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## CANTERBURY EARTHQUAKE

**"The earthquake simply confirmed our choice of UHF IP radios as a mission-critical communications solution. There was, and still is, no other alternative"**

*- Neville Digby  
Senior Systems Engineer*

On the 22nd February 2011, a 6.3-magnitude earthquake struck one of New Zealand's largest cities, Christchurch, claiming at least 180 lives and causing catastrophic infrastructural damage throughout the entire region. This was the second major earthquake to hit the region since a 7.1-magnitude quake struck Christchurch and the surrounding province of Canterbury in September 2010. The second quake was New Zealand's deadliest earthquake in the past eight decades. Power and phone lines went down, and many cellular sites became either quickly congested or disconnected. Thousands of commercial, industrial and residential entities throughout Canterbury and Christchurch lost voice communications and power. The following is a study of how one utility's network fared during and after the earthquake.

### **PROFILE: ORION NEW ZEALAND LTD**

#### **CHRISTCHURCH'S ELECTRICITY DISTRIBUTION NETWORK**

Christchurch and central Canterbury's power distribution network is owned by Orion New Zealand and is one of the largest electricity networks in New Zealand. The network covers 3,000 square miles of diverse geography, including Christchurch City, Banks Peninsula and adjacent high country. It delivers electricity to about 193,000 homes and businesses.

Orion's foremost priority was to develop a cost effective, spectrally efficient, sophisticated communication network, that they were able to independently monitor and control. MiMOMax Wireless had already provided Orion with the Optimized Protection Variant (OPV) and the Network Digital Link (NDL), which they used to connect power line Protection Relays.

Orion's urban substation SCADA communications were carried by a privately owned fibre and DSL network. One of the predominant challenges Orion faced when specifying their network requirements, was the need to transmit sophisticated SCADA IP through wireless links, over long distances at the fastest possible rate with low latency and high reliability, consuming as little spectrum as possible.



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### **NETWORK: ORION'S MISSION-CRITICAL COMMUNICATIONS NETWORK**

Orion utilises an independent, integrated and hardened private communications network that has been specifically designed to meet their requirements for both mission-critical voice and data. The network topology was customized to ensure high performance and very reliable mission-critical communications, especially under adverse environmental conditions when other systems may fail.

The network is comprised of various telecommunications technologies, including copper symmetric digital subscriber lines (SDSL), fibre-optic cables and MiMOMax UHF point-to-point and point-to-multipoint intelligent IP radios. Combined, these technologies provide a complete and comprehensive mission-critical communications solution including tele-protection, supervisory control and data acquisition (SCADA) and packet-based Ethernet IP data. Copper SDSL and fibre-optic technologies service the central Christchurch area and are primarily deployed underground within the urban centres of Orion's network, while outer Christchurch and Canterbury are predominantly serviced by MiMOMax UHF IP radios.

Orion's innovative network topology is designed to provide redundancy, versatility and flexibility even during adverse circumstances. Strategic and thorough site engineering coupled with robust software protocols ensures that the network remains either operational or is able to be swiftly and remotely repaired and re-routed if outages do occur. All highly critical communications sites have access to at least two communications paths.

Orion's core mission-critical communications network does not utilize public access solutions, such as leased lines and public microwave or cellular networks. As a result, they are able to retain control, reliability and independence of their private network, which ensures very high security and enables them to better serve their customers during both crises and day-to-day operational activities.

### **FATAL DISASTER: THE EARTHQUAKE STRIKES**

When the earthquake struck in February, severe damage was sustained to both Orion's communications and electrical networks in some areas. Thousands of commercial, industrial and residential customers throughout Christchurch lost power because of tripping protection equipment and infrastructural damage. Massive earth movement stretched some underground cables up to 1 metre and caused more faults than Orion would normally see in a decade. Four substations were severely damaged. Some network equipment in Christchurch's central business district (CBD) was either damaged from falling debris or covered beneath condemned buildings. "In some areas, the shaking was so violent, wires were simply pulled off poles and the barge boards of houses," says Roger Sutton, former Orion CEO. "The earthquake caused large transmission lines to clash together, producing some pretty spectacular fireworks displays." Much of Orion's communications equipment originally built into concrete or immersed within liquefiable soils was instantaneously torn apart or stretched beyond functional tolerance, including both underground copper SDSL and fiber-optic cables. Orion reported that because copper SDSL cables were smaller, more malleable and were laid at blunt angles, they withstood further shock and sustained less damage compared with fiber-optic cables. Despite this, the intensity of the quake destroyed about 10 percent of SDSL cables and more fiber-optic cables, preventing critical SCADA communications and leaving a number of areas in the network inaccessible.

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*The earthquake caused large transmission lines to clash together, producing some pretty spectacular fireworks displays"*

*- Roger Sutton*

**"Because our wireless radios operate in licensed UHF frequencies and have relatively widebeam antennas, antenna towers can be skewed up to 45 degree angles and still retain functionality"**

- Neville Digby  
Senior Systems Engineer

While wired communications equipment was damaged from the force of the quake, Orion's hardened UHF IP radios continued to perform. Overhead and underground cable damage was not a factor. Tower misalignment from ground movement also did not affect the IP radios as they operated in licensed UHF frequencies using wide beamwidth antennas. Days and weeks after the quake, staff realized that a number of radio antennas were in fact skewed from aggressive land movement, but maintained communications. Other telecommunications providers experienced network failure when their microwave solutions ceased to operate after microwave towers tilted from the force of the quake.

The advanced remote software capabilities of Orion's MiMOMax UHF IP radio communications enabled the network to promptly and automatically facilitate recovery efforts minutes after the quake. Remote radio reconfiguration and fault repair functionality meant that when minor disruptions were experienced the UHF IP radio network was able to self-heal and re-route almost instantaneously. This eliminated the need for network operators to physically commute to substations if a path was down, which was a particular advantage given that many Christchurch roads were destroyed by land movement, flooded from liquefaction and grid-locked by traffic.

One of Orion's UHF IP radios at a central point-to-point base station radio became inaccessible because of further infrastructural disturbance from aggressive aftershocks. The radio network automatically used rerouting adaptation protocols to reroute the data to the next available radio link. The protocols prevented data loss and network disturbance during subsequent aftershocks. After investigating the network, an official reported no apparent data loss even during and seconds after the quake.

When Orion became blind to areas of its network that were inaccessible, they initially worked to restore functionality by connecting to the remaining public cellular towers to gain visibility, assess the damage and determine where repair efforts were needed. However, the cellular sites proved ineffective because of congestion from heavy public use and limited capacity to operate from reserve power. As a result, critical SCADA data was transmitted intermittently, preventing a reliable and consistent communications link from being maintained.

Seeking alternatives, Orion installed an additional MiMOMax UHF IP radio to connect to their fully operational mission-critical radio communications network. The UHF IP link was installed in the middle of Christchurch, over a 12 kilometre non-line-of-sight path. This IP radio link provided Orion with the network visibility they required to restore electricity to some of the severely affected areas of their network.

During the weeks after the earthquake Orion began to repair existing communications equipment and deploy alternative solutions to restore less critical communications links. However, in the minutes and hours after the quake when Orion needed immediate, reliable and robust communications, it was their UHF IP radio network that continued to perform. Underground and overhead communications cables stretched and snapped while robust IP radios continued to operate.

Orion reiterated that their MiMOMax UHF IP radios assisted to restore areas of both their communications and electricity networks. This was due to the well-engineered topology of the radio network and the radios' robust software protocols and ability to promptly self-heal. Engineers reported that they noticed nothing out of the ordinary with the performance of the radios, which meant one less thing to worry about when other areas of the network experienced severe disturbance.

**ORION'S CHOICE OF UTILISING A MIMOMAX SYSTEM IS ESTIMATED TO HAVE SAVED THE REGION OVER \$250 MILLION IN ECONOMIC LOSSES**



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### **AWARD WINNING:**

In 2012 Orion New Zealand Limited was awarded the prestigious Apex Award by the Utilities Telecommunications Council (UTC). UTC is an American body which represents critical infrastructure operators worldwide, and this is the first time an Apex Award has been granted outside of the United States. UTC acknowledged that Orion's earthquake response was of a standard that would, in its view, not normally be achievable and that Orion is a world leader in this area.

This award recognises utilities that employ communications networks to benefit the communities they serve. To determine who should receive the award, UTC looked at the impacts of the service provided and the difference it made within the community.

A statement from UTC informed that "Orion won the Apex Award because of its private mission-critical radio communications network which withstood all of the Canterbury earthquakes, allowing teams to start restoring power immediately while maintaining communications in the field. This innovative wireless technology was vital to Orion's response and created benefits for the entire community, as it shortened the length of power cuts."

### **THE FUTURE: LESSONS LEARNED & FUTURE PLANNING**

Technical specialists from Orion have since reported that their mission-critical UHF IP radio network was highly resilient, reliable and performed well relative to the magnitude of the earthquake. While areas of their network were inevitably severely damaged, Orion attributed a speedy recovery to the high-quality equipment, network architecture and structural reinforcement deployed throughout the network.

Orion and other international communications specialists alike have emphasized the importance of deploying high-quality, mission-critical communications solutions and having a strategically planned, well-engineered and highly reliable hardened network topology. The consensus was that without the strengths of both during an environmentally challenging event, many mission-critical communications networks are likely to be more susceptible to damage, poor performance or, in the worst instance, failure.

The Christchurch earthquake demonstrated that while Orion had a well-integrated, robust and durable communications network, privately operated UHF IP radio communications solutions continued to perform when overhead and underground cables, public cellular and microwave solutions failed. While public systems went down from damage, loss of connectivity and congestion, during and after the fatal earthquake, Orion retained a significantly high level of independence, control, accessibility and certainty of their privately operated communications network.