
Trunking repeater technology - old principles for new applications

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With many radio communications businesses facing increased competition from the cellular industry, one Australian company is applying old principles to overcome the modern challenge.

General Communications of Newcastle (Gencom) has catered to the commercial, government and industrial markets in the Newcastle and Hunter Valley areas of NSW for over 20 years.

The company owns and operates its own transmission sites throughout the region and offers clients a choice of conventional PMR and trunking system solutions, which include the VHF Multiax system, as well as an LTR 800 MHz network. It also offers the Biscom MPT1327 network for clients requiring coverage into Sydney and beyond. (The Biscom system is a very large TAITNET system, operated by Vertel Telecommunications in Sydney. It offers (semi) state-wide coverage, using a large number of sites with hundreds of channels).

Like most radio communications businesses Gencom had, over recent years, been facing increased competition from the cellular industry, which boasts superior coverage and lower up-front costs. Existing clients were increasingly demanding better coverage, faster access times and more features, and the company rapidly started to lose its traditional market business. The originally quite profitable conventional repeater sites became increasingly uneconomical and had to be closed down in alarming numbers.

In response to this trend a decision was made to install and operate the company's own wide area network. MPT1327 was the logical choice with its status as an open protocol, true wide area trunking platform.

In an MPT1327 system the number of channels at each site can be tailored to suit the local traffic demand patterns. This ensures that resources are not wasted. Expansion is also facilitated as additional channels can be added at any time without affecting other sites or mobile programming. Furthermore, field radios automatically select the best site, without any operator intervention (as is usually required in less sophisticated trunked systems). In this regard the system is similar in operation to a mobile phone, and this is what users are looking for these days.

Finally, enhancing features such as private calls, group calls, caller identification, call queuing and out of range/busy indicators are all standard inclusions in an MPT1327 system environment.

The release of Tait's T1810 single site trunking controller allowed the ability to interface to virtually any radio base station, and the fact that the T1810 offers most of the standard MPT features and functions makes it an attractive option. Having recently closed down most of its original conventional repeater sites, Gencom could re-use most of its existing RF hardware, frequencies, antenna systems and combiners to build a new, up-to-date commercial radio network, with only minimal new investment.

The problem, however, was how to obtain an affordable wide area network.

Costs for a traditional wide area solution were prohibitive, in view of the relatively small size of Gencom's available market area. It was then that the company approached Frits Van Enk, from Radio Systems Technologies (RST) in Melbourne, to provide the answer.

RST specialises in MPT1327 technology, having already developed and marketed the 'Cell Extender®', an MPT1327 repeater system designed specifically for larger network operators around the world. Gencom, however, did not need all of the features of Cell Extender® and asked RST to come up with a lower featured and more economical alternative to Cell Extender®.

The answer became Range Extender. Specifically designed for operation with a T1810 based 'donor' site, it extends a central T1810 site with a number of 'satellite' sites, which link back to the main site via fixed low cost radio links that operate on existing mobile frequency channels. The Extender site transmits the original MPT1327 signalling data on a new set of MPT channels, thus creating a fully seamless and transparent trunked site.

Sophisticated software and hardware ensure that each Range Extender site operates in a pseudo 'standalone' mode, only requiring traffic channels at the main site for intersite calls.

One of the characteristics of a Range Extender site is that its number of traffic channels can be chosen in accordance with the local traffic demand, regardless of the number of channels used at the main site. In other words, if a T1810 site operates with (say) one control channel and six traffic channels, the Range Extender site will readily operate with (say) only two traffic channels.

While the '1+2' configuration (a control channel plus two traffic channels) is the more common choice, Range Extender can in fact successfully operate with one single channel only (the so-called 'self-assign' mode, where the channel normally operates as control channel but switches to traffic mode if and when a local call has to be processed).

This data translation process is a very complex affair, embodying a number of algorithms. The basic need for this process, however, will be readily understood when considering, for instance, the MPT1327 GTC (go to channel) data message. The GTC message is sent by the T1810 controller following a successful call set-up. It commands mobiles involved in the call to switch to voice mode ('traffic') on the MPT channel number encoded in the GTC message. Since a Range Extender site uses a set of MPT channel numbers that is different from that at the T1810 site, the original channel in a GTC message has to be 'translated' to that of the Range Extender traffic channel that has been assigned to process that call.

Multiple Range Extender sites can successfully operate from the one T1810 main site. The maximum possible number of Range Extender sites is limited by three main factors: the total control channel message capacity, the local traffic demand and the number of multi-hop intersite calls. Since all call set-up transactions are handled by the T1810, it will 'see' all control channel transactions at and from all its Range Extender sites.

The total number of traffic channels that can be handled by an MPT1237 controller depends on a number of factors, which includes the total number of radio units connected to the system and, specifically, the amount of short data messaging that is demanded from the system.

A commonly used 'rule of thumb' asserts that an MPT1327 controller can handle at least some 24 traffic channels. On this basis the total number of 1+2 Range Extender sites operating from a six traffic channel T1810 site would be at least nine. Hence, control channel capacity will rarely, if ever, be a limiting factor.

The second factor, the local traffic demand, has a more immediate impact on Range Extender system design. The number of Extender traffic channels is chosen to meet the local traffic demand. In theory, if calls between radio units would be primarily 'local' calls (ie, calls between radio units all locked onto the same Extender site) the number of Extender traffic channels could in fact be higher than that at the main site. However, this would rarely be found in actual practice as, in most cases, the main site will be located in the area with the highest radio user density.

Care is also to be taken with the number of multi-hop intersite calls (that is, calls between radio units at two different Extender sites). Since in such cases the main site normally operates as the central hop, these calls do not only require a traffic channel at each Extender site, but at the main site as well.

Consequently, a main site with say three traffic channels servicing two Extender sites also with two traffic channels would not operate very well if all Extender site calls would be multi-hop intersite calls, as this would cause all traffic channels of the main site to be busy all the time, leaving no capacity for local calls at the main site. So in general, the main site's pool of traffic channels should at all times allow for adequate local traffic demand, as well as for

expected (multi-hop) intersite calls demand. (As in 'normal' trunked systems it is therefore important to adequately control the number of intersite group calls. For this reason, intersite group calling is a fully programmable Range Extender option. When the option is disabled, the system can still service intersite group calls for up to 16 pre-programmed group call fleet numbers).

To further extend the 'range' of the system, two Extender sites may be cascaded (applied 'in series'). Further extension is not recommended due to compounding system timing constraints.

The new Gencom network operates its T1810 system from Mt Sugarloaf, which is 25 km west of Newcastle. This is the company's main site and, at an elevation of 400 m above sea level, it is ideally located to support its Range Extender sites.

A total of five Extenders are currently installed throughout the region. They are located at the town of New Lambton and in the Nelson Bay, Gosford and Hunter Valley areas (two sites). Coverage extends from the Hawkesbury River to Buladelah and Scone. Such is the success of Range Extender that additional sites are already planned to further enhance coverage, particularly for portable users.

Gencom's Managing Director, Martin Mcleod, said that so far, the feedback from clients using the system has been very positive. The network was started up in the last quarter of 2001, and the last Range Extender was installed only recently.

"Currently, the system services hundreds of users, and we are finding a real niche in the marketplace," Mr Mcleod said. "Careful design and planning of any network is always essential, but probably even more so with this type of system.

As the main site channels are effectively used as the RF links with the Extender sites, the frequencies used have to be thought out properly. You don't want frequencies on the Extender sites too close to those of the donor site otherwise you may get desense problems that cannot be easily fixed.

Furthermore, if you are locating a Range Extender at a busy radio site you have to take into account the existing equipment as well. On the other side of the equation, you can't have them too far apart otherwise they can't all be programmed into the mobiles."

For these reasons Gencom chose the 500-520 MHz band with 12.5 KHz channel separation. This frequency band is relatively unpopulated in the region and this allowed the company to have a high degree of input as to which frequencies were used and where.



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Typically, the donor site channels are in the 505 MHz part of the band and Range Extender channels are located above 508 MHz. This, together with adequate antenna separation, gave sufficient isolation, eliminating any potential interference problems.

"Without the support of Tait and RST we just couldn't have built this type of network," Mr Mcleod continues. "The combination of the T1810 controller and the RST Range Extender has provided us with a highly effective, yet affordable wide area MPT1327 system and given a new lease of life to our older conventional repeater sites, which were rapidly becoming non-profitable."

Please Note! Range Extender was a version that was specially developed at the time for multiple Cell Extender® s operating off the same Donor Site applications. Since the writing of this article, the Cell Extender® product range was rationalised to cover this application as well and the name Range Extender was subsequently dropped.