FASTER THAN FIBRE
CONNECTING THE NASDAQ AND NEW YORK STOCK EXCHANGES

Rowan Gilmore, CEO and MD, EM Solutions
Brisbane-based microwave company EM Solutions and its links subsidiary, EMClarity, have recently completed installation of a network of 5 Gbps radios to interconnect New York Stock Exchange servers with those of the NASDAQ exchange.

Designed, developed and manufactured in Australia from intellectual property contributed by both organisations and CSIRO’s Digital Productivity Flagship, the network is currently undergoing commissioning and acceptance testing, and will shortly provide unprecedented speed and latency to financial traders.

The multimillion-dollar development resulted in a commercialised product that transmits and receives data at fibre-like rates, but with 20% faster end-to-end propagation time than fibre. The new E10G radios, operating in E band at 80 GHz, support data throughputs three times faster than the closest radio competitor, over link distances twice the length, at benchmark latency.

The advantage of radio
Because radio waves propagate through air faster than through fibre, wireless links achieve lower end-to-end latency. This makes radio preferable to fibre for applications where microseconds matter, such as with high-frequency trading.

However, microwave wireless systems lack the capacity of fibre to carry large volumes of traffic. Because mmWave systems can use much larger bandwidths to support data rates of several gigabits per second, E-band systems are growing in popularity to carry data traffic as volumes explode. Unfortunately, the transmission distance of E-band links has been limited, preventing their widespread adoption for wireless backhaul.

The classic way of increasing hop length between radios is to increase the transmitter power, but at mmWave frequencies the power is limited by the available transistors and power amplifiers. An alternative is to increase the antenna gain — doubling the diameter of an antenna increases the link budget by four times (6 dB) per end, or 16 times (12 dB) for each hop. The most common E-band antennas are 300 mm in diameter; therefore, using a 1200 mm antenna achieves a significant improvement in link budget and, consequently, range.

Unfortunately, such a large antenna will have a beamwidth of just 0.25° at E band, a pencil-thin beam narrower than a laser pointer. This makes it impossible to manually align two ends of such a link several kilometres apart, or to maintain such alignment when the antennas and their towers are subjected to wind or temperature changes that arise during normal operation. Even smaller antennas that have a broader beamwidth can otherwise take hours to manually point towards each other using optical telescopes, with no resilience to any small motion at either end.

To overcome this limitation, E10G antennas are mounted on steerable gimbals driven by motors. By measuring the strength and phase of a separate broader beam tracking signal transmitted from each end, a sophisticated pointing system can drive the motors to re-centre the antenna along boresight and ensure both ends ‘see’ each other prior to transmission. Such a system proves remarkably effective at acquiring the remote end in a matter of seconds and maintaining lock even when the towers at both ends are moving.

In this way, large antennas can be steered to transmit data at the speed of light along relatively long paths and to provide sufficient gain to traverse even a path made lossy by the effects of rain and fog.

The latency that the radio itself adds to the propagation time is so small as to be almost negligible — particularly since the serialisation delay with a 10 GigE interface is even smaller than lower speed radios. This has ensured the Australian technology has produced the world’s fastest backhaul radio, and it’s finding important markets overseas.
There have been several contributing factors to this successful commercialisation and manufacture of an Australian advanced technology product. The first has been the early identification of a lead customer, prepared to advise on specifications and invest in development. In fact the customer first approached CSIRO based on its research publications, but CSIRO then astutely sought an experienced commercialisation partner in EM Solutions and its subsidiary, EMClarity, to develop the product.

The second factor was the collaboration that brought a unique combination of technology and skills from both organisations and shared the risk. EM Solutions provided the innovative automatic pointing technology and RF integration skills needed to steer big, high-frequency antennas, while CSIRO contributed its broadband digital radio modem technology that enabled the extremely low latencies to be achieved. A third was the judicious use of overseas supply chains where appropriate, in order to take advantage of lower-cost materials and labour and to undertake initial product assembly.

A fourth has been the company’s exposure to global markets, where the incessant pressures of both demand and competition have sharpened skills. Finally, a lower Australian dollar has undoubtedly improved the competitiveness of pricing in global markets.

The biggest barrier to advanced Australian manufacturing may well be penetrating the home market first. EM Solutions’ biggest challenge has been entering Australian supply chains dominated by foreign multinationals. Too many potential Australian buyers prefer to procure advanced manufactured product from offshore suppliers.

Whether they work in telecommunication or utility companies or defence, purchasing officials feel safer buying from a large offshore corporation than an innovative Australian small business. The attitude that ‘nobody ever got fired by buying IBM’ is pervasive in our culture. But as the Queensland Health payroll fiasco has proven at taxpayers’ expense, bigger is not necessarily better, nor risk free. Our very own procurement people need to innovate themselves and see the bigger picture.

The next step in the product development is to upgrade the speed to 10 Gbps, with product release scheduled by the end of 2015. This will entail the use of higher-order modulation formats and symbol rates and a higher receiver signal threshold, potentially shortening the hop length or reducing the availability. However, typical link distances will still be approximately double those of equivalent E-band implementations due to the use of larger antennas.

Apart from applications in financial markets, telcos are expected to begin trialling the product to service their anticipated backhaul requirements as 5G mobile applications are deployed. Wireless backhaul is still the dominant backhaul technology for cellular systems worldwide due to its lower total cost of ownership and quicker installation time.

EM Solutions Pty Ltd
www.emsolutions.com.au

**E10G a captive market in the financial sector and, as the product matures and its cost is reduced, ongoing markets in public telecommunications.**

**Australian technology**

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