significant risk of this approach is that if the tower is outside the commercial NextG providers guaranteed coverage footprint, they will not guarantee service availability prior to installing the system.

The reduction in costs associated with the transition from unlimited satellite to unlimited NextG internet is outlined in Table 4 below.

Table 4 Reduction in costs associated with the transition from unlimited satellite to unlimited NextG

System	Annual cost
Leased Satellite	$57,161
NextG	$9,150
Net reduction in annual cost	$48,011
Return on capital expenditure (Years)	0.56

The return on investment for the installation of the NextG tower to enable unlimited downloads is 0.56 years when compared to leasing satellite capacity. The annual benefit when the cost of identifying the NextG tower's location is annualised over 10 years is $48,011. The main constraint with this system is that the service provides will not guarantee the service availability prior to system.

In summary the NextG technology utilised has shown to provide a viable option to enable connectivity of properties in remote Australia. The only constraint is the cost of identifying the tower location and installing the system without a guarantee that it will work. A suggested approach to this risk is to manage it as a Research and Development Project along with the appropriate evaluation of risk, costs and success. Where suitable locations are identified, the solution may suit a cluster of properties assisting in defraying capital costs.

4.2 Connectivity and data transfer across the business

4.2.1 Connectivity Infrastructure

As indicated in Section 1 Background, the business undertook a separate project to investigate improving communications connectivity across their businesses, specifically those in remote and regional locations. This separate project focussing on connectivity provides an "enabling" platform to underpin the development of supply chain management systems.

A diagram displaying the solution for service connectivity and data movement across the business businesses is outlined in Appendix I - Properties WAN and Network Structure.

Table 5 below outlines a summary of the connectivity options for the business's locations.

Table 5 Business Locations Connectivity Summary

Site	Riverbed	Fibre Internet	IP Cloud	Internet	NBN Satellite	NextG
Properties						
Property A	X	X	X	X		X
Property B	X	X	X	X		X
Property C	X	X	X	X		X
Property D	X	X	X	X		X
Property E	X	X	X	X		X
Property F	X	X	X	X		X
Property G	X	X	X	X		X
Property H	X	X	X	X		X
Property I	X	X	X	X		X (with relay stations
Property J	X	X	X	X		X (with relay stations
Property K	X	X	X	X		X (with relay stations
Property L					X	
Property M	X	X	X	X		X
Property N	X	X	X	X		X
Property O	X	X	X	X		X
Property P	X	X	X	X		X
Abattoir						
Abattoir (Fibre)						

The business's approach to systems design is to operate a central database at its head office synchronised to local databases and applications operating at its remote locations (properties and feedlots). The advantages of this from an IT perspective is enabling remote application support and maintenance of IT systems. The advantages if a centralised system is that it enables animal performance and treatments to be traced through their lifetime across multiple properties/feedlots. The solution implemented aims to support these objectives.

The business has been challenged through the development and implementation of an effective and cost-efficient communication infrastructure due to rapid development of technology with technologies becoming superseded or cost structures becoming redundant during the period between evaluation and ordering and final implementation.

4.3 Production trials and outcomes

As noted in Section 1 above, the business's approach to systems design is to operate a central database at its head office synchronised to local databases and applications operating at its remote locations (properties and feedlots). All modules detailed below align with this approach with the

advantages enabling timely data analysis while providing redundancy to remote locations in the event that connectivity is interrupted. The advantages of a centralised system for animal information is that it enables animal performance and treatments to be traced through their lifetime across multiple properties/feedlots.

Following the development of each individual module including:

- Livestock Procurement Booking Module;
- Saleyard Data Interface Module;
- Feedlot Induction Data Interface Module;
- Feedlot Induction Data Interface Module; and
- 'iLivestock' Livestock Management System Module

each module was "component tested" in the business's commercial production operating environment prior to rollout across the Integrated Supply Chain. The outcomes of these production trials are outlined below.

4.3.1 Livestock Procurement Booking Module

The Livestock Procurement Booking Module developed by Software provider delivered functionality including:

- Add, Modify and Delete Bookings
- Reschedule Booking
- Receipt/Receive Livestock Against a Booking
- Modify Receipt
- Finalised Booking

Additional functionality regarding a visual summary of the status of targets, bookings and deliveries was also developed.

A commercial pilot trial of the Livestock Procurement Booking Module was conducted over a two-month period involving in excess of 23,000 head across more than 200 individual bookings.

The Livestock Procurement Booking Module was successfully integrated into the business's operational processes and the functionality of the Module successfully met the business and operational requirements. The outcomes of implementing the Module observed during the commercial pilot trial were significant improvements in ease of use, accuracy, timeliness and maintenance of Livestock Procurement data by business system operators located at the business's head office and at the business's remote sites. No errors or issues were detected over period of the commercial pilot trial.

4.3.2 Saleyard Data Interface Module

The Saleyard Data Interface Module developed by Software provider and implemented at the business's head office and remote sites included the following functionality:

- Import data into booking system from Saleyard systems participating in the business's supply chain.
- Functionality involving the feature of "auto learning" any changes in format or data structure as it is importing

A commercial pilot trial of the Livestock Procurement Booking Module was conducted over a two-month period involving in excess of 5,000 head across more than 120 individual sale lots from 18 saleyard locations.

The Saleyard Data Interface Module was successfully integrated into the business's operational processes and the functionality of the Module successfully met business and operational requirements. The outcomes of implementing the Saleyard Data Interface Module observed during the commercial pilot trial were significant improvements in ease of use, accuracy, timeliness and maintenance of the Saleyard Data Interface by the business's system operators located at the business's head office and remote sites. No errors or issues were detected over period of the commercial pilot trial.

4.3.3 Feedlot Induction Data Interface Module

The Feedlot Induction Data Interface Module involved the design, development and evaluation of the Feedlot Induction Data Interface by Software provider. Software provider in collaboration with the business's IT personnel reviewed the current Feedlot Data Interface and identified modifications/enhancements in order for the system to align with the business's business and operational requirements. New and modified functionality was developed and incorporated into "Livestock Console" to provide a new interface for Feedlot and other induction data Interface. The functionality developed included:

- New feature to import feedlot induction information.
- Data presented in a fixed Excel sheet.
- Any CSV files to be converted into Excel in the specific format before import.

In addition, this new interface also has the capacity and is used to import all types of induction data into the business's livestock system and is not limited solely to Feedlot induction data.

A commercial pilot trial of the Feedlot Induction Data Interface Module was conducted over a two-month period involving in excess of 56,000 head from 3 feedlot locations. The business's operational staff were provided with automated half-hourly reports advising of individual animal Export Slaughter Intervals (ESI) status, Withholding Periods (WHP) and alerts. Over the two-month commercial trial period, in excess of 1,000 individual files were produced and processed automatically containing individual animal induction and status information.

The Feedlot Induction Data Interface Module was successfully integrated into the business's operational processes and the functionality of the Module successfully met the business's business and operational requirements. The outcomes of implementing the Module observed during the commercial pilot trial were significant improvements in ease of use, accuracy, timeliness and maintenance of the interface for Feedlot and other induction data by the business system operators located at head office and remote sites. No errors or issues were detected over period of the commercial pilot trial.

4.3.4 'iLivestock' Livestock Management System Module

The 'iLivestock' Livestock Management System Module developed by Software provider and implemented at the business's Factory/Head Office and remote site. Software provider in collaboration with the business's IT personnel reviewed the current Livestock Data Capture system and identified modifications/enhancements in order for the system to align with the business's business and operational requirements.

The new and improved functionality incorporated into the Livestock Data Capture system included:

- Receiving
- Purchased Backgrounders
- Bred Backgrounders
- Purchased Breeders
- Check Weigh
- Breeder Fertility

Additional functionality was developed and implemented within "iLivestock" Livestock Management System Module operating across the business including functionality to group properties, manage paddock and gate allocations, and established drafting rules. Automated drafting rules significantly improves the accuracy of livestock drafting and subsequent improvements in management and inventory control.

A commercial pilot trial of the 'iLivestock' Livestock Management System Module was conducted over a two-month period involving approximately 3,000 head across more than 7 locations involving properties, feedlots and the business's abattoir.

The 'iLivestock' Livestock Management System Module was successfully integrated into the business's operational processes and the functionality of the Module successfully met the business's business and operational requirements. The outcomes of implementing the Module observed during the commercial pilot trial included significantly improved business performance by:

- Identifying underperforming animals earlier and enabling crush-side decisions based on animal history; and
- Enabling informed decisions based on dynamic rules increasing the quantity of animals within optimal specification entering each stage of the production process.

In addition, the system has enabled full reconciliation of stock inventory with accurate records of treatments, ESI and WHP.

4.3.5 Roll-out across the Integrated Supply Chain

Following the successful component testing and commercial pilot trials of each of the four modules (Livestock Procurement Booking, Saleyard Data Interface, Feedlot Data Interface and "iLivestock" Livestock Management System) of the Integrated Information Management System, the business commissioned the full commercial implementation of all modules across the business's entire integrated supply chain. The integrated supply chain includes 13 properties, three feedlots and head office.

The key learnings from the successful design, development and implementation of the Integrated Information Management System encompassed within this project include:

1. The project was planned and successfully implemented using a phased approach enabling each phase and module to be individually planned, designed, developed and tested before implementation.
2. A collaborative approach to identifying detailed needs by all stakeholders across the integrated supply chain resulted in each component of the system meeting business and operational requirements. Stakeholders included the software developer (Software provider), the business's Information Technology personnel, and the business's operational and managerial personnel.

3. Underpinning the success of the software development through the project was the detailed technical and operational understanding of business operations and constraints by the business's Information Technology personnel and detailed planning in managing the significant risks associated with implementing such functionality into live commercial business operations.
4. A key to the successful implementation of the Integrated Information Management System was the availability of a dedicated resource providing input into functionality design and assistance with training during implementation. This resource (Agribusiness Analyst, Development & Innovation Officer sponsored by MLA) was able to provide valuable, flexible and timely input due to being a dedicated role without the day-to-day priorities of other production and operational roles.

4.4 Value chain benefits of implementing a best practice integrated system

The red meat industry is becoming increasingly aware of the value that data can deliver across the entire supply chain. Producers can use data to adapt their processes to minimise costs and optimise livestock growth and performance; processors can increase operational efficiency, reduce product wastage and better predict supply. These are just a few examples of the benefits data collection and analysis can yield these companies.

With the aim of better utilising data collection to improve pasture and animal management, the business partnered with Software Provider. This was to develop a system that spans its vertically integrated supply chains with applications and/or interfaces with procurement, saleyards, feedlots, processing and industry/regulatory systems. A significant focus was to improve efficiency and accuracy of data capture particularly in on-property/feedlot (crush-side) operational activities will then be used to inform on-farm management. This markedly improves livestock quality and help identify key problem areas in their on-farm processes. By addressing these issues, the business aims to decrease the occurrence of poorly allocated livestock, reduce costs and thus increase the profitability of their operations. This will then benefit the business's processing, as their supplier partners will supply higher quality livestock, thus increasing the value the business will obtain per carcass.

4.4.1 Objective and methodology of identifying value chain benefits

The objectives of the business in the analysis of benefits to their value chain from this project include:

1. Identify the different benefits the new data collection system will provide the business and its supplier partners.
2. Evaluate the value the business will receive in terms of financial benefit per head.
3. Increase supplier commitment in data collection to increase efficiency and quality of livestock supply.
4. Provide recommendations that will help the business capitalise on their data collection and maximise the value it delivers to across their supply chains.

MLA report V.MQT.0071 focused on the value of objective measurements in the livestock industry and was used as a foundation for this analysis. Subsequently the assumptions and values developed in that report are consistent with those developed in this analysis.

The value created by the utilisation of the Integrated Livestock Management System has been calculated though estimating the cost of Pregnancy Tested in Calf (PTIC) heifers and unsuitable dentition at purchase. The average annual cost of PTIC and dentition discounts (recorded in TABLE 8??) were calculated using the figures in Table 6. These were based on calculations referencing average head per annum inducted into backgrounding properties.

Table 6 Grid discounts imposed on animals for undesirable PTIC and dentition results.

PTIC Discount	
PTIC ($/kg)	$1.00
Dentition Discount	
Teeth	Discount ($/kg)
0	$0.00
2	$0.00
4	$0.50
6	$1.00

4.4.2 Benefits of the Integrated Information Management System

Several benefits of the Integrated Information Management System have been identified for both suppliers and processors. These include the main categories below:

1. Animal Management
    a) Improved fertility:- identify healthiest animals from different breeding stock, reduce livestock fatality rates
    b) Genetic selection- breeders yielding the highest quality (value) livestock identified to enhance breeding stock
        i. The change from Droughtmaster to Ultrablack bulls resulted in an increase in the performance in the live animal and carcase quality and quantity characteristics. These increases have been analysed using data collected through the integrated system.
    c) Livestock purchase:- based off livestock performance, identify best feedstock suppliers, best time to purchase feedstock
        i. More informed decision making in relation to animal purchasing is already occurring in several areas. The following are outcomes have been changes main dur to data collect on animals purchased:
            - Discounts imposed for PTIC heifers and dentition, the value of imposing these discounts are included.
            - Animals have been identified as moving into the backgrounding and feedlotting systems multiple times. The system allows operators inducting animals to remove any animals which have entered the business previously and culled for any reason. Future developments of the system propose to enable buyers to know which vendors to avoid when purchasing livestock.
    d) Growth rates of animals:- identifies pastures yielding highest growth, best breeding stock, average kg/head/day growth and thus establish growth benchmarks for future animal performance
        i. Performance of animals on backgrounding properties during the 2018 Financial year drought was analysed. Animal purchased locally where

performing from arrival, whereas animals purchased from Northwest NSW lost weight after arrival.

e) Health management:- identify and target issues in on-farm processing that adversely affects health (i.e. data suggests a certain water source is less reliable)
    i. Animal health and treatment data is being collected throughout the entire value chain. The data analysis has not been completed but is expected that benefits will be realised through more informed animal health management. This includes identification of vendors selling animals less susceptible to Bovine Respiratory Disease in the business's feedlots.

2. Pasture Management
    a) Record growth rates of animal all paddocks to understand the optimal stocking rates for the viability of pasture.
    b) Links to animal health management, measuring animal growth rate and improving efficiency and effectiveness of on-farm processes
3. Processor Benefits
    a) Identify the vendors who supply the highest quality livestock and the vendors with the lowest quality livestock- provide feedback to both regarding livestock quality
    c) Increased livestock quality yields higher margins on end product- less wastage, improved retail product quality

4.4.3 Cost benefit Analysis

The broad range of benefits outlined in Section 4.4.2 are expected to be realised, only benefits from PTIC and dentition are calculated due to the system only being recently implemented and data not currently available to support this cost benefit analysis for benefits including: genetic selection; fertility management; growth rate improvements; pasture management; and animal benefits. For these reasons, benefits aren't quantified in Table 7 below.

Table 7 Summary results of individual savings associated with Integrated Information Management System shows the value benefit that the business expects to initially obtain from the data collection system. As noted above, only $/head benefits are projected due to improved purchasing strategies by assisting suppliers identify select and/or purchase livestock within specification, thus increasing the overall quality of carcases. The benefit of $8.28 per head is very conservative as it assumes that the suppliers will take time and will need to invest in building capacity to use the data to optimise other on-farm processes relating to pasture usage, managing animal health etc. The benefit values shown in grey represents the benefits which this system will provide over time but were unable to be costed due to a lack of supporting data due to the recent commissioning of the system. It also assumes that the data collection will not be applied to the operational efficiency of the plant, and thus the business will not derive direct or immediate benefits from improved processing throughput, increased OH&S performance or reduced labour requirements.

Table 7 Summary results of individual savings associated with Integrated Information Management System

Total Benefit		
		Integrated Information Management System
Benefit Summary		**$/hd from**
1. Product value	Genetic selection	$0.00
	Purchasing strategies	$8.28
	Fertility management	$0.00
	Growth rate improvement	$0.00
	Pasture management	$0.00
	Animal management	$0.00
2. Throughput benefit		$0.00
3. OH&S benefit		$0.00
4. Labour benefit		$0.00
5. Equipment costs	Maintenance	$0.00
	Operation	$0.00
	Risk of failure	$0.00
	$ Benefit per head	$0.00
$ Annual benefit overall		**$8.28**

However, it's anticipated that with structured support to the business's staff, data collection and analytical capabilities further increasing margins through the business will be achieved over time. As a result, this analysis (and further developments resulting from this project) are likely to yield a higher annual benefit than the annual benefit of $372,571 listed in Table 7 above .

Capital costs of the project are outlined in Table 8 below. The total capital cost for developing the 5 modules of the information management system was $188,075 and was incurred in Year 1 i.e. non-recurring. No other costs recurring costs have been accounted for as there no additional ongoing to support the 5 modules over and above the existing annual software maintenance and support agreement between the software provider and the business. Therefore, the capital cost of $188,075 is the total cost the business is projected to incur from this project.

Table 8 Estimated capital and operating costs of the Integrated Information Management System

Capital Cost	**Integ. Info. Man. System**	
	Cost	**Life span (years)**
Livestock procurement booking module	$21,875	10
NLIS Connect replacement module	$59,475	10
Livestock management System	$57,375	10
Saleyard interfae Module	$31,375	10
Feedlot induction import module	$17,975	10
Total	**$188,075**	**10**

Table 9 below identifies the benefit achieved through decreasing costs associated with lower value animals entering the value chain. When the business properties or feedlots receive livestock from suppliers (breeders or backgrounders), they will now be able to accurately and easily track where they sourced each animal from and even if they have previously been in the business's supply chain and rejected for non-performance. PTIC (pregnant livestock) are generally considered undesirable due to the unplanned extra cost for managing the birthing and rearing of calves. Therefore, the induction team are able to easily identify the breeder and add a discount to the purchase price of the livestock, providing an estimated annual reduction in costs of $354,340 due to PTIC not entering the value chain. They'll also receive an average $0.41 per head discount for cattle with 4 or 6 teeth, adding an additional $18,231 annual benefit to the system installation.

Table 9 $/hd discounts for PTIC livestock and dentition costs

	$/hd	Average annual costs
PTIC discounts	$7.87	$354,340
Dentition discounts	$0.41	$18,231
Total discounts		**$372,571**

Table 10 indicates the projected benefit per head and Net Present Value (NPV) of the project investment over a 5-year period. The capital cost of the project was $188,075 and projected that there will be no return on this investment in year 1. This is due to data collection only commencing in Year 1 and the system requires this data before it can be effectively used in identifying areas of inefficiency in the plant and in supplier operations. As more data is collected, the data set becomes more reliable and more applicable in identifying trends and correlations between variables that support management decisions and impacts the quality of the livestock supply and effectiveness of livestock management.

Table 10: Summary of benefits of Integrated Information Management System

Summary Performance Measures	Integ. Info. Man. System
Hd/annum	45,000
Production increases with system	0.0%
	Average
Capital cost (payment option, upfront)	$188,075
Gross return per head	$8.28
Total costs per head	$0.42
Net Benefit per head	$7.86
Annual net benefit per head	$353,763
Annual net benefit for the Ex Cap	$372,571
Payback (years)	$0.50
Net Present Value of investment	**$2,428,707**

Therefore, the net benefit per head will gradually increase as the data becomes more complete and robust. By year 5, it's projected that the net benefit per head will be $0.45, and the NPV of the project will be $2.43M. In following years, as the business continues to develop and refine their data collection system and analytical capabilities, the value obtained per head will significantly exceed the projected benefits indicated in this analysis.

Table 10 indicates the overall benefit per head to be $8.28, and the total cost per head to be $0.42, resulting in a rounded net benefit per head of $7.86 (Table 10). At a projected throughput of 45,000 head per annum, this results in an annual net benefit for of $353,763. The anticipated payback period for the project is 0.50 years.

Table 11: Ex-post costs and benefits breakdown for the current throughput.

Cost Benefit Analysis of System	**Integ. Info. Man. System**
Benefit summary	**$/hd Average**
$ Accuracy benefit per head	$8.28
$ Technique benefit per head	$0.00
$ Labour benefit per head	$0.00
$ Overall benefit per head	**$8.28**
* Cost is reported as the inaccuracy from target specification	
Costs associated with operating the system	**$/hd**
Capital costs	$0.42
Maintenance	$0.00
Operation	$0.00
Risk of mechanical failure	$0.00
Total cost per head	**$0.42**
Total Cost per head (Ex Cap)	**$0.00**

4.5 Framework for successful implementation of future projects of this type

Important learnings were identified during the planning and delivery of this project. These are outlined below.

4.5.1 Identify and implement enabling technologies

The businesses span broad and diverse geographical regions. As part of the review of their data transfer and management systems across their businesses, significant limitations were identified in the connectivity and communications infrastructure of their properties and feedlots. These limitations provided significant barriers to the effective implementation their vision for improving business performance through developing and implementing an Integrated Information Management System. These barriers needed to be addressed in order to enable the benefits of the proposed integrated system to be realised. Based on these requirements and the other benefits of improving staff amenity and safety, the business undertook a separate project to investigate improving communications and connectivity across their businesses, specifically those in remote and

regional locations. This separate project focussing on connectivity provides an "enabling" platform to underpin the development of the Integrated Information Management System.

4.5.2 Approach to successful project execution

Valuable learnings were identified during the successful implementation of the Integrated Information Management System into full commercial production operational environments.

Key learnings regarding the successful design, development and implementation of the complex system encompassed within this project included:

- The project was planned and successfully implemented using a phased approach enabling each phase and module to be individually planned, designed, developed and tested before implementation.
- The project leveraged off an existing system with demonstrated robustness and performance in production environments.
- A collaborative approach to identifying detailed needs by all stakeholders (Content Experts) across the integrated supply chain resulted in each component of the system meeting business and operational requirements. Stakeholders included the software developer (Software provider), the business's Information Technology personnel, and the business's operational and managerial personnel.
- Underpinning the success of the software development through the project was the detailed technical and operational understanding of business operations and constraints by the business's Information Technology personnel and detailed planning in managing the significant risks associated with implementing such functionality into live commercial business operations.
- A key to the successful implementation of the Integrated Information Management System was the availability of a dedicated resource providing input into functionality design and assistance with training during implementation. This resource (Agribusiness Analyst, Development & Innovation Officer sponsored by MLA) was able to provide valuable, flexible and timely input due to being a dedicated role without the day-to-day priorities of other operational roles.

5 Discussion

5.1 Benefits to the business

5.1.1 Connectivity and data transfer

The benefits to the business by having enhanced connectivity and data transfer capability and capacity are numerous including:

- More efficient and cost-effective reporting; live dashboarding; more timely reconciliation and business transactions;
- More timely and accurate costings;
- Reliable animal transaction data (including NLIS) and payments;
- Improved staff amenity in rural and remote locations leading to better staff availability and retention rates; and
- Importantly staff safety.

Improved connectivity per. se. may not necessarily provide direct benefits over and above coverage, reliability and performance improvements and potential cost reductions. Connectivity does however provide an "enabling" platform facilitating the implementation and harvesting of benefits from more accessible and better designed and performing decision support systems.

The return on investment for the installation of the NextG tower where appropriate (Section 4.2 Connectivity and data transfer across the business) to enable unlimited downloads is 0.56 years when compared to leasing satellite capacity. The annual benefit when the cost of identifying the NextG tower's location is annualised over 10 years is $48,011. The main constraint with this system is that the service provides will not guarantee the service availability prior to system.

5.1.2 Value chain benefits

The objectives of the business in the analysis of benefits to their value chain from this project include:

1. Identify the different benefits the new data collection system will provide the business and their supplier partners.
2. Evaluate the value the business will receive in terms of financial benefit per head.
3. Increase supplier commitment in data collection to increase efficiency and quality of livestock supply.
4. Provide recommendations that will help the business capitalise on their data collection and maximise the value it delivers to across their supply chains.

A conservative benefit analysis (Section 4.4 Value chain benefits of implementing a best practice integrated system) indicted that the overall benefit per head just from PTIC and dentition to be $8.28, and the total cost per head to be $0.42, resulting in a rounded net benefit per head of $7.86. At a projected throughput of 45,000 head per annum, this results in an annual net benefit for of $353,763. The anticipated payback period for the project is 0.50 years.

5.2 Benefits and implications for industry

5.2.1 Identification of enabling technologies

Significant learnings that are available to other industry participants were identified for the successful delivery of similar projects (Section 4.5). These include identification and implementation of enabling technologies e.g. improved connectivity of remote properties.

In addition, NextG technology utilised has shown to provide a viable option to enable connectivity of properties in remote Australia. The only constraint is the cost of identifying the tower location and installing the system without a guarantee that it will work. A suggested approach to this risk is to manage it as a Research and Development Project along with the appropriate evaluation of risk, costs and success. Where suitable locations are identified, the solution may suit a cluster of properties assisting in defraying capital costs. Collaboration between property owners/managers is required to facilitate the main tower to be located in a suitable location.

5.2.2 Collaborative approach

By utilising a collaborative design and delivery model with a dedicated Project Manager working with the Integrity Systems Technology group, learnings will feed back into the Digital Supply Chain Strategy in way of practices, principles and reference architecture patterns to enable future success of projects of this type.

5.2.3 Availability of Intellectual Property to industry

Other significant benefits to Industry are that the business does not retain any Intellectual Property in the systems developed, allowing the vendor (Software provider) to make this new functionality available to other customers.

5.3 Achievement of project objectives

The main project objectives are outlined below including a brief summary of their outcomes.

5.3.1 Implement a fully integrated supply chain information management system

The Software provider 'Promptu' system has been in operation for several years across the business's sites. The pre-existing system was reviewed and a number of enhancements were identified (refer Section 3 Methodology) to deliver significant benefits to the businesses. The enhancements were designed as separate modules and when implemented into the pre-existing system, formed the Integrated Information Management System.

5.3.2 Collaborative development process with key learnings incorporated into reference architectures and principles

A collaborative approach to identifying detailed needs by all stakeholders (Content Experts) across the integrated supply chain (refer Section 4.5.2 Approach to successful project execution) resulted in each component of the system meeting business and operational requirements. Stakeholders included: Project Manager; Software provider; Integrity Systems Company's (ISC) Technology team;

the business's Information Technology personnel; and the business's operational and managerial personnel. This process led to the successful delivery of the project to the business.

5.3.3 Delivery and deployment of four new modules into pilot sites

Software provider delivered four new modules: Livestock Procurement Booking; Saleyard Data Interface; Feedlot Data Interface; and iLivestock Management Module. Following successful development of the modules, the Project Manager with key business personnel coordinated the deployment of the updated modules at selected business pilot sites for live commercial trials. The outcomes of these successful trials are detailed in Sections 4.3.1 to 4.3.4.

5.3.4 Full implementation across all Business sites.

Following the successful conduct and analysis of live commercial trials of the systems four modules, Project Manager with key business staff coordinated the full implementation of the Integrates Information management System across all Business sites (refer Section 4.3.5).

5.3.5 Document findings in preliminary reports and final reports covering all aspects of the delivery of the project.

The Project Manager with key business personnel coordinated all project activities and documented findings in preliminary reports as per the project schedule. This report constitutes one of the two reports (Industry and Confidential to MLA) covering all aspects of project delivery.

6 Conclusions/recommendations

6.1 Conclusions

The project approach proved successful in achieving project objectives while adapting to the challenges presented during the project period.

Conclusions drawn from the project include:

a) Significant returns on investment can be achieved from successfully developing and implementing integrated information management systems
b) Identification of enabling technologies was critical to the success of the project including innovative solutions.
c) Viable options (private NextG towers) were identified to support connectivity (data and voice) to clusters of properties to assist with defraying capital costs. However, risks to success need to be seriously considered. Collaboration between property owners/managers is required to facilitate the main tower to be located in a suitable location.
d) Utilising a collaborative design and delivery model with a dedicated Project Manager working with the Integrity Systems Technology group, learnings feeding back into the Digital Supply Chain Strategy in way of practices, principles and reference architecture patterns to enable future success of projects of this type.
e) Benefits to Industry can be gained by Intellectual Property in the systems developed being retained by the software vendor allowing new functionality available to other customers/industry participants.

6.2 Recommendations

6.2.1 Collaborative approach to connectivity and communications

Collaborative approaches (by clusters of properties) should be considered to improve the viability implementing connectivity solutions (e.g. private NextG towers) to assist with finding suitable tower locations and defraying capital costs.

6.2.2 Collaborative design approach

Due to the successful design, development and implementation of the Integrated Information Management System encompassed within this project, it is recommended for future similar projects that:

- A phased approach be utilised enabling each phase and module to be individually planned, designed, developed and tested before implementation;
- Where possible, leveraged off an existing system with demonstrated robustness and performance in production environments;
- A collaborative approach to identifying detailed needs by all stakeholders across the integrated supply chain resulted in each component of the system meeting business and operational requirements;

- Detailed technical and operational understanding of business operations and constraints by the business's Information Technology personnel and detailed planning in managing the significant risks; and
- A dedicated resource providing input into functionality design and assistance with training during implementation.

6.2.3 Cost benefit and data

Due to the significant 'buy-in' from all property and feedlot personnel signifying that the vertically integrated value chain recognises the value of this system and is thus ready to adopt the technology to obtain the benefits it provides. It is recommended that the business should consider focusing on the following:

a) Further develop data collection protocols through their value chain to further ensure all data is collected consistently across all properties.
b) Translate the value from data collected and collection flatform into other business processes.
c) Utilise data analytics to maximise value of insights obtained from data

7 Key messages

Key messages from this project include:

a. Significant returns on investment can be achieved from successfully developing and implementing integrated information management systems
b. Viable options (private NextG towers) were identified to support connectivity (data and voice) to clusters of properties to assist with defraying capital costs. However, risks to success need to be seriously considered. Collaboration between property owners/managers is required to facilitate the main tower to be located in a suitable location.
c. Utilising a collaborative design and delivery model with a dedicated Project Manager working with the Integrity Systems Technology group, learnings feeding back into the Digital Supply Chain Strategy in way of practices, principles and reference architecture patterns to enable future success of projects of this type.
d. Benefits to Industry can be gained by Intellectual Property in the systems developed being retained by the software vendor allowing new functionality available to other customers/industry participants.

8 Appendix

8.1 Appendix I - Properties WAN and Network Structure