Power choices to minimise maintenance

The choice of power source can reduce telecomms maintenance cost.

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The telecomms RAN (radio access network) is essential to almost every aspect of our daily lives and operators are being challenged to deliver ever greater capacities and coverage with high uptime and low costs. Unsurprisingly, energy is one of the largest operating costs for cells and towers that support the RAN infrastructure. Meanwhile, the power consumption of macro cell radios has increased steadily as access technologies have evolved. Typical power consumption for radio units was in the range of 100 to 300W in 2001 and is estimated to reach up to 1,800W by 2030[1]. As a result, careful selection of the power supply, converter and power management technologies is a fundamental aspect to enabling modern RAN design.

However, there is another significant cost associated with running a RAN that can also be impacted by the choice of power technologies, namely maintenance. Unplanned downtime and maintenance costs can mount very quickly, reaching many hundreds if not thousands of times the cost of any specific part or system that has failed.

The cost of failure

Consider a large network such that has 100,000 cell sites in a network. Each will have a variety of power supplies and modules, including AC/DC and DC/DC converters (Figure 1).

There are two key areas for power supply technologies in a RAN infrastructure. One is the DC/DC converters that support the power amplifiers in the integrated radio antennas and the second are the high-power systems deployed in base station controllers. In terms of a DC/DC converter in a remote radio head (RRH), even the highest quality, well-engineered module may have a failure rate of about 10ppm (parts per million), so it would be expected to exhibit failure at some point. Once time is factored in to diagnose the fault, and an engineer is dispatched to ascend the antenna and fix the problem, costs can run to many thousands of dollars.

Actual costs will vary depending on the individual scenario. However, an approximate cost of $20,000 to $30,000 to repair a fault of a failed DC/DC converter located in the RRH equipment is many times the value of the DC/DC converter itself. Figure 2 shows the key factors contributing to such a cost might break down. As the cost of the converter is likely to be in the range of $50, the cost of repair makes the cost of the original part negligible in comparison. If a batch of DC/DC converters has a latent fault, the ppm failure rate could be higher. Furthermore, if this were to reach 500ppm, then the same network could experience 50 failures at a significant cost.

While clearly these figures are just for illustration purposes and could be debated, it is clear that component / module fallibility has the potential to drive

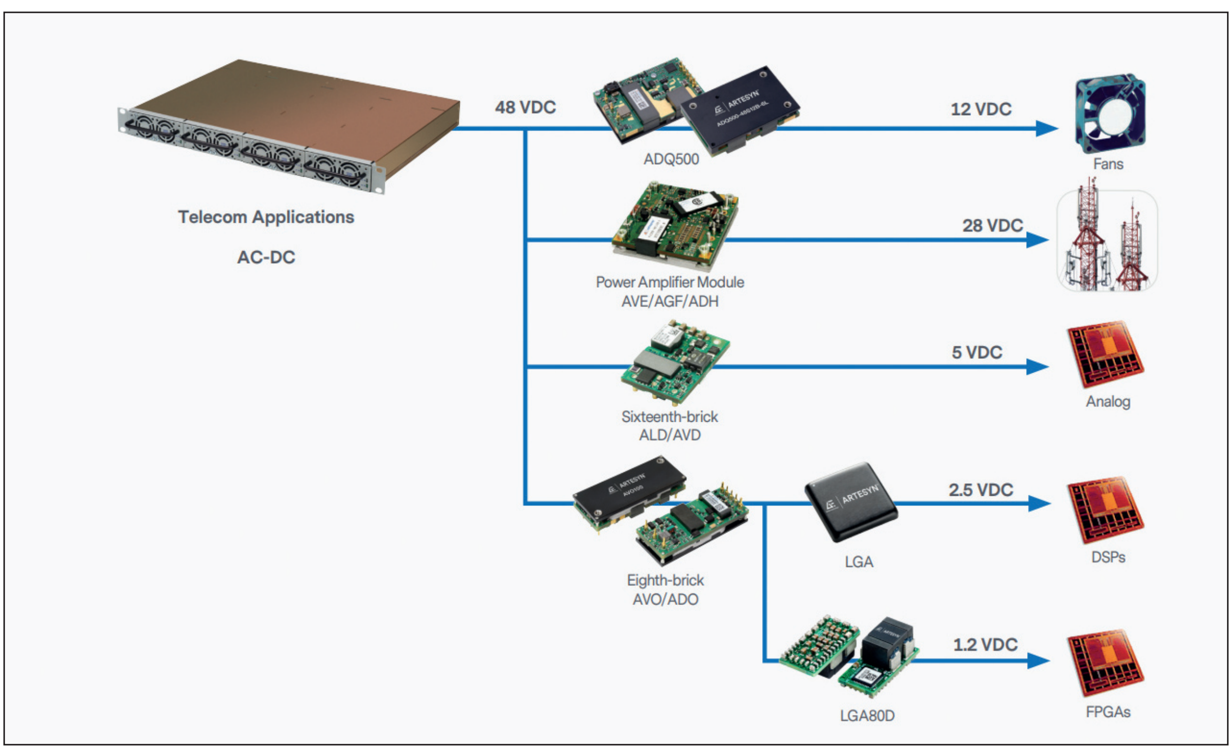

Figure 1: Power modules for RAN applications.

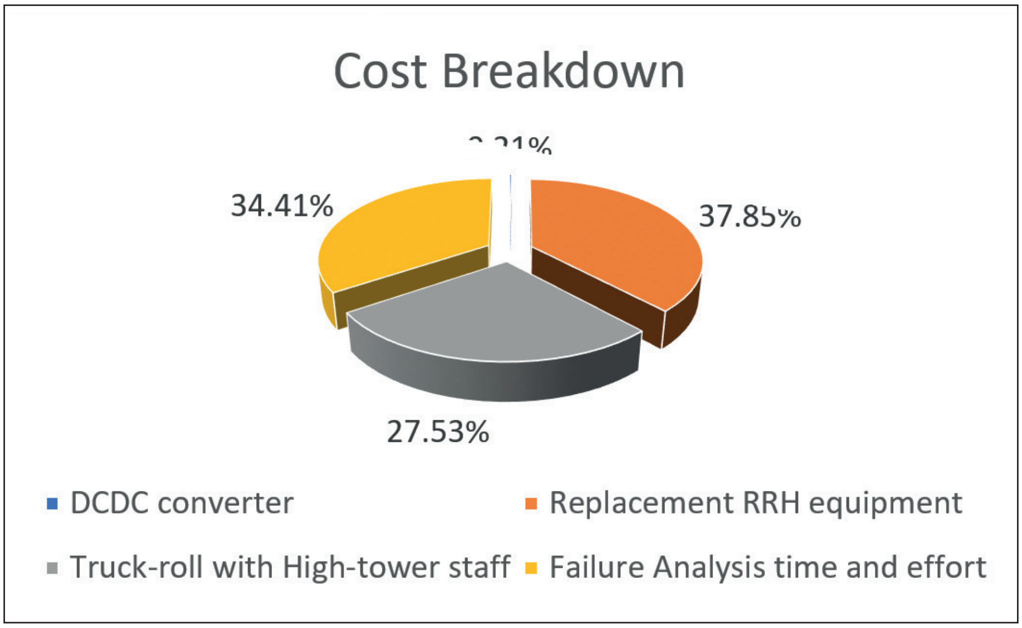

Figure 2: Example breakdown of costs to rectify a DC/DC converter failure in a RRH

very significant costs for a network operator.

The piece-part cost of a DC/DC module becomes almost irrelevant once the true cost of long-term unplanned maintenance is understood. Therefore, engineers need to design power architectures that meet performance requirements as well as the current, voltage and power specifications of an individual design and create them with optimum reliability in mind. As a failure in the field can cost hundreds, or even thousands, of dollars, the cost of the individual component is very sobering and precludes any cutting of corners in the design and qualification process.

Component selection

Operating efficiency is a critically important factor when selecting a power component. Efficiency has become more important in product design. This is driven by commercial demands i.e., more efficient components reduce the total cost of ownership by driving down energy costs and also legislative pressures relating to sustainability. Efficiency plays a fundamental role in reliability because of the consequent excess heat in causing component failures. The rule of thumb is that every 10°C increase in temperature reduces the life of electronics by 50% although this is a broad approximation. It is clear that elevated temperatures reduce the operating life of both the power components themselves and other components around them.

For this reason, power supply manufacturers are developing high performance power products that deliver percentage levels of efficiency well into the high nineties. Advanced Energy's AVE450B 450W single output, half brick DC/DC converter, for example, is a product suitable for supplying power to a power amplifier in telecomms and datacomms applications. It operates at 95% efficiency with demonstrated long term field failure rates under 15ppm. The Artesyn ADH700 700W half brick converter also operates at efficiencies at or above 95% and its thermal management allows it to operate at full power in enclosed spaces with a baseplate temperature up to 100°C.

Designers that understand how a design can impact maintenance costs take a more conservative approach to tolerances and design margins – especially in terms of thermal and electrical stress. This ensures components operate at levels that reduce the likelihood of failure. Focusing the component selection process on reliability, rather than cost, can lead to a dramatic reduction in field failures. While calculated MTTF (mean time to failure) data is a good first step, choosing power products that have been tested to an IPC9592-based qualification process often has more relevance and benefit.

Working with an experienced telecomms supplier brings greater likelihood of design success as there is a pathway to leverage the many years of experience designing power modules for Tier 1 OEMs that operate in the telecomms space.

As well as direct cost savings that can be attributed to maintaining and repairing the infrastructure there are also several indirect cost benefits that result from a more robust approach to designing in reliability from the start. Engineers, for example, can spend less time on failure analysis and field repairs and more time developing those products and systems that will generate future revenues. Even more intangible, but still important, is the fact that minimising callouts at unsociable hours reduces the impact on the morale of employees, improving the quality of their work and minimising possible retention, hiring and training costs.

TCO is key

The true impact of reliability in a telecomms network cannot be under-estimated, whether in terms of direct and indirect maintenance costs, lost revenue through downtime or more intangible factors including customer loyalty and a de-motivated workforce. Power amplifiers and the circuits that support them represent critical elements of a RAN infrastructure, and ensuring reliable, long term operation in harsh environments is fundamental to successful implementation.

Taking a total cost of ownership (TCO) approach that goes beyond just the piece-price and operational expense related to conversion efficiency is key to success when choosing and designing products - including the power conversion technologies at the heart of the RAN hardware.

Market innovators must widen the definition of TCO to include the very real and considerable costs associated with any potential field failures or compromised network performance. This thinking leads to an emphasis on product reliability beyond just using the usual calculated mean time between failures (MTBF) figure as a benchmark data point between supplier solutions.

As a result, wireless access system designers are now focusing their efforts to reduce the overall cost of ownership by designing systems in a way that significantly reduces the number of unscheduled maintenance incidents and the consequences caused by product failures.