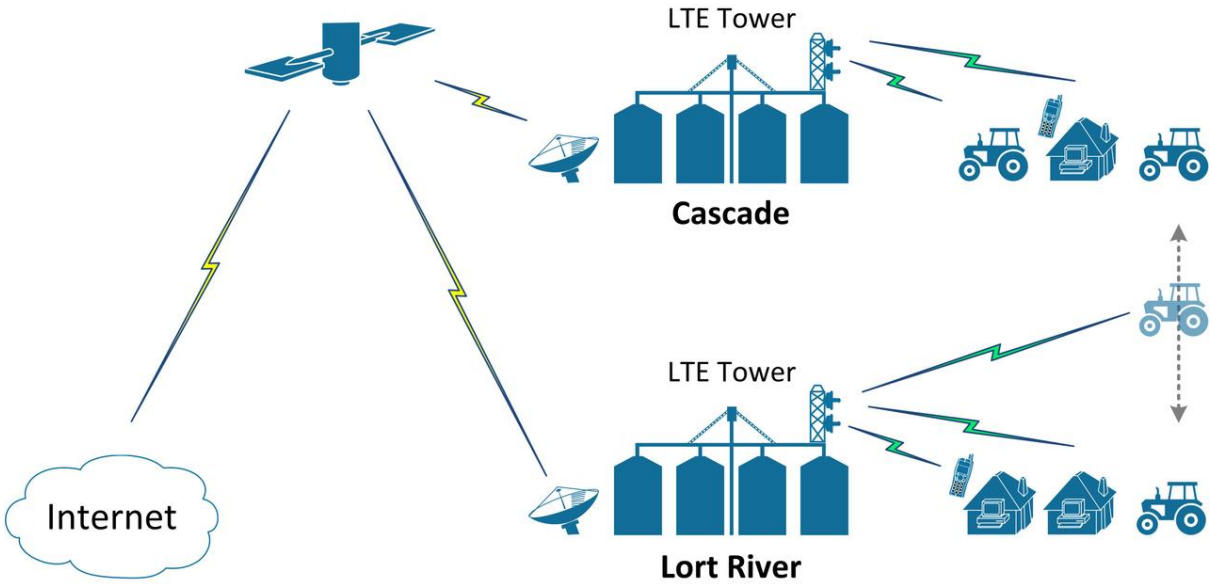
90 Day Trial of a Private LTE-Network within the Esperance Port Zone

Final Case Study Report



Prepared by SEPWA, May 2018

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Executive Summary

During harvest 2017/18 a data network trial using Long Term Evolution (LTE) technology was established in the Esperance Port Zone. The purpose of this trial was to test the performance of this technology as a last mile solution to provide internet connectivity for agricultural producers in a remote, regional landscape.

Two LTE network locations with Optus commercial satellite backhaul were established. The one in the Cascade area comprised of 6 host users operating within a 12km radius of an LTE antenna located at a grain drying facility. The operating footprint of this network was 452km^2. Four types of receiving unit were deployed including a house unit with an antenna attached to the roof, a house unit with no external antenna, a ute kit with detachable roof mounted antenna and a ute kit with antenna fixed to the vehicle.

In the Lort River area, the trial network consisted of 3 host users located within a 12km radius of an antenna located at a decommissioned grain handling facility, giving the network an operating footprint of 452km^2. One type of receiving unit was trialled in this area, a house unit with an antenna attached to the roof. No mobile units were deployed.

The network delivered 4 bar signal strength to all network users in both locations throughout the duration of the trial. Download and Upload speeds were more symmetrical closer to the tower, with Download speeds increasing with distance from the tower. User hosts found the service to be reliable with little change in performance regardless of total network load. Overall feedback also indicated that the service was a bit slow; which was as expected due to the trial's use of satellite to provide backhaul.

In terms of mobile internet access, the trial tested 2 ute kits in the Cascade area. These ute options demonstrated some of the design improvements a more permanent unit would require before deployment. Some of these included front mounting of the antenna so that the driver can see them, ensuring the antenna are lower than the ute cab and ensuring the antenna are robust enough to cope with the rigours of high speeds on bumpy surfaces. The unit inside the ute also needs to be compact and able to be mounted or fixed in position. Unfortunately, the one ute kit which did work relatively well was damaged before SEPWA could make a formal assessment of its performance.

All trial hosts were visited and interviewed about their current data connection performance and their experiences with the LTE trial connection. When they were asked what their key considerations were for evaluation of their internet service they regularly quoted: reliability, coverage, data volume caps and cost.

At the end of the trial, hosts were asked if having reliable, uncapped internet covering their paddocks would make a difference to their operations. All hosts responded similarly; that they were aware of options that would improve the way they ran their businesses and deliver improvements in efficiency of their operations. Technology such as telematics to help with seeding and harvest logistics, variable rate input application to reduce crop production costs and remote monitoring of watering points were highlighted. They also raised opportunities for improvements in staff safety and staff retention rates.

While being aware of some of the technology currently available to improve their business, to date none of the hosts in the trial had fully explored the options. All hosts indicated they felt there was little point in investing time and money in adoption until on farm connection improved. The feedback provided during this project's interviews clearly highlight the correlation between farm technology adoption and the quality of internet connection.

During the 90-day trial period many of the hosts only preliminarily experimented with technology options. The current limited data environment has ingrained an internet use culture amongst rural people to avoid data intensive technologies. As a result, the trial served to stimulate people to consider what technology

might be out there for adoption. Given the trial's limited time frame it did not lead to any ground-breaking changes in user behaviour or investments in new technology at the farm level.

The importance of a local presence to support the installation and day to day function of the network was highlighted during the trial. Issues that required resolution at the local scale ranged from interruptions to power supply at the Lort River Site, to re-location of modems in hosts buildings, and Wi-Fi user connection troubleshooting. This demonstrated that any regional or remote roll out of services would need on ground service personnel to ensure that the network was running, and connections were correctly in place.

During the trial's installation and operation there were several Albany and Esperance based businesses which assisted. The installation and troubleshooting assistance these businesses were involved with provided exposure for them to the LTE equipment. The need for this process in the trial highlights the skill development required to support technology solutions in regional WA. There is potential for new businesses to develop in regional areas to supply and support connection technology as well as to train people in its use.

1.0 Introduction

1.1 Background

WA agriculture is extremely dependent on mechanisation and technology for it to competitively export products to international customers. This reliance on technology has now become a key concern for regional agribusiness as the assumed level of data connection by technology developers does not exist in regional WA.

The problem of data connection is well documented amongst government and industry and WA faces significant challenges in this area. In terms of data connection in regional locations, the problem can be broken down into 2 categories: backhaul and last mile solutions.

Backhaul is the connection of a network of users to the world wide web. Ideally this is via an optic fibre connection, however it can also be in the form of microwave links and satellite connection. The issue for regional users with respect to backhaul centres around difficulty in accessing reliable, affordable data of sufficient size and is a function of both wholesale data market distortion (monopoly single service provider) as well as infrastructure availability. For backhaul to be successfully addressed it will need to be viewed from a state-wide perspective and include key infrastructure partners.

Last mile solutions are the connections between the backhaul termination point and the final user. This can be via copper wire, fixed wireless or mobile phone style Long-Term Evolution (LTE) networks. These solutions require expertise and service providers in regional WA for their installation and maintenance.

In addition, the type of last mile solution that is most appropriate to a regional area depends on the geography, subscriber density, subscriber payment level and overall data requirements. Examples of last mile solutions working in the eastern states are South West Wireless (currently starting to deploy service in WA) and Red WiFi. There are also numerous fixed wireless services privately connected in regional WA as well as the mobile service providers LTE “mobile broadband” connections.

Currently there is a lack of knowledge and independent assessment of last mile data solutions in regional Australia. This trial sought to address this lack of information by offering an assessment of an LTE last mile option.

1.2 Project Scope

This project conducted a 90-day trial of LTE technology as a last mile solution in the agricultural region north of Esperance in the Cascade/Lort River area.

The trial engaged the service provider Ursys to deploy satellite backhaul, provided by Optus Satellite, and last mile LTE radios (with subscriber devices) for the harvest period of 2017. The participating farming businesses in the trial were provided with a house or vehicle receiver unit with unlimited internet connection for the duration of the trial.

1.3 Key Project Outcomes

The key outcomes from the trial were to:

• Understand the key challenges for last mile deployment in a remote location in the agricultural region of WA. To date deployment of LTE technology has primarily been in the mining industry which has significantly different geographical footprint requirements and an aggregated demand provided to a single customer.

• Expose local service providers in southern WA to LTE radio technology and its likely performance as part of upskilling for future last mile solution deployment.

• Test the real-time performance of the service compared to the current regional options.

• Test the user behaviour of the farming clients at a peak period of the agricultural calendar.

• Summarise the findings for government and industry to use in the future development of last mile solutions in the agricultural region of WA.

2.0 Trial Host Internet Connectivity Experience

2.1 Questions Asked

Each host was asked a series of questions at several stages during the LTE trial to gauge their experience with their current internet service and the success of the LTE data connection. Questions asked included:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this internet connection service? Eg. NBN Satellite, Mobile phone network
2. If they had a mobile unit what distance did they have connection for?
3. Without a monthly data allowance restriction has your internet use changed?
4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?

The common response of the trial hosts was unequivocal. During the trial period, given harvest was the focus of their operations, their first priority in relation to use of their internet connection centred on:

1. Business administration, including grain marketing.

2. Access to weather apps to assess weather conditions

3. Employee access for personal use to encourage satisfaction in their employment conditions.

No-one was in a position during the trial period to invest time in to sourcing, learning and using new technology. Hosts were also not keen to put themselves in a position where they were relying on the trial technology for connection at such an important time in their business cycle when they didn't know if they could rely on the internet service being provided. The fact that the trial was offering a temporary service exacerbated this thinking.

As such, hosts preferred to continue with their pre-existing connection methods (even when this meant coming to town) to meet their direct business requirements and so it was the more personal and less urgent tasks that were performed to test the technology. One host did trial use of the technology for Phoenix Live and this was not a successful experience.

It should be noted that personal use during the trial did encompass the use of children's education tools and access to healthcare services which are key aspects to maintaining staff and families in farm businesses.

The views expressed by of one of the trial hosts provided a succinct summary of the current situation in relation to internet connection and technology uptake in the Cascade and Lort River area ….while he could see that there were a range of technology options available for use in his business and he was prepared to invest in connection infrastructure located on his property, and in the region, he wasn't passionate enough to want to get involved in establishing and administering a telecommunications company. He was keen to be part of a solution but did not want to create and be responsible for the "solution." He was in the business of farming not the provision of telecommunication services.

2.2 Grower Responses

2.2.1 Lort River **– All fixed position user locations received 4 bar signal (Blue dots)**

It must be noted that there were interruptions to service in the Lort River area throughout November due to a problem with the power supply to the Lort River LTE tower caused by moisture tripping the RCD switch that supplied power to the site whenever conditions were wet, ranging from heavy rain and hail to light mist. This problem was resolved by a local electrician in early December and there were no interruptions to service from then on.

The process involved to resolve this issue was not driven by the remotely based network manager, Ursys. One host, Farmer B, let SEPWA know when they were unable to achieve connection, SEPWA then contacted Ursys to see what their network diagnostics revealed. Ursys was able to clarify that the problem was most likely a power outage so SEPWA staff visited the site and, through a process of elimination, restored power. After this happened a few times in a row a pattern emerged linking the power outages with rain or days of high humidity so SEPWA sought the services of an electrician and the problem was resolved. The other 2 hosts connected to the Lort River LTE Tower did not let SEPWA know that they couldn't get connection.

i) Farmer A

• Interview Date: 14/2/18, 1/3/18

• Unit supplied for the trial: House unit with external antenna located on the roof.

• Distance between the house antenna and the Lort River LTE tower: 12km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience been of this service?
   Telstra mobile phone tower with WiFi modem in the house. Connection is reliable and download and upload speeds are fast but the expense involved in going over their plan's data allowance is a constant issue that impacts how much time they spend on the internet and what they do when on the internet. In addition, their connection coverage is patchy across the farm with areas of no coverage so they are unable to use in-paddock technology that requires internet connection across their farming operations.

2. No mobile unit was supplied.

3. Without a monthly data allowance restriction has your internet usage changed?
   Farmer A's internet usage has increased for personal use during the trial but because the trial didn't offer a change in mobile internet coverage Farmer A was not able to try out in-paddock options. Given it was harvest, Farmer A chose not use the temporary trial connection for business administration activities, preferring to stick with their existing service located in the town of Esperance which they knew they could rely on.

   Farmer A experienced a lot of problems in achieving internet connection at the start of the trial and was very disappointed with the LTE technology. Following measurement by SEPWA of the data speeds achievable at the house and comparing it to that being achieved by the other 2 hosts linked to this tower, SEPWA personnel visited the site to ensure all devices were linked to the network and were being used to full capacity. Once this support was provided Farmer A's experience of the LTE connection improved.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?
   While the LTE service was slower than their Telstra phone tower service available at their house on the farm Farmer A commented that they still found the browsing experience and download times acceptable and indicated they would use it if it meant they did not have to worry about their data allowance all the time.

   Personally: It would contribute to their leisure time opportunities and enhance their quality of life. For example, they'd love to watch movies at the touch of a button rather than driving for over 2 hours return to pick a movie up. It also means they can be socially connected to friends and family, especially their children.

   For their enterprise: At the moment they use their internet connection for business administration and grain marketing. They would look at utilising more paddock-based technology if they had sufficient in-paddock internet connection coverage to do so.

ii) Farmer B

• Interview Date: 8/2/18, 15/3/18, 16/3/18, 19/3/18

• Unit supplied for the trial: House unit with an external antenna on the roof.

• Distance between the house antenna and the Lort River LTE tower: 6km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   Farmer B uses mobile phones to deliver internet service connected to a Telstra tower. Farmer B finds this service fast and reliable but is constantly managing use so as not to exceed monthly data limits. This is a key influence on user behaviour. For example, Farmer B does not use a lap top to access the internet to look at YouTube or movies because when they do this they go over their data limit and so incur relatively expensive additional data charges. The internet is important to some members of Farmer B's family as tools like social media apps and Skype assist in dealing with the isolation of living over an hour from Esperance and even further from friends and family.

   In terms of paddock coverage to enable the use of in-paddock technology options Farmer B experiences patchy coverage across their farming area so they currently do not experience adequate connection to meet their needs; there are signal dead spots especially near the Lort River.

   In terms of meeting the administration needs of their business Farmer B uses NBN Satellite to deliver reliable internet service that is available when they require it. They are satisfied with this service in that it delivers the internet connection they require to meet the administrative needs of their business. As yet they have not gone over their data allowance as a result of undertaking business administration activities.

2. No mobile unit was supplied.

3. Without a monthly data allowance restriction has your internet use changed?
   Farmer B enjoyed the freedom of a reliable service with no data limits and this definitely meant they accessed the internet more often, for longer periods and downloaded more. In terms of WiFi coverage in the house from the modem, which was installed in the kitchen, they did find they didn't have connection in the far end of the house but connection was reliable in the living room, close to the modem. Farmer B summed up their experience by saying their phone internet access was faster than the Telrad service but they loved the freedom of unlimited data access and they didn't find it so much slower than it impacted the quality on their user experience.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?
   Farmer B indicated they would be interested in using in-paddock technology more in their farming operations but they haven't looked in to options too much because they don't have internet connection over the whole farm so they haven't seen the point. Farmer B thinks that once the issue of patchy internet connection coverage is resolved technology and machinery companies are likely to promote technology options to their clients in the region and bring good ideas to their attention.

iii) Farmer C

• Interview Date: 8/2/18, 16/3/18

• Unit supplied for the trial: House unit with external antenna located on the roof.

• Distance between the house antenna and the Lort River LTE tower: 9km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   Wireless modem connected to Telstra 4G tower. Farmer C has found this service to be reliable and fast enough. They use it to do some bookwork, banking, internet browsing and searching for farm machinery and equipment and to watch the occasional movie. Their data allowance has not been a significant issue for them as they aren't high users of data intense options. They haven't noticed issues with slower internet speeds at different times of the day with their current service.

2. The were not supplied with a mobile unit.

3. Without a monthly data allowance restriction has your internet use changed?
   Their pattern of internet use did not change significantly during the trial, they did watch a few more movies but they did not investigate new business administration or farm operation technology options given the temporary nature of the trial and the fact that harvest was the priority for their time.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?
   Farm Administration – at the moment they have sufficient data access to meet their requirements but this is not the case for the member of the business that undertakes the majority of their enterprise's administration tasks. This person is located further away from the mobile phone tower and does not have as a good a connection service.

   Employee Retention – supporting employees to deal with the challenge of social isolation. Having internet access and significant, affordable data allowances is an important factor in attracting and retaining staff. Most employees now come with the expectation that they will be able to stay connected to their friends and family via social media and use the internet for entertainment.

   In-paddock Technology Options – Farmer C experiences patchy phone and internet coverage across their farms. This impedes their ability to take full advantage of tools like Remote Display Access. Data allowance is a factor on Farmer C's mind given the equipment that comes in their machinery that used to update location data points every few minutes is now doing so every 1 or 2 seconds. With this increased precision comes increased data requirements. They would pursue more high tech options if they had continuous internet access and affordable data allocation.

   In Farmer C's opinion they need reliable, fast (but not necessarily supersonic) internet connection over all or most of their farms. While they can live with speeds slower than urban settings the speeds need to be fast enough to be workable and give the user a positive experience otherwise they won't bother with it.

2.2.2 Cascade – **All fixed position user locations received 4 bar signal (Blue dots)**

i) Farmer D

• Interview Date: 13/12/17, 2/2/18, 20/2/18, 1/3/18, 16/3/18

• Unit supplied for the trial: House unit with external antenna located on the roof and a mobile unit in Farmer D's ute with external Telrad antennas fixed to the back of the ute cab.

• Distance between the house antenna and the Cascade LTE tower: 12km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience been of this service? Eg. NBN Satellite, Mobile phone network
   Currently using Telstra 3G mobile phone tower. Farmer D has found this service to be variable in speed depending on the time of day they are trying to use it (at peak times it's very slow or can't be accessed at all) and quite expensive so they have not used the internet for leisure activities or for education purposes for their primary school aged children. They have not had sufficient download capacity from their existing service to update their device operating systems and apps.

   Farmer D is currently seeking to have NBN Satellite access installed but this has involved delays in deployment. Once installed their expectation is that this service will provide sufficient reliable internet access for them to meet the administrative requirements of the business, a new role for them this year. They don't expect the data allocation will be enough to offer opportunities for their personal time, beyond the use of education apps for their children.

   In terms of in-paddock internet access both phone and internet coverage across their farms is very poor. As a result, they are unable to utilise in-paddock technology to its potential.

2. If they had a mobile unit what distance did they have connection for?
   Farmer D was able to listen to internet radio up to 12km from the LTE tower.

   There was a significant issue with the poor suitability of the equipment provided in the trial to survive the rigours of in-paddock use. The modem unit inside the vehicle was too large, could not be anchored down, did not fit under the seat and required cables running through the ute cab. This was not practical given the ute is required to travel at speed over corrugated paddocks and the cabling was easy to get entangled in.

   In addition, the antenna supplied weren't suitable. Two types of antenna were trialled, both mounted on top of the back of the ute cab. The first set were short stumpy domes but one of these was dislodged going under tress while handling stock before the unit was operational. The second set were hard stick antenna about 400mm in length. The first of these was snapped within a day of installation and the second within a few days of installation.

   Farmer D's experience demonstrated the importance of the antenna for mobile units being front mounted, at a height that is lower than the ute cab and with enough flexibility to handle the rigours of paddock driving (eg whip aerials). In terms of the kit inside the ute, it would be best if it could be located under the seat with cabling secured (eg under floor mats).

3. Without a monthly data allowance restriction has your internet use changed?
   Farmer D did not alter their pattern of use too much as they were not keen to get used to something that would not continue beyond the trial. They did take the opportunity to update all of their device operating systems and apps which they had not been able to do for a long time (as they couldn't maintain connection long enough with their existing 3G service to complete the updates). They did also use their apps to their full potential and access You Tube and shows to have the experience of doing so as this had not been possible for them to date.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?
   Farmer D is well informed about a range of logistics and remote stock management options that are available and can see a lot of benefit from these to improve the efficiency of their farming operation in terms of time, labour and machinery requirements. They are also clear they require significant data allocation and reliability of service to undertake their new business administration role.

   Farmer D can see that reliable internet connection with sufficient affordable data access is important to meet the needs of their staff; helping to both attract and retain staff.

   They are also keen to look at ways to improve their communication options, especially in emergencies such as bush fires, as their phone service is very poor both at their house and across their farms.

ii) Farmer E

• Interview Date: 14/2/18, 19/3/18

• Unit supplied for the trial: House unit with external antenna located on the roof.

• Distance between the house antenna and the Cascade LTE tower: 6km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   NBN Satellite – Westnet is the provider. Farmer E has found their existing internet service to be very reliable. It is a bit slow but they understand that this is part and parcel of connection via satellite. They do have a data limit that they feel they need to be mindful of. Prior to the trial they were going over their allocation but during the trial period they joined the NBN service through Westnet and was able to sign-up to a larger data allocation. They are expecting though that there will be issues with going over their data allocation after the trial because they have been using both their Westnet service and the uncapped trial allocation.

   Farmer E uses the internet for business administration. The adults in the family don't have time to use the internet for personal use but their children do use it.

   Farmer E does not currently use the internet in the paddock as they are constrained by patchy service coverage. At the moment they use apps on their ipad in locations where they can connect to the mobile phone tower and that's as far as it goes.

2. They weren't supplied with a mobile unit.

3. Without a monthly data allowance restriction has your internet use changed?
   Their internet usage didn't change during the course of the trial. For the first 2 months of the trial they were not in the house much as it was harvest time and they were not supplied with a mobile unit to test. Then in January they were away from the farm for a number of reasons. Because the trial was just that, a trial rather than a permanent option, they didn't invest time or money in sourcing and training themselves in the use of apps or software that have the potential to improve their business operations.

   They did give their children permission to access the internet via Telrad to watch Netflix but this privilege was removed during the trial period.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?
   Farmer E is aware of, and interested in, a number of apps and software they have heard about that they believe will make their business operations more efficient and streamlined but they will not be investing time in investigating these options until they know they will be able to use them.

   Farmer E believes that if the issue of connectivity can be sorted there are big opportunities for their business to improve efficiency and that there will be opportunities for local businesses to supply and train people in the use of technology but until there's wide coverage there's no window for this to happen.

   Farmer E also indicated they would like to see the issue of communication addressed in emergency management, especially during natural disasters like bush fires.

iii) Grain Drying Facility

• Interview Date: 7/12/18

• Unit supplied for the trial: A house unit with built in antenna.

• Distance between the Drying facility's office and accommodation facilities and the Cascade LTE tower: A few metres.

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   Currently using Telstra mobile phone tower which does provide a good service but data is limited and relatively expensive.

2. A mobile unit was not supplied.

3. Without a monthly data allowance restriction has your internet use changed? N/A

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation? N/A

5. What was your experience of using the LTE tower for internet connection?

   The employee that used the internet connection during the trial was an Estonian working in Australia for the harvest period. He found the connection stable, finding it didn't drop out at all. He wasn't able to get internet connection inside his accommodation donga as the WiFi signal could not penetrate the building's metal walls but he had good connection just outside his quarters.

   He was able to Skype home (the connection dropped out at the Estonian end but not the Cascade end), upload pictures of his life in Australia, view You Tube videos and use social media apps on his phone. All of these things made a positive contribution to his time working in Australia.

iv) Primary School A

• Interview Date: 7/12/17, 14/2/18, 20/3/18

• Unit supplied for the trial: Two house units with built in antenna, one in each class room.

• Distance between the school and the Cascade LTE tower: 0.55km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   Primary School A has the service determined by the Education Department. They do find their internet connection problematic. During the trial the Department had new WiFi infrastructure installed to improve connectivity for the school campus.

2. They were not supplied with a mobile unit.

3. Without a monthly data allowance restriction has your internet use changed?
   Inclusion in the trial has not changed how Primary School A engages with technology, they use education apps and search engines often with the children but their inclusion in the trial has

provided the opportunity to see how the LTE technology performs with up to 21 users connected to the network at the same time, in the same location.

Initially a modem with no external antenna was installed in the staff room. Signal strength was very good in the staff room and data speed was sufficient that operating system and app version upgrades could be performed on all 21 of the school's tablets at the same time. Internet connection was poor in the Senior and Junior classrooms however, with no connection being possible on a number of occasions.

Signal strength testing indicated that the reason for this problem was that the location of the modem in the staffroom meant that for a WiFi connection to be achieved with a device in one of the 3 classrooms the signal had to go through multiple thick brick walls and a metal backed interactive whiteboard in the case of the Junior Classroom.

This problem was resolved in February when the modem was moved from the staff room and installed in the Senior Classroom and a second modem was installed in the Junior Classroom. The system then performed reliably with approximately 7 devices being used at any one time in each of the 3 classrooms.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation? N/A

iv) Farmer F

• Interview Date: 30/1/18, 2/2/18, 14/2/18

• Unit supplied for the trial: House unit with external antenna located on the roof.

• Distance between the house antenna and the Cascade LTE tower: 3.8km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   The Cascade 3G phone tower which is less than 10km away from their house. The cost of data allocation is an issue as is the fact that this service does not deliver internet connection throughout Farmer F's house let alone across their home farm or the other farms in their business.

2. A mobile unit was not supplied. An Ursys built mobile unit was trialled on one of Farmer F's farms, approximately 10km from the LTE tower on a hill with clear line of sight to the tower, but the signal strength was too poor to pursue trialling this unit. This unit had also not performed well in signal strength testing closer to the LTE tower prior to visiting Farmer F's property.

3. Without a monthly data allowance restriction has your internet use changed?
   Farmer F's internet use didn't change a lot during the trial but they did appreciate having good signal on their devices throughout their entire house rather than having to restrict device use to one end of their home as is the case with their mobile phone tower service.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?

For Farmer F, while they were interested in having internet connection across their farms to look at increased use of in paddock technology, they were primarily interested in having reliable internet connection with sufficient data allocation at not too high a cost to assist in attracting and retaining staff. In Farmer F's experience, employees are coming to work in his business with the expectation that they can use tools like social media, YouTube, Netflix, education apps for children etc to help them cope with the isolation of life in Cascade. Trying to attract and retain employees is a significant challenge for their busniess and this is an area Farmer F can see significant advantage in having reliable internet connection with affordable data volume.

vi) Farmer G

• Interview Date: 20/3/18

• Unit supplied for the trial: A house unit with built in antenna.

• Distance between the modem and the Cascade LTE tower: 7.5km

• Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   The Cascade 3G mobile phone tower but Farmer G moved to NBN satellite during the trial in an effort to ensure they had enough data allocation at a reasonable cost to meet the administrative requirements of their business, for which they use Phoenix Live. Farmer G indicated they had found the LTE Trial connection delivered a better service than their 3G phone tower service but they did find it too slow at times. They had tried using the connection to work on Phoenix Live but experienced dropouts and screen freezes which meant they found it unsuitable for their needs.

2. No mobile unit was supplied.

3. Without a monthly data allowance restriction has your internet use changed?
   Farmer G did not alter their internet use significantly. They did watch a few movies and found the experience OK but they don't have the time to use the internet heavily in their personal lives, their children are too young to have high internet needs and the service was not suitable for accessing Phoenix Live to undertake farm administrative tasks. Farmer G has not invested a lot of time in exploring in-paddock options that use internet connection because they don't have connection across their farms so they haven't felt its been worth investing time in to something that at the moment isn't a viable option.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?
   Farmer G was happy with the data allocation and associated costs for the NBN satellite service they have just signed up to but they have yet to use it enough to test if it delivers the relatively fast, reliable service they are seeking. Farmer G is interested in taking advantage of the in-paddock technology options available to enhance their farming operations if good coverage becomes possible.

vii) Farmer H

• Interview Date: 16/3/18

• Unit supplied for the trial: Ursys made mobile unit in a 3-D printed housing with external antenna mounted on roof of ute when in use with magnets.

- Distance between their house and the Cascade LTE tower: 7.4km
- Feedback on Internet Connectivity, Pre-trial and During the Trial:

1. What's been your farm internet connection for the last 12 months? What's been your experience of this service? Eg. NBN Satellite, Mobile phone network
   Farmer H currently uses the 3G Cascade phone tower with a WiFi modem at their house; they regularly go over their monthly data plan. Farmer H uses this house-based connection to undertake the business administration requirements of their operation and the family also uses this plan. Farmer H uses his phone, with a separate plan, for in-paddock internet access which he uses to send emails or check weather websites. Farmer H also uses their connection to do some variable rate inputs but this is not a routine part of their operation.

   Farmer H has fairly good coverage from the Cascade tower on one of their farms, dropping out only in the hollows. On another of their farms in the Cascade area coverage is poor while on another reception is OK at the back of the block but poor elsewhere. They have fairly good coverage on their Munglinup farm.

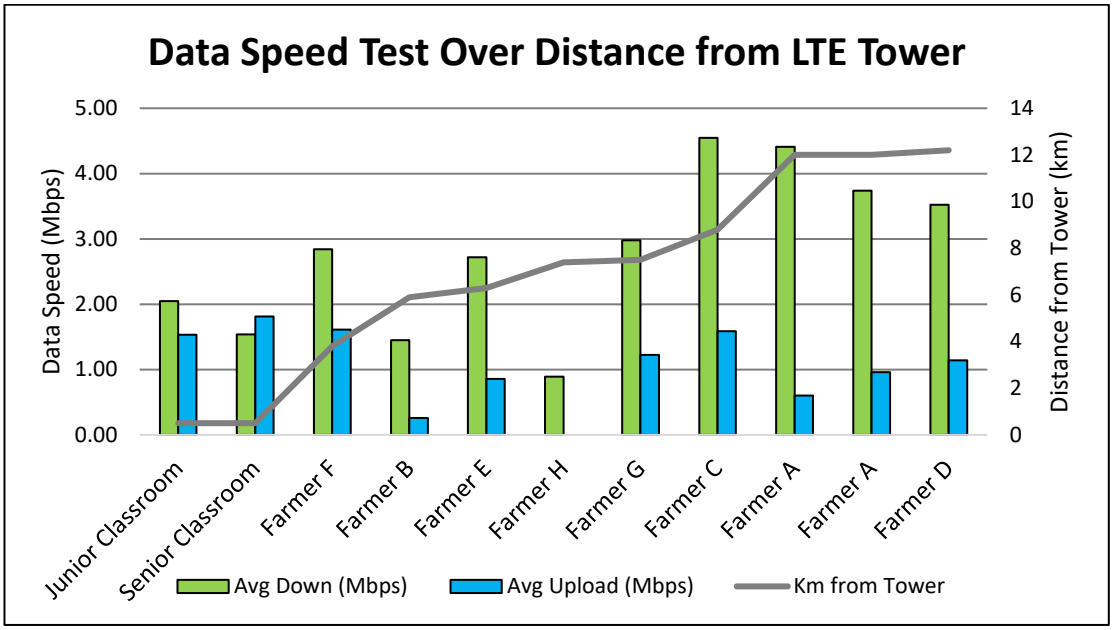
2. What distance was connection achieved for from the mobile unit?
   Farmer H had connection in his ute for about an 8km radius from the LTE tower but only at 1 bar signal strength, a slow download speed and no upload. The coverage was not as good as that achieved with Farmer H's phone internet service in terms of signal strength and coverage. The mobile unit housing was not really robust enough for in-paddock use. It was not able to be mounted securely in the cab and it warped on the dashboard one hot day during February. The unit still worked but the housing was distorted. This was a demonstration unit only and not of a standard for long term deployment.

3. Without a monthly data allowance restriction has your internet use changed?
   Farmer H did not have this experience during the trial because the mobile unit they were supplied with didn't perform well. It was not used for anything beyond testing its range.

4. With a data cap off and internet connection possible is there any technology you would like to consider to change how you manage your operation?
   Farmer H did not experience uncapped data allowance nor improved mobile coverage during the trial with the equipment provided. Farmer H did express interest in pursuing telematic options to assist with the logistical issues that come with their farming operation. Farmer H was interested in looking at ways to improve data connectivity but doesn't want to be purchasing individual units for each farm, they'd prefer it to be part of a network with a large operating footprint.

3.0 System Performance

During the trial SEPWA conducted various speed tests at each host location using the speed test website http://www.speedtest.net/ . The speed test was conducted 3 consecutive times at each location over the trial period to generate the data displayed below. Distances of the host users from the transmission tower (Cascade or Lort River) are also presented in the figure below.



It can be noted that the subscriber units which were closer to the LTE transmission towers provided more symmetrical Download and Upload speeds that those further away. The asymmetric performance achieved as distance increased is a characteristic of radio performance over range. The further away subscriber units are from the transmission tower the more power is required to achieve the same performance as that closer to the tower.

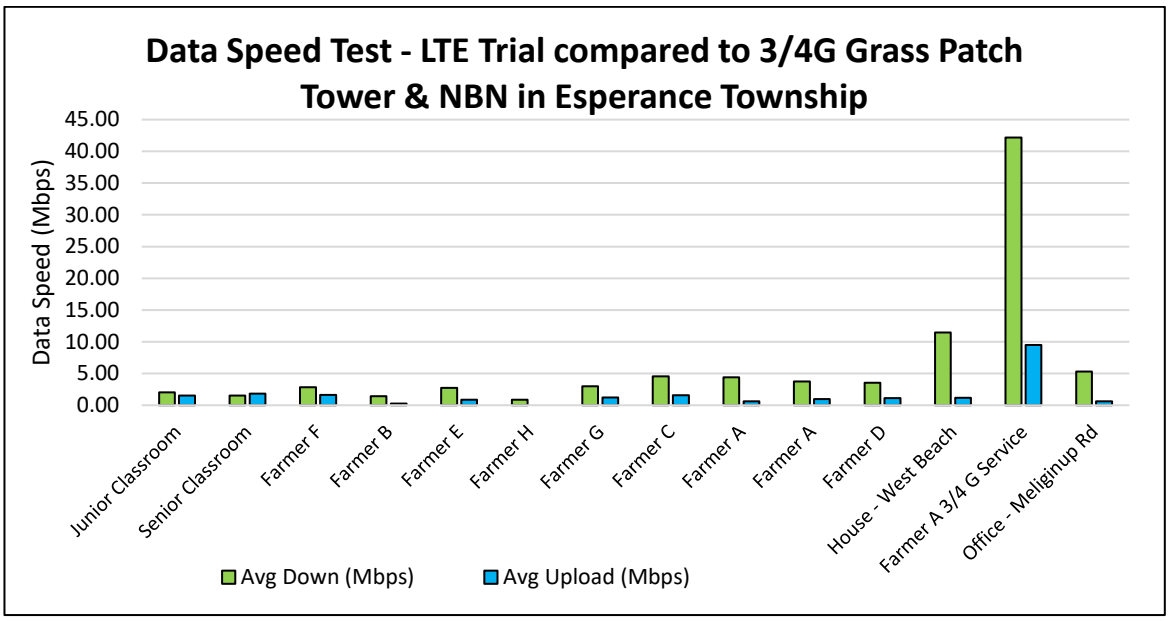
During the trial two signal strengths from the tower units were tested which carried the Download signal to subscribers. This change in signal power output had little effect on the overall network performance and all units had sufficient signal at the lower signal power level.

During the trial the house unit equipment consistently performed at around 3 Mbps for Download and 1.5 Mbps for Upload. While by many advertised data speeds these performance numbers are very low, more than often they were an improvement on the current service level being used by the trial host farmer business. These speed test results may have been greatly improved if there had been a terrestrial backhaul service (optic fibre) rather that the satellite backhaul service that was available. The latency inherent with satellite backhaul was explained to trial hosts to ensure their expectation of data speed was managed from the outset.

Discussion with the LTE manufacturers indicated that significantly higher data speeds were possible however in this trial this was not possible to test due to the satellite backhaul.

In the trial, house units with external antenna performed at full signal (4 bars) at up to 12km from the tower. This data suggests that given good topography the LTE equipment would be able to reach longer distances than those tested in the trial, possibly up to 20km, and still maintain an acceptable level of signal (around 3 bars).

The trial also conducted speed tests for other internet connections including an “in town” Esperance NBN connection (ie. Johns St West Beach). The comparison data is presented below.



It can be noted from this dataset that by far the fastest internet data connection was achieved via the Telstra 3/4G mobile network at Farmer A’s house in the Grass Patch area. This test result is an excellent demonstration of the effectiveness of optic fibre backhaul connected to an LTE last mile connection. The test site tower was the nearby Mobile Black Spot Grass Patch tower via a Telstra house booster kit which provided excellent signal connection. The high speed achieved from this service is also an indication of the relatively low levels of data traffic many regional phone towers have in comparison to an urban environment.

Despite being first grade for speed, the monthly limitation of Telstra 3/4G data volume plans (still in place for many regional locations) as well as this signal being limited to the immediate footprint of Telstra tower are significant draw backs of this type of service and hence don’t offer a farm wide business internet solution. **Ways to extend connection beyond the tower range and with more data volume allowance need to be considered.** The LTE technology used on this trial would definitely offer opportunity for this type of improvement in farm scale internet connection.

As part of the trial SEPWA also tested an urban based NBN fibre to the node connection at John St West Beach. While having close to 3 times the Download speed (11.4 Mbps), Upload speeds were not significantly different (1.15 Mbps). When considering future options for agribusiness data connections a more symmetrical Download and Upload service will more than likely need to be considered than being currently delivered by NBN in a regional urban environment.

Please see attached PowerPoint presentations for information provided at the trial review held at Cascade on the 22March 2018:

- LTE Connectivity Trial – what we learnt (prepared by SEPWA)
- SEPWA Close-out Presentation (prepared by URSYS)

4.0 Conclusion and Recommendations

The LTE solution trailed by SEPWA was shown to be very effective as a last mile distribution of data connection to businesses in regional areas where internet access was required in a fixed location.

Due to the limited bandwidth in backhaul (via satellite) the network was never loaded to a level in which the bandwidth performance of the LTE equipment could be assessed at full-capacity. Combined with this, the user culture of the trial participants and the relatively short duration and temporary nature of the trial meant that we did not see a change in user behaviour. For this reason, SEPWA cannot comment on the technology's future proofing abilities for the ever-expanding data requirements that appear to be associated with new technologies.

In terms of distance reach, all the house-based units performed at the maximum 4 bars signal strength over the full network footprint. Only one of the mobile units was up to a standard where an acceptable performance was recorded. Unfortunately, this unit was damaged before a formal assessment could be conducted by SEPWA. The mobile units deployed in the trial were of a temporary style and were acknowledged by Ursys as being in need of design improvements if they were to be deployed in a permanent network. While we can't recommend the mobile units tested during the trial it is our understanding that there are better mobile units available on the market.

From this trial, LTE technology appears very adequate as a last mile data connection solution. Competitor technology of open source WiFi configuration is somewhat cheaper than the LTE equipment tested and may have provided a similar result but this was not tested in the trial. Anecdotally, the LTE equipment appeared to provide further distance reach of signal than that known for Wi-Fi options which is an important consideration in the sparse landscape of the WA wheatbelt.

It was evident as the trial progressed that an LTE network requires management from some form of remote service provider coupled with on-ground local support. Simple fixes by a local person were required to ensure the system remained in operation and subscribers were connected properly to the network. Without this support any future service could quickly be branded as being of poor quality and no improvement on existing connection options. Currently there are relatively few businesses and trained personnel in regional WA to provide this type of service and any long-term solution would need to consider this skill shortage. It is our understanding that a WiFi based network would require similar remote management coupled with local support to deliver a reliable service to end users.

The LTE equipment trailed in this project appeared to be well built. The LTE equipment included in the project was, however, a step down from the Telco grade equipment used by current mobile phone providers. It is our understanding that the level of network complexity is higher with an LTE network than with a comparable WiFi network. Each subscriber unit requires a SIM card with an LTE network whereas access to a WiFi network is controlled by passwords.

It's important to note that the factors that are considered in the selection of "the best" data solution must include consideration of backhaul connection options and the topography of the landscape to reach subscribers. Both of these factors vary throughout regional WA and the application of a "one size fit's all" approach isn't feasible. Customisation is required to economically reach WA farmers with a business grade data connection into the future.

The provision of satellite back-haul fulfilled the needs of the trial in that it provided backhaul connection in all locations included in the trial, on a short-term basis that was available immediately. Significantly, there simply was no other backhaul solution available in these locations. In our view the uptake of new technology by agricultural businesses will continue to be impeded until this situation is addressed.

Before the business case can be made by individual farming enterprises to invest their resources in new technological options they first require access to backhaul that is reliable, relatively affordable, of sufficient capacity to cope with the data loads and requirements of some of the more sophisticated options, and of sufficient speed to enable smooth operation. Our experience of satellite backhaul during the trial was that it provided reliable connection, of sufficient speed, to facilitate the use of downloaded business administration software and personal use but the data limits and the speeds achievable were not sufficient to enable effective use of Phoenix Live and no-one attempted use of in-paddock options such as remotely based sensors.

From our perspective the State Government has a key role to play in addressing this situation given there are tax payer funded mobile phone towers which are sitting on optic fibre throughout the landscape which could provide the opportunity for regional people to access data backhaul that meets their needs.

To date we have not been able to access this type of fibre connection. As a result of this trial, we have been able to get a quote on fibre connected backhaul purchased from the Grass Patch mobile blackspot tower. This rate was quite expensive which we were not surprised by given that only Telstra fibre terminates at this location. Between the group purchasing power of Government as well as ACCC wholesale requirements on Telstra, it is possible that significant cost reductions could be gained.

This potential solution has been on the radar of various people at the State Government level for around 4 years but so far there has been no resolution. SEPWA feels it's imperative that the State Government leverages historical taxpayer investment in mobile phone deployment and ensures that new investment via the RMCP and Mobile Blackspot programs does more than simply providing extra coverage for a single Telco company.

Without a change such as this (as well as competitive pressures from alternative backhaul providers such as the WA Super Net concept) there can only be piece meal experimentation with alternative data connection in regional WA. The performance of last mile solutions, be it LTE or something else, is dependent on the performance of the backhaul you plug into.

One of SEPWA's key activities during this trial was to visit and interview trial hosts about their current data connection performance and their experiences of the LTE trial connection. When they were asked what their key considerations were for evaluation of their internet service they regularly quoted: reliability, coverage, data allocation and cost. Hosts often mentioned that they were aware of technology options that would improve the way they ran their farming businesses however none had fully explored the options to date due to their current internet connection status. The feedback received during this project's interviews clearly correlate farm technology adoption and the quality of internet connection.

The other common discussion in relation to internet connection was around connection speeds. Consumers often compare speeds at face value and often don't understand the details behind advertised speeds and actual performance. Work needs to be done in this area so that real service delivery can be measured and compared between connection options for regional WA. This trial provided a snapshot of services between various location and connection methods via speed tests. This would be an obvious space for government to gather information on actual service performance levels to add to hearsay and complaints about service performance. This real measured service level could be useful in informing future government policy and investment.