Unison's Secondary Communications Network

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Abstract

This paper will discuss UNL's experience with the MiMOMax Wireless Point-to-Point Network Digital Link (NDL) and Point-To-Multipoint Digital Link (MDL). UNL is using a combined NDL and MDL system to provide higher capacity wireless communications, primarily for SCADA purposes to its rural zone substations.

Introduction

Unison Networks Limited (UNL) is the electricity distribution company for Hawke's Bay, Taupo and Rotorua regions. UNL is trust owned by the electricity consumers of Hawke's Bay and has in total approximately 109,200 Installation Control Points (ICPs).

Over the last four years UNL has been progressively replacing its communications infrastructure with modern equipment as an enabler to the Smart Grid. This new communications infrastructure consists of a primary and secondary network. The primary network is built on multicore single-mode optical fibre and runs between UNL's urban zone substations in all three regions, effectively terminating in the UNL Control Room in Hastings. The fibre network is a Layer 2 802.1ad network.

UNL's secondary communications system is based on wireless communications technology, specifically a mesh radio system and a narrowband Multi Input Multi Output (MIMO) radio system. This paper discusses this secondary communications network.

Narrowband MIMO Communications Network

Over the last 18 months UNL has been testing a narrowband Multi Input Multi Output (MIMO) communications system, developed by MiMOMax Wireless, to provide SCADA and remote access services to Eskdale, which is a rural area to the north of Napier.

MiMOMax Wireless is a New Zealand company that was spun off from the Tait Advanced Wireless Technologies Group and produces a full duplex IP radio, which operates in licensed 12.5 or 25kHz UHF (450MHz) channels. It has a spectral efficiency of 16bit/s/Hz, which equates to an effective (measured) data rate of 220kbits/s in a 25kHz channel [4]. This quite remarkable spectral efficiency is achieved by the use of MIMO technology.

MiMOMax Wireless produces two basic products, they are:

1. Point-to-Multipoint Digital Link (MDL)
2. Point-to-Point Network Digital Link (NDL)

The MDL is a point-to-multipoint narrowband (12.5 or 25kHz) IP radio system specifically designed to support SCADA. The MDL system consists of a single Base Radio Unit (BRU) that can connect to up to 1,020 Remote Radio Units (RRUs). The RRUs are typically connected to RTUs via an IP connection. To maximise the total number of RRUs that can be communicated with, the BRU is typically located on an elevated site, similar to a VHF repeater. The MDL system uses adaptive modulation and steps from QPSK to QAM16 through to QAM256 (nitro option) to achieve the specified data rate [4].

The MiMOMax NDL is a point-to-point Network Digital Link (NDL), consisting of a couple of Linking Radio Units (LRUs) and is typically used to communicate between two fixed sites.

All the MiMOMax radios (BRUs, RRUs and LRUs) contain two separate transmitters and two separate receivers. It is this, along with a 2-port (horizontal and vertical) antenna that enables a single radio link to produce pattern diverse MIMO signals which increases both signal quality and path resilience. Due to the effective doubling of hardware the cost of the current MiMOMax radios is currently considered by UNL management to be too expensive for use with devices such as ENTEC switches. However, the MDL system is ideal for the more data rate intensive applications such as communications with UNL's rural zone substations or switching stations.

In the Eskdale trial a combined MDL and NDL system was tested. The NDL, consisting of a couple of LRUs, was installed between the Tamatea substation and the BRU which was installed on the most elevated UNL pole in the Eskdale area. The Tamatea substation is the most northern fibre equipped substation in the Hawke's Bay region. RRU's were installed at the Eskdale substation, Smith's Road switching station (33kV) and on an ENTEC switch (4259). This combined MDL and NDL system replaced an unreliable telcon cable, which linked the Tamatea and Eskdale zone substations and the Smith's Road switching station. Figure 8 contains a Google Earth map showing the location of the various sites.

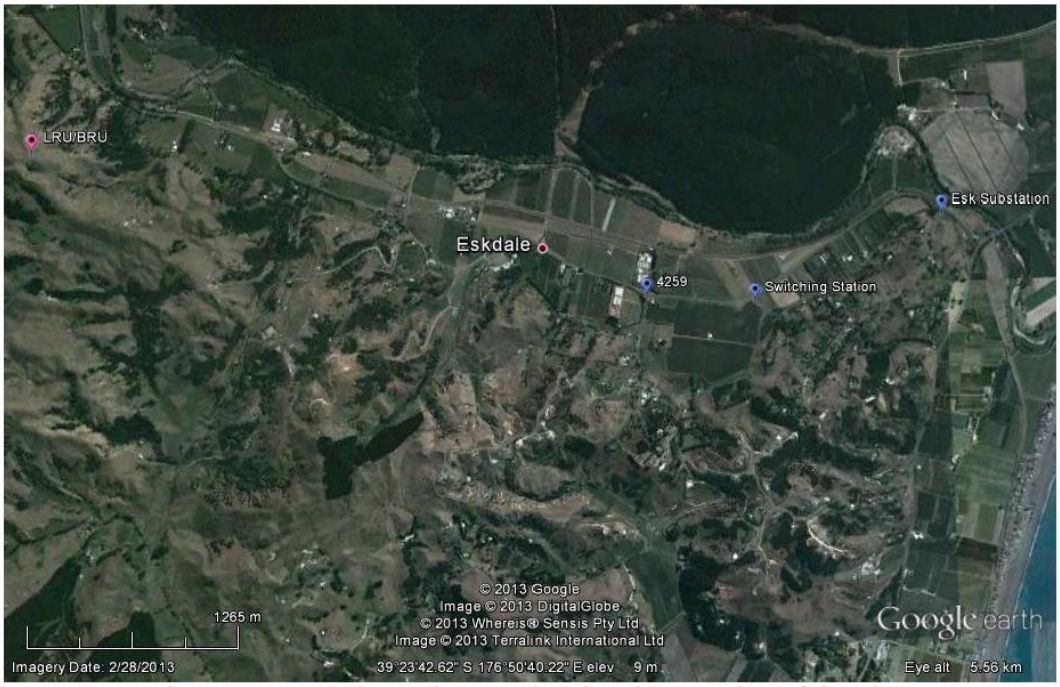

Figure 8: A Google Earth Map Showing the Location of the Sites

With respect to Figure 8, the Tamatea substation is not visible, but is approximately 13.5km to the south east of the LRU/BRU site. Due to the pine forest at the top of the map the link to the Eskdale zone substation is not line of sight.

Figures 9 and 10: Photographs of the BRU and LRU Installed on the UNL Pole and the RRU Antenna at the Eskdale Zone Substation Respectively

With respect to Figure 9, the stainless steel cabinet contains an inverter and batteries and provides approximately 6 hours of power in the case of supply failure. The BRU and LRU are located either side of the cabinet. In Figure 10 the antenna is a dual loop Yagi antenna. This antenna provides double the gain of the standard antenna, with a halved horizontal beamwidth. The reader's attention is drawn to the trees adjacent to the substation. This is very much a non-line-of-site link.

Apart from a few teething issues both the NDL and MDL have performed exceptionally well. Both products perform exactly as specified on their respective data sheets. Data rates of 220kbits/s have been measured in all sorts of weather conditions using IPerf. Typical latencies are 30ms for a 32 byte packet from the UNL Control Room to the Eskdale zone substation.

Due to the success of the Eskdale trial, UNL is currently installing another combined MDL and NDL system to provide SCADA and remote access services to all four of UNL's rural zone substations in the Hawke's Bay. These zone substations currently communicate via two VHF repeaters. The BRU has been installed at Te Waka, which is a Chorus site at an elevation of 1029m that overlooks the entire Hawke's Bay. An NDL link has also been installed between UNL's Headquarters in Hastings and Te Waka. The distance between these two points is 68km. This link is currently being tested.

Once operational the intention is to augment this network with an additional NDL and MDL system to provide redundancy. The BRU will probably be installed at the Chorus Kahuranaki site.

UNL has ordered the new Tornado radio from MiMOMax Wireless and is eagerly awaiting delivery. The intention will be to trial these radios in NOVA Reclosers in rural Hawkes Bay.

The MiMOMax systems and the mesh radio network are not mutually exclusive. For instance the author could envisage using say a MiMOMax NDL to provide a backhaul for an isolated island of mesh radios.

Conclusion

Over the last four years UNL has been progressively replacing its communications infrastructure with modern equipment as an enabler to the Smart Grid. This new communications infrastructure consists of a primary and secondary network. The primary network is built on multicore single-mode optical fibre and runs between UNL's urban zone substations in all three regions, effectively terminating in the UNL Control Room in Hastings.

UNL's secondary communications system is based on wireless communications technology, specifically a Silver Spring Networks mesh radio system and a narrowband MiMOMax Wireless Multi Input Multi Output (MIMO) Point-to-Point Network Digital Link (NDL) coupled to a Point-to-Multipoint Digital Link (MDL). Both of these systems are currently performing well and will be expanded into the future.

References

[1] Middlemiss G., Tesla Consultants Ltd, "Smart Grid Communications Network Report", November 2009

[2] Silver Spring Networks, "Product Data Sheet - Bridge", December 2012

[3] Hi-Tec Aerials NZ Ltd, "Product Catalogue", August 2004

[4] MiMOMax Wireless Ltd, "Point-To-Multipoint Digital Link (MDL) Data Sheet", November 2012