FUTURE FORESTS RESEARCH

HARVESTING TECHNICAL NOTE

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2016

Improved In-forest Communication Methods

Summary

This report explores different communication systems that are available to the forestry industry in New Zealand. Traditionally the forestry industry has used analog VHF radio networks for voice communication, and in the past has been a leader in utilising this technology for business purposes. In recent times, modern communication technology has transformed business. Today it would be difficult to find a modern urban business that is not utilizing the internet and cell phones for communication. Harvesting contractors and workers are often unable to use these devices at their actual workplace, due to the remote nature of many New Zealand logging sites, as connectivity to communication networks is limited. A simple cost effective communication setup is proposed that could deliver high speed internet to even the most remote logging sites. The system requires the installation of a satellite dish and modem and a wireless access point. The setup cost would be less than $4,000 with a running cost of less than $200 per month.

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INTRODUCTION

Modern business is built around good communication systems. Today few of us could work without email, internet, cell phones or large data storage. The New Zealand Government has invested millions of dollars into the Rural Broadband Initiative (RBI) to provide rural communities with the advantages of high speed internet that businesses and consumers enjoy in the larger cities of New Zealand. However in the forestry industry our logging and silvicultural contracting businesses have limited scope for improved communication due to poor cell phone coverage in remote areas where the majority of our forests are located.

Historically, New Zealand forestry has used very high frequency radio (VHF) for communication within the forest. A number of companies own their own networks, most being analog systems, but there is a growing move to implement new digital VHF networks. Although this form of radio communication has served the industry well over the years, changes in the way business is now done mean that forestry could benefit from improved voice and data communication. VHF has the advantage in that its range generally is further than line-of-sight from the transmitter. VHF is also the first band at which wavelengths are small enough to make efficient transmitting antennas for vehicles and handheld devices.

As part of the development of the HarvestNav on-board navigation application (Marshall, 2012) the potential advantages of being able to communicate the location of each machine or worker in the harvesting crew to each other as well as to the contractor back in the office was seen as a huge step forward in safety. Through working on this concept the benefits of improved communication have become apparent, particularly as they relate to data communication, in addition to improved geotracking of machines using the HarvestNav application.

This report reviews the reasons why a logging contracting business should look to implement improved communication for both voice and data. The communication options are discussed, and based on the research undertaken, a low cost option is proposed which could have significant benefits for harvesting contractors.

OBJECTIVES

The following is a list of applications in forest harvesting where modern communications could improve a logging contractor's business.

1. **Health and Safety** – The New Zealand forestry industry needs to improve its health and safety performance. Health and Safety software is increasingly been offered as cloud-based services, for example Mango Live (http://www.mangolive.com/) and Hasmate (http://www.hasmate.co.nz/). Having these systems available on the harvesting site would significantly improve reporting times, and would also allow safety notices and updates to be communicated out to crews in real time. In a life and death incident situation, having easy and direct access to emergency services is critical to the long term health of the patient. Under the current situation where only VHF radio is available communication with service requires radioing in to the radio headquarters. The patient gets very little in the way of privacy, and neither do they get direct access to emergency services. With access to

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HARVESTING TECHNICAL NOTE

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either satellite phone or a Voice Over Internet Protocol (VOIP) service, quick, direct and private communication with emergency services would be available.

2. **Online Virtual Office –** Health and Safety, environmental and other legislative requirements are increasingly requiring harvesting crew foreman to carry a large range of manuals and documentation in their trucks. These paper-based documents could be eliminated by simply loading the digital copies onto a laptop or tablet. The next step forward which would be possible with logging site data communication would be to implement an online library of documentation. That way all crews would be using the same up-to-date documentation which can be controlled in a partnership between forest managers and logging crew owners. Having access to email and the internet would mean that ordering of supplies and parts would be faster as it could all be done over the internet. This would reduce delays for waiting for new parts and in turn increase productivity.

3. **GPS Tracking –** In an industry such as logging where there are many machine-to-machine and machine-to-human interactions per day, risk of accidents is great. Knowing the exact location of all the machines and people around you is critical in reducing the risk of accidents on a logging site. However the location of other people and equipment around you can only be made available to you with an effective on-site communication system. The ability for offsite managers of both the harvesting crews and forests to monitor the processing of harvesting equipment has a wide array of benefits from machine productivity monitoring to improved harvest reconciliation.

4. **Online Visitor Book –** It may seem a simple concept but the idea of having an online (real-time) visitor book has a number of benefits. Having the visitor book online means that all authorized people can access and know who is on site at any point in time. Combining this with GPS tracking (as described above) of visitors would mean that each visitor's location and purpose is known to all, which should result in improved safety around the work site.

5. **Trucking Interactions** – The management of the interactions between harvesting crews and cartage contractors is an area where significant gains could be made to increase the overall productivity of the industry. It is now common practice to have logging trucks equipped with GPS trackers, allowing trucks' locations to be communicated back to their dispatching office. With access to data communication, the GPS location of the trucks could be communicated to the logging crews in real time. This would allow crews to better manage their loading equipment as well as their stocks. Improved skid site loading time would improve the overall efficiency of the whole forestry supply chain.

6. **Production Monitoring and Stock Management –** Interpine Group Ltd is currently offering a harvesting data management system called Sticks. Sticks was developed by an Australian-based company called ForestPhD. If a crew was connected to the internet, the production data could be transferred between the processing machine, the Sticks database and the contractor's office in real time. Tree Metrics, a company in Ireland, is offering a similar service that uses satellite communication. Access to email would significantly improve the current practice of calling stocks.

7. **Security –** Due to the remote nature of most logging sites, security is always an issue. The main security issue facing most harvesting crews is theft of diesel, as well as tampering with equipment. With an internet connection, live web cameras could be installed which would allow monitoring of the site 24 hours per day, seven days per week. Cheap wireless motion sensors could be placed on the doors of machinery and on other valuable equipment, and out-of-hours motion could be recorded and notification sent to the appropriate people (security, police, or equipment owner).

8. **Voice Communication** – As most logging sites in New Zealand have no cell phone coverage, communication is limited to VHF radios. Depending on the communication solution chosen, a second private form of voice communication could be provided. Satellite phones are the logical solution, but this requires a significant investment in hardware and plans. With satellite internet, VOIP applications could be used to provide cheap voice communication for all crew members.

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HTN08-06
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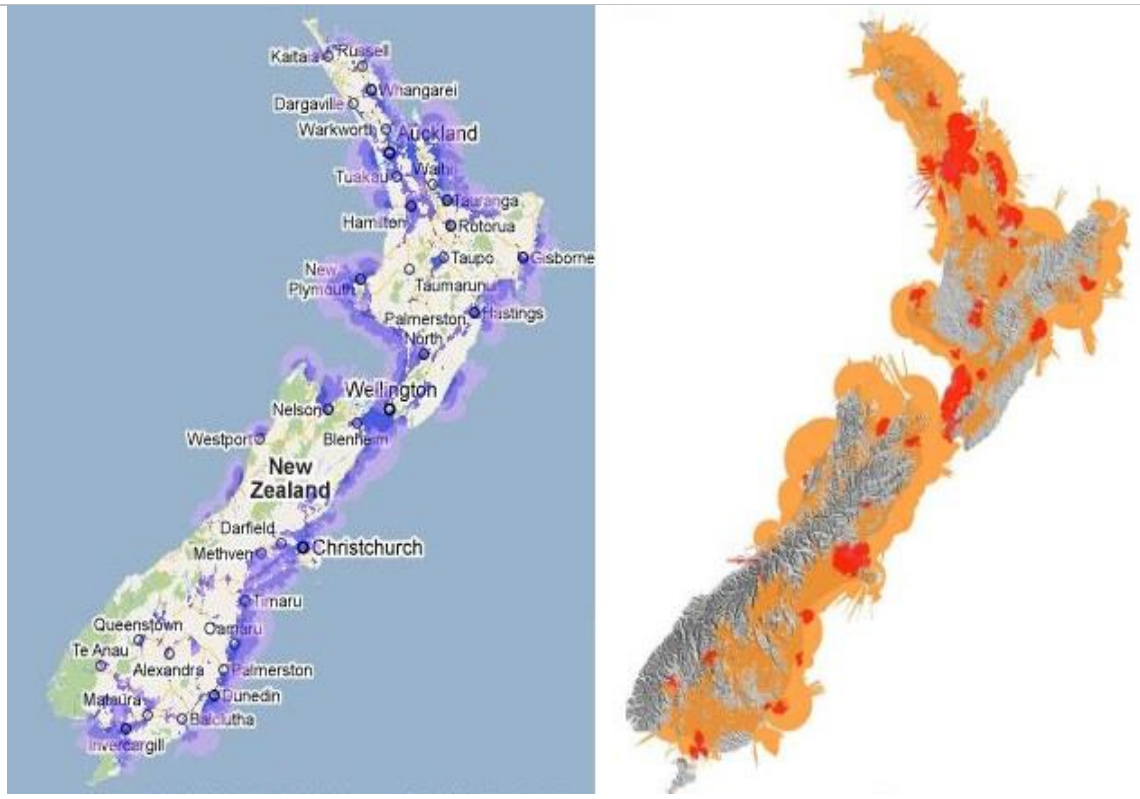

Figure 1: Network coverage maps of the New Zealand Spark network (www.spark.co.nz – left) and the Vodafone network (www.vodafone.co.nz - right)

METHODS FOR IMPROVED COMMUNICATION

Potential methods of improving in-field communication for both voice and data communication in the New Zealand forest industry include:

Mobile Phone Networks

Utilization of available cell phone / mobile networks is the simplest way of improve both voice and data communication. There are hundreds of mobile devices that connect to the internet through 3G/4G network, so finding network and software to communicate on the network is straightforward. However New Zealand's limited market size and difficult terrain means that the cell phone networks cover only a small portion of New Zealand plantation forests.

Figure 1 shows the coverage maps for the Spark and Vodafone networks.

The coverage maps above can be deceptive as localized black spots mean that coverage can be patchy in hilly terrain even if there is a cell phone tower in close proximity. Although having cell phone / mobile coverage at the work site has huge advantages, there are issues due to the network access not being controlled by the employer. For example, in the construction industry it is common practice for personal mobile phones to be confiscated due to health and safety concerns.

Rural Broadband Initiative (RBI)

The Rural Broadband Initiative (RBI) was conceived when the New Zealand government acknowledged the challenge of delivering better broadband to rural areas. RBI utilises fibre optic connections to long range wireless technology to provide high speed internet to rural communities and locations such as schools. RBI would still require an internet plan with an RBI internet provider, of which there are many, but once connected the internet experience will be similar to internet at home or the office. There will still be a need for a wireless access point to connect Wi-Fi enabled devices to the internet. Wi-Fi is a registered trademark for a popular wireless networking

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technology that uses radio waves to provide wireless high-speed Internet and network connections.

Figure 2 gives the projected RBI coverage for New Zealand. As with the mobile phone coverage map, it can be deceptive as localized black spots mean that coverage can be patchy.

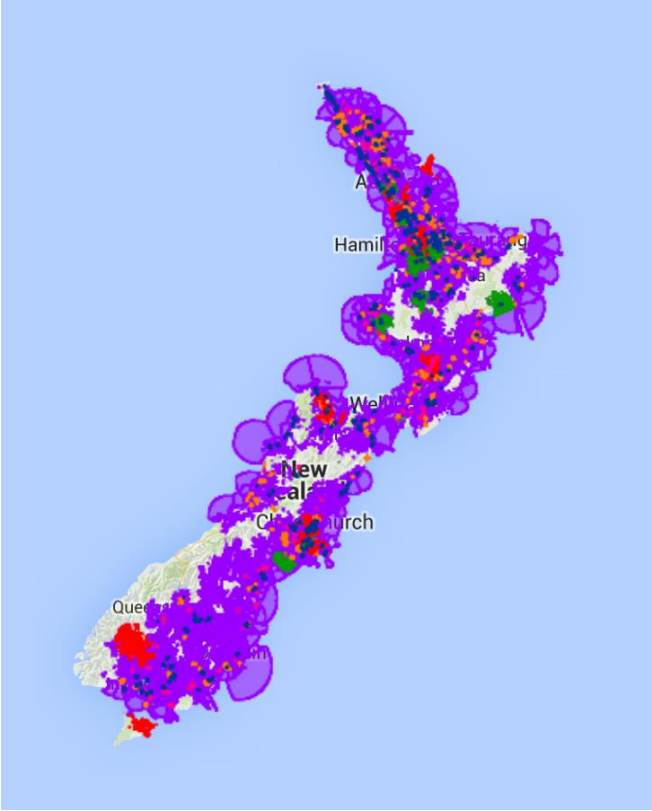

Figure 2: Projected RBI coverage

Digital VHF Radio Networks

Currently the New Zealand forestry industry largely utilizes the analog radio network, which is mostly privately owned. As mentioned earlier, this network has several limitations for modern communications. However, it is possible to implement a digital radio network which has a number of advantages over the existing analog network. This allows both data and voice to be transmitted over the network simultaneously. Old analog radio networks could transmit data, but it was very limited. Most modern digital radio equipment can transmit text messages etc. using data rates in the 1,200-19,200 kilobit-per-second range, and have the capability to carry data as found in Internet Protocol. This means that virtually anything can be sent or received. This allows the number of applications, in particular those transmitting data across the network, to increase dramatically. Digital VHF networks do require all new equipment to be installed, such as radios and receiving and transmitting equipment. A number of forestry companies such as Pan Pac Forest Products Ltd and Summit Forest Management Ltd have already implemented digital radio networks in their estates.

Satellite Phone Networks

There are number of satellite phone providers globally, including Iridium, Globalstar, and Inmarsat Global Satellite Phone Service (or GSPS). As an example of a satellite phone network, the Iridium network uses a constellation of 66 Low Earth Orbit satellites about 780 kilometres above the earth surface. The satellites orbit once every 100 minutes. A user only has to have line-of-sight between their Iridium antenna and one of the Iridium satellites for a connection to be obtained. The signal is then transferred from one satellite to another satellite until a connection can be achieved with a ground station. For more information see (http://www.satconnections.co.nz/iridium.php). The Globalstar network is similar to the Iridium network with data transfer rates of 256 kbps.

The following are examples of how satellite communication is currently being used in logging applications:

- **Southstar Equipment** offers Startrax, a communication system that utilises satellite phone communication to send and receive production reports, grades, assortments, machine information or instructions. The system can send text, emails and GPS tracks (http://www.southstarequipment.com).
- **John Deere** offers JDLink on their forestry equipment. It sends machine performance information from the machine back to John Deere so they can monitor the mechanical health of the machine. It also can send geolocation data which can be used by the contractor using a smartphone app to track the whereabouts of their machine.
- **Personal Tracking Devices.** A large range of personal tracking devices such as SPOT and inReach is now used in forestry contracting companies as a health and safety tool. Both devices use the satellite phone network to transmit GPS information from the device back to the office.

Each network has slightly different costs but it seems whether making a voice call or transferring data the

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cost is around $1.50-2.00 per minute plus a monthly fee of $50. The hardware costs are approximately $2000 for an Iridium phone, $600 for a Globalstar phone and $1700 for a satellite hotshot device such as Iridium GO!

Satellite Internet Networks

There are number of satellite internet providers in New Zealand, such as Wireless Nation and Farmside. These providers do not use the same satellites as the satellite phone network. Farmside uses the IPSTAR satellite but can also use the Eutklsat CE23, whereas Wireless Nation uses the OPTUS D2 Satellite. The Wireless Nation's satellite broadband can achieve download speeds of 10 Mbps download, which is equal to standard broadband speeds. All that is required is a satellite dish and a satellite modem. Most often the costs of these are covered if a customer signs a contract for two years. The satellite dish is required to be aligned correctly with the satellite. Self-aligning dishes are available but are extremely expensive. Satellite Internet plans start at approximately $100 per month.

Low-Power Wide-Area Networks

A new start-up company called Kotahi.Net is starting to roll out LPWAN (Low-Power Wide-Area Network) across New Zealand. They currently have coverage across only the Wellington City region. A LPWAN is made up of a number of local networks, each serviced by one or more gateways. Each local network can cover a radius of 20 km in open rural areas, but forest and terrain will affect that range significantly. The data transfer speed on this network will be slow compared to the cellular or satellite networks, ranging from 0.3 kbps to 50 kbps. The network is designed for data from remote battery-powered sensors to a centralized server connected to the internet. The suggested cost is $1 per month per end connection. For more information see: www.kotahi.net. This network is not designed for transferring large amounts of the data required for such things as voice communication etc.

SUMMARY OF COMMUNICATION NETWORKS

Of the six communication networks presented in this review, only the satellite-based networks have complete coverage. The mobile and RBI networks are unlikely to have coverage required by all the industry. In some of New Zealand's plantation forests connecting to these networks will be possible and could be utilized. The new LPWAN has some potential but it is limited to sending only small amounts of data.

As mentioned earlier, a number of companies have already switched their radio network across to digital from analog. This switch means that data can be more readily transmitted using the network, but it requires a significant investment in new radios and transmitting equipment.

This project has identified a solution using a satellite internet network that could deliver all the advantage of the other networks at much lower cost.

PROPOSED SYSTEM

For forestry locations without a digital radio network and outside of the cell phone and RBI networks, the options for modern data communication are currently limited to the satellite networks. The satellite phone networks have significant potential in the forestry industry, and are currently been utilized by some industry members, but the cost is still extremely high.

Based on the research undertaken for this project, the potential of using satellite internet to improve communication has been identified. Most harvesting sites in New Zealand use a second-hand shipping container as a crew "smoko" or equipment shed. This is often designated as the safety zone. The concept is to place an internet satellite dish on the shipping container. This dish would need to be connected to a modem housed inside the container. This modem would then be connected to a long range wi-fi access point. This would provide high-speed internet across the logging site in much same way as internet is provided in homes and offices. This system has recently been implemented at Volcanic Plateau Harvesting Ltd (Steve Yeoman's logging crew) in the central North Island of New Zealand (Figure 3).

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Figure 3: Satellite internet dish sitting on equipment container at Volcanic Plateau Harvesting Ltd (Photo: courtesy of Goetz Roth)

SYSTEM COMPONENTS

There are three components to this new system:

- **Satellite Internet Connection**
  The connection requires a satellite dish, modem and power supply. These can be purchased from any of the satellite internet providers, or as indicated above most often will be provided as part of a two-year contract. The setup of the dish and modem is relatively straight forward, the only real issue being that the dish needs to realigned every time it is moved. This would mean that every time the crew "smoko" shed has to be moved the dish would need to be realigned. It is important it is aligned correctly as a misaligned dish can affect to the performance of the whole network. Wireless Nation provides a range of internet service for remote location focusing on RBI and satellite internet. The cost of the satellite equipment was approximately $1500.

- **Wi-Fi Access Point**
  There is a range of Wi-Fi equipment that can be used to transmit an internet connection around the logging site. There are three main Wi-Fi frequencies used in the industry, all of which are free to use and do not require users to hold a RF licence:

  1. 2.4 Ghz – Most normal home and office Wi-Fi networks work on this frequency. All Wi-Fi enabled devices are able to connect to this frequency.

  2. 5.8 Ghz – This is a high band width frequency and can carry significantly more data than 2.4 Ghz. It is also less susceptible to interference as this frequency is not as crowded. However its range is significantly less than 2.4 Ghz. Given these characteristics it is probably not suitable for this application.

  3. 900 Mhz – The 900 Mhz (924 Mhz) frequency can also be used under the General User Licensed RF bands. 900 Mhz is seen has having better ability to penetrate through trees. It has a lower band width than both 2.4 and 5.8 Ghz so data transfer rates will be significantly lower than the other frequencies.

  As part of this project a number of 900 Mhz and 2.4 Ghz access points and long range Wi-Fi antenna were tested to determine their performance in different situations which were

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similar to those in logging operations. The testing showed the 2.4 Ghz worked well in line-of-sight situations even through a reasonable distance of radiata pine forest. Using this equipment an email could be sent from over 1900 metres direct line-of-sight with no interference, or just over 250 metres of which at least 25% of the distance was through 20 year old radiata pine trees. No real advantage was found with the 900 Mhz equipment.

Most of the applications described in this paper would require the connection to be available only around the skid site, based on the testing carried out as part of the project – this would easily be achieved using 2.4 Ghz equipment. The 2.4 Ghz equipment also has the advantage that it is the frequency used by nearly all phone, tablet and laptops to connect to a Wi-Fi network.

- **Power Supply**
  A satellite modem and Wi-Fi access point will require a power supply. Both could be run from a solar-based power system or a generator. The modem requires 24 volt (2.91 amp) power supply and the Wi-Fi access point requires 48v (0.5 amp) power supply.

CONCLUSION

The key benefits of having internet at the work site using the proposed system are:

- Coverage – Anywhere there is a clear view of the sky with an azimuth of between 311.8-324.1 degrees and elevation of between 35.4-46.8 degrees above horizon will get coverage. The exact location in the sky depends on where in the country you are located.
- Data Limits – The minimum data limit through www.wirelessnation.com per month is 6 GB with up to 50 GB of free off-peak data.
- Speed – Significantly faster than digital radio and satellite phone networks. Speeds of 10 Mb download and 1 Mb upload speeds.
- Wireless Connection – With the correct wireless equipment any number of devices could be connected to the internet via this system.

The only really limitations / disadvantages of this system are:

- The system requires a stable platform from which to monitor the satellite equipment and house the modem and Wi-Fi equipment.
- Depending on the satellite used, the dish size will range from 84 cm to 96 cm. This will mean that the dish will need to be protected during transportation of the platform to which it is attached.
- The satellite dish needs to be realigned every time the platform is moved. The process is not particularly difficult but does require the right equipment and training. If the dish is not aligned correctly with the satellite, the internet provider will likely cut off the connection.

The combined setup cost and running cost are extremely low. The total setup cost of the system would be less than $4,000 dollars (including power supply). The monthly running cost is less than $200 excluding periodic costs associated with realigning the dish when shifting forest locations.

This report has explored different communication systems that are available to the forestry industry in New Zealand and the potential uses of improved voice and data communication technology in a logging business. A simple cost effective communication setup that could deliver high speed internet to even the most remote logging sites has been proposed.

REFERENCES

1. Marshall, H. 2012: On-board Machine Stability Information System. Harvesting Technical Note HTN05-01. Future Forests Research Limited, Rotorua, New Zealand.