The East-West Microwave Radio Relay System – Recollections

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Abstract: The revisiting of the 1971 paper, 'The Australian East-West Radio Relay System', in this issue of the *Journal* has stimulated this author to recall several of the design challenges encountered with the project in the early 1970s, and the engineering solutions achieved.

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The East-West Radio Relay Project

I joined the Postmaster General's Department as a Class 1 Engineer in 1970, just as the East-West Radio Relay System was entering its initial construction phase. I had the good fortune to be assigned to Radio Communications Maintenance, where I was given a free hand to observe the project and to learn everything I could about the system.

The demand for trunk connections between the cities of Australia and the regions was growing rapidly and there was an urgent need for Perth to be connected to the Eastern States, which already had a growing network of coaxial cable and microwave radio links. The East-West Radio Relay System was the beginning of addressing that demand.

It was recognised very early that there were many challenges. The distance was approximately 2,400 km through sparsely populated, inhospitable country with temperature ranges from 0°C to 50°C. The necessity for the lowest possible energy footprint drove many innovations. The 2 GHz band was chosen specifically because the available technology offered the best chance of meeting the low power requirements. It was also thought that 2 GHz would have better propagation characteristics. A trade-off was that the number of voice channels that could be carried per bearer was limited to 600, compared with 960 for a 4 GHz system at the time.

Some meteorological tests undertaken in the feasibility stage by the Telecom Research Laboratories showed that there were potential radio propagation problems arising from the

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interface of dry air from the continent and moist air from the Great Australian Bight where the route followed the coastline. It was thought that switched space diversity on selected paths and the backup standby bearer would deal with all but the worst events.

All solid-state electronics meant lower energy demand but also lower transmitter power. Low loss preformed elliptical waveguides offset this disadvantage. Equipment shelters were designed to be passively cooled involving a thin-skinned inner shelter, shaded by an insulated outer shelter with natural convection cooling between the two.

Power was to be provided by wind generators charging lead-acid batteries through a deep charge/discharge cycle. This avoided the common telephone exchange battery problem of excessive hysteresis, which could result in the complete loss of backup power — but it did require special plate design to minimise gassing and to extend the battery life.

With all of these innovations, things were bound to go wrong.

On the first section between Port Pirie and Ceduna, the preformed waveguides were found to be significantly out of spec. Fortunately, the sub-contractor, Andrew Antennas, accepted full responsibility without dispute and replaced them all at their own expense. This level of customer support was a winner for Andrew Antennas and contributed to Andrew became the supplier of choice for microwave antennas for decades.

The solid-state power amplifiers proved to be unstable and had to be reworked in the field to achieve the required group delay to support 600 voice channels. The equipment shelves had a roll-up plastic connector to the backplane running the full width of each shelf. The heat generated by the equipment caused these to delaminate and so a replacement design was introduced.

Amongst the first things to fail were the wind generators. Whether this was a design problem or a lack of understanding of the stresses is not known. The wind generators were abandoned, and power had to be provided by the local generators refuelled by tankers. This was a major lost opportunity for the PMG, which could have led the way in both wind and solar power generation.

The radio propagation problems also proved to be much more severe than anticipated. As weather patterns moved from West to East, moist air from the Great Australian Bight rolled under the dry air from the continent creating a non-linear refractive index profile, which trapped the radio signals causing rapid loss of signal level to the microwave receivers. Neither space diversity switching nor standby bearer switching could keep up with the changes. This might last half an hour on one path and then move on to the next, often causing several hours of severe disruption to the route.

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At this time, the Murdoch press was hiring a 2 Mbit/s data link on the route at night to print *The Australian* newspaper locally in Western Australia. You can imagine the pressure.

A few years later a test path was set up between Wigunda and Yangoonabie (about 40 km) using a 6 GHz 1800 channel system with phased combination space diversity. The tower heights were increased, and the 6 GHz antennas were located above the 2 GHz antennas, contrary to the standard design rules. This combination proved able to overcome the problem. The provision of the 6 GHz system was accelerated with increased tower heights and space diversity provided on all paths.

The passively cooled shelters proved to be very successful. They became a model for some major projects in the future, such as the Dampier to Perth pipeline communications system. The shelters were designed by the Telecom Structural Engineering Group and were prefabricated in a Perth factory before being trucked directly to site.

Contractual Implications

Under the terms of the contract, the delays meant that GEC would be liable for liquidated damages of some $600K ($8.6M today). GEC protested this but, after high-level negotiations, they paid the liquidated damages but received an equivalent amount in return for a series of reports which were of questionable value.

This was an unfortunate outcome, which undermined trust between the organisations. In fact, GEC did address all the problems within its control except for the wind generators; and the PMG chose not to pursue this. The radio propagation issues were by far the most serious problem, but they were not within the control of GEC.

Concluding Remarks

Despite the many challenges, the project was undoubtedly a great step forward and paved the way for a high capacity 6 GHz system which was largely free of radio propagation problems, and which was expanded as required to meet demand for many years.

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