VIRTUAL ASSESSMENT WITHIN 24 HOURS OF A DISASTER

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ABSTRACT

Imagine your network has just sustained a direct hit from a hurricane, flood, wildfire, or earthquake. Hundreds of kilometres of poles are lying flat on the ground, trees are strewn like matchsticks, and power lines dangle or rest directly on the wet ground. Thousands are without power and the disaster zone extends for kilometres with roads inaccessible due to flooded rivers and debris. If this has happened to you before, how did you handle it? What would have improved your recovery time?

Precise 3D virtual world asset models can be created by efficiently modelling infrastructure from fixed-wing aircraft combined with rapid cloud computing and analytics. Used in disaster response mode, the same infrastructure can be even more quickly mapped, modelled, and then compared against the pre-disaster model to detect changes in the assets and all surrounding features including trees, structures and roads. The result is a comprehensive picture of extent and severity of damage from which important decisions can be made to strategize, assess, and prioritize response efforts. This has created the possibility for completing disaster assessment in hours compared to days, and reducing total recovery times to days from weeks, saving millions of dollars and turning the lights back on much sooner.

This very technology was deployed by Ergon Energy of Queensland, Australia in response to a Category 5 Cyclone (Marcia) which struck Queensland in February 2015. Ergon achieved significantly faster than normal restoration times; more than 64,000 customers were restored in only 10 days - an achievement that had taken 23 and 28 days to restore for two previous events of a similar magnitude within the last six years. Ergon also utilised a virtual world asset model disaster assessment to model flood extent and damage to their network for the 2010 flood in Bundaberg, Queensland, Australia, and the Australian government also completed a full damage assessment following a large 2013 bushfire in Tasmania.

BACKGROUND

Severe tropical cyclone (TC) Marcia made landfall as a category 5 cyclone at 8am Friday 20th February 2015 at Shoalwater Bay, North of Yeppoon, Queensland. The cyclone then weakened steadily as it moved Southward over land during the day. The town of Yeppoon received significant damage, and wind gusts up to 156 km/h were recorded there as the cyclone passed to the west. A storm surge of 2 metres was recorded at Port Alma, but luckily this occurred near low tide.

The weakening cyclone passed over Rockhampton during the early afternoon of Friday 20th February 2015, where wind gusts up to 113 km/h were recorded and again significant damage occurred. Marcia then turned to the south-southeast and impacted the town of Biloela early that evening, where wind gusts to 85 km/h were recorded. Marcia was finally downgraded to a tropical low at 2am on Saturday, February 21st 2015.

Coastal Crossing Details

Crossing Time: 8am AEST Friday 20th February 2015
Crossing Location: Shoalwater Bay
Category when crossing coast: 5

Extreme Values during Cyclone event (estimated)

Maximum Category:	5
Maximum sustained wind speed:	205km/h
Maximum wind gust:	295km/h
Lowest central pressure:	930hPa

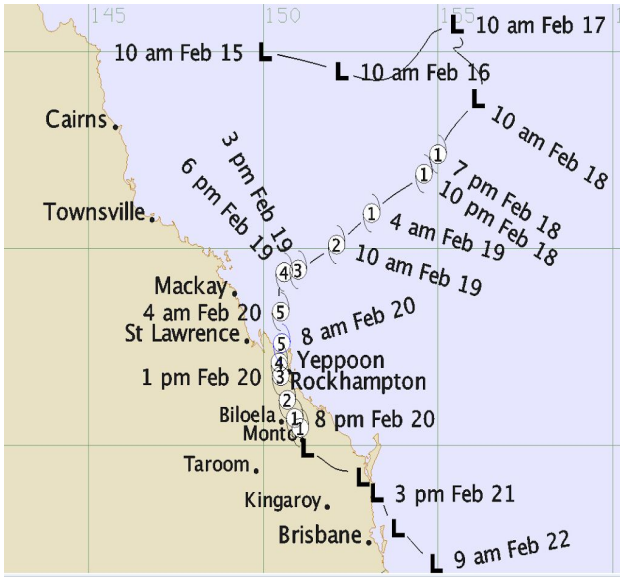

Figure 1: Track of Tropical Cyclone Marcia

Virtual World Asset Management

Ergon Energy pioneered the development of Virtual World Asset Management (VWAM) in mid 2000's after a series of disasters in Australia cost many people their lives. Due to this development and movement into remote sensing for asset inspection Ergon Energy has modelled all their overhead line assets in precise 3 dimension for a number of years.

The 3D digital representation of their overhead network enables Ergon Energy to have a baseline with which to compare any event that may cause the network to change.

Once it became clear TC Marcia would hit the coast in Queensland Fugro were instructed to mobilise and prepare their VWAM system, Roames, as a part of their Disaster Response framework for VWAM services.

Ergon Energy required the following:

- Quick Response - Mobilize equipment (aircraft and sensors) and report within 24 hours
- Provide visualisation layers within a GIS system (Camera, Grey Scale) to assist Ergon to identify asset impacts
- Provide information to assist Ergon to identify damaged assets
- Service the community, and provide situational awareness to Government departments in their response

Aircraft equipped with remote sensing sensors; airborne Light Detection and Ranging (LiDAR) scanners and medium format cameras were deployed within hours of the cyclone passing through the affected area.

The acquired data was processed using highly automated algorithms and cloud processing facilities within 24 hours of acquisition.

Standard processing of these datasets using OEM processing software and technicians could take up to a week to complete. This would have resulted in the utility supplier being heavily fined for breaching their regulatory requirements. Having the near limitless processing power of the cloud and automated algorithms allowed Roames to provide this response within a timeframe acceptable to Ergon.

VWAM output consists of the following output generated from the data:

- 3D model of all poles, wires, buildings etc. with correct voltages applied and all associated attributes such as pole height, wire length etc.
- Analytics that allow for quick interpretation and assessment of the network and its surrounds - a method to query all geospatial elements quickly and accurately
- Determination of clearances to objects such as vegetation, buildings and roads.

Damage Assessment

The data collected from the post disaster event was pushed through the pipeline within 24 hours after acquisition had been completed.

Automated algorithms assessed the network and its surroundings and provided a report of the effects on the overhead network.

The summary of the damaged reported within the path of the cyclone can be seen below:.

- Fallen Powerlines - 393
- Low Conductor - 189
- Fallen Pole - 28
- Debris/vegetation on powerline - 44
- Damaged building - 479
- Debris across road - 607
- Damaged Road - 41

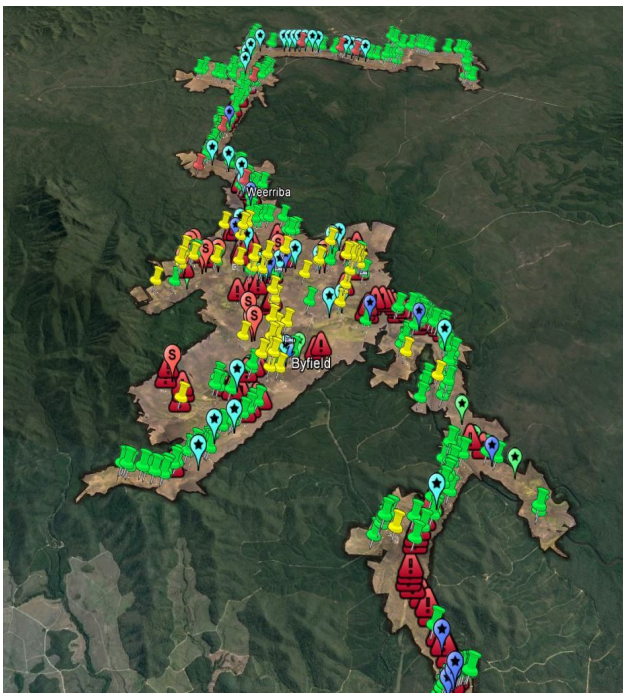

Figure 2: Overview of the Byfield area with storm damaged assets highlighted

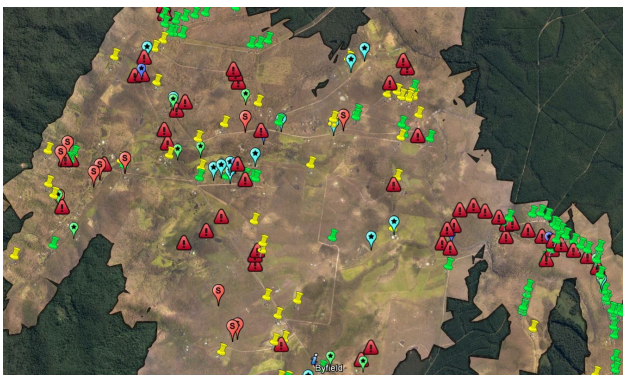

Figure 3: More detailed view of Byfield area with storm damaged assets highlighted

Typically this information can only be collated after the field crews have returned to the office once the disaster response is over which can be anything up to 3 to 4 weeks post storm. To have this information available within 48 hours of the cyclone passing provides numerous benefits to the utility supplier.

In total there were approximately 64,000 customers without power after the cyclone passed through the central Queensland area and with the Roames virtual world data all connections were restored in a record breaking timeframe..

Ergon Energy established a Disaster Response Committee who were responsible for the safety and coordination of 1,000 Ergon and Energex employees on the ground. The committee met twice daily to monitor progress and prioritise field crews. It also sent twice daily reports to the State Government.

VWAM Advantages post disaster

Utilising the detailed analytics, 3D network model and imagery layers produced through the VWAM programme allowed Ergon Energy to perform a comparison between the baseline collected in previous years and the post disaster flight. This allowed Ergon Energy to quickly and precisely detect changes in the assets and all surrounding features including trees, structures and roads. The result is a comprehensive picture of extent and severity of damage from which important decisions were made to strategize, assess, and prioritize response efforts

Routing

One of the biggest challenges facing emergency services and responders is routing information allowing vehicle access to the worst hit areas in most need of assistance.

One of the most common causes for access restrictions are fallen trees on roads. VWAM is able to integrate road network information and analyse constraints and blockages such as fallen trees on road and use this information for coordinating routing information for more efficient vehicle access to affected sites.

Priority Circuits

Using the Roames analytics Ergon were able to identify the order in which circuits should be restored based on the extents of damage (e.g. backbone or spurs), criticality of feeder, and the number of households each feeder supplied.

The routing was also factored into this selection to ensure that feeders with access issues had an increased number of crews working on it to restore the connection more rapidly.

Potential Safety Risks

Normal practice after a storm is to mobilise as many field crews as possible and get them into the field immediately. However with limited communications in these disaster areas and not being able to 'see' the extent of the damage the crews can be exposed to numerous safety risks.

Both the Roames 3D network model and imagery layers

were invaluable in the process of identifying potential risks prior to dispatching of crews.

David Gray Ergon's Regional Asset Manager provided the following assessment of the Roames response.

"The data provided by ROAMES in the Operations Control Centre gave Ergon the first picture of the entire battlefield at Byfield" We have used this information to best determine where to send our field crews as well as place our generators."

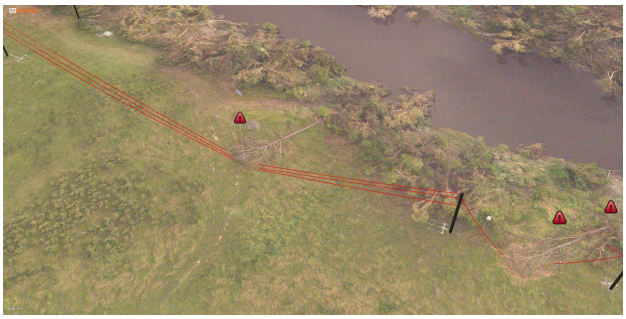

Figure 4: Roames imagery & 3D network highlighting downed trees on the network

Conclusion and Lessons Learnt

Ergon achieved significantly faster than normal restoration times; more than 64,000 customers were restored in only 10 days - an achievement that had taken 23 and 28 days to restore for two previous events of a similar magnitude within the last six years.

The key priority issues from the lessons learned are noted below.

Things that went well

- Early, regular, frequent communications
- Provision of raw data turned around efficiently
- Speed of obtaining data
- Having the ability to contact Network Optimisation liaison for advice and direction
- Getting planes in air quickly meant getting data earlier
- Initial information (imagery and network) was able to be used to locate Pegasus correctly - major benefit - used as a staging plan
- First pass data - imagery and network – was a key input into reducing time to remediation

Things that could be improved or done differently

- Could have had planes started earlier had area of interest GIS files been available earlier
- Having maps that shows history of where the cyclone has crossed the coast so can predict where cyclone will impact – undertake earlier planning for likely placement of planes and identification of priority feeders
- Need to have advice on where to fly and what order – prioritisation
- Data preparation required beforehand to understand key data capture locations
- Multiple aircraft would speed up data capture
- Who in Ergon uses this and operationalises it - choose correct/trained people to assess data and make decisions
- Ensuring the right feeders are prioritised - ensure it is ready within 24 hours of cyclone hitting
- Network images before and after are very important to help identify circuits that could be at risk from future storms.

Other disaster applications

There are other disaster scenarios where VWAM can play a critical roles in understanding scale of the disaster and the efforts required to restore electricity supply to customers.

Queensland Floods

VWAM provides an affordable means for a utility to identify and manage assets at risk to flood water breaches and the management of these assets in the event of a flood.

A proactive approach can be applied to the management of floods both before, during and after the event. This approach mitigates possible electrical safety events related to the flood and a more coordinated and planned approach to flood management.

VWAM Flood Modelling provides an assessment of flood inundation scenarios and their footprints across all areas captured, identifying assets exposed to flooding within these footprints that may be breached by flood water. Identification of flood inundation footprints and associated assets affected improves the mitigation of related electrical incidents.

This product was successfully deployed by Ergon Energy during the 2010 flood events in Queensland. A series of

floods hit Queensland, Australia, beginning in December. The floods forced the evacuation of thousands of people from towns and cities with at least 90 towns and over 200,000 people affected. Damage initially was estimated at around A$1 billion before it was raised to A$2.38 billion.

Three-quarters of the council areas within the state of Queensland were declared disaster zones. One such council was Bundaberg. Fugro were tasked by the council to acquire data to populate the Roames VWAM system. These analytics were used to identify the parts of the OHL network that were cut off by the rising flood waters and report any damage on the network.

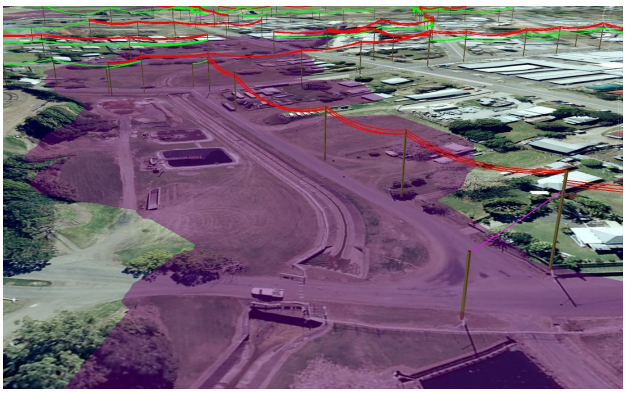

Figure 5: Roames 3D Network model and 2010 Flood extents in Bundaberg, Queensland

Tasmanian Bushfires

Climatic conditions in certain parts of Australia mean that there is a significant chance of bushfires particularly during the long, dry summer period. A number of the utility providers have a 'bushfire season' which runs between December and March each year.

In 2013 a series of bushfires struck south-eastern Tasmania. Overall the fires destroyed 20,000 Hectares, 170 buildings and resulted in the death of one firefighter.

Consistent with similar electricity networks in Australia, the Tasmanian electricity infrastructure (particularly in the semi-rural and rural areas) is predominantly of an overhead construction consisting of bare conductors supported by poles and towers crossing farmland, bush and vegetated areas. This type of construction carries an inherent public safety and environmental impact risk in the event of a bushfire.

As part of the disaster response programme initiated by the Australian Federal and State Governments Fugro were instructed to mobilise and prepare their VWAM system. Roames was used to rapidly identify the damaged and destroyed OHL network and the information gathered was used as part of the emergency services response programme.

Figure 6: Aerial View of bushfire at Copping/Forcett

Acknowledgements

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