Electro Rent

Test Instrument Evolution

In the Aerospace and Defence sector

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T&M equipment evolving in line with rapidly advancing A&D systems

There is no doubting the ongoing growth in demand when it comes to aerospace and defence (A&D). According to a recent Deloitte report, spiralling demand for passenger travel is driving commercial aircraft production and is responsible for the record high backlog of 14,215 units at the end of 2017. Once 2018 figures are finalised, the global A&D industry is expected to show revenue growth of 4.1%, up from 2.1% in 2017. In fact, over the next 20 years, passenger traffic is likely to expand at an average annual growth rate (AAGR) of 4.7%, contributing to even higher levels of aircraft production.

Although official figures are yet to be released, in 2018 it is anticipated that global defence sector revenue will grow at 3.6% as global tensions persist and a majority of the affected countries plan to recapitalise and boost their defence portfolio. Indeed, Deloitte estimates that global defence spending will grow at a CAGR of about 3% through to 2022, crossing US$2 trillion by 2022.

Another respected professional services network, PwC, says in a new report that deal activity in the global A&D sector is being driven by an increased focus on emerging technologies, intensified competition and a rise in government spending to modernise defence IT infrastructure.

With these thoughts in mind, there is ever-greater pressure on test and measurement (T&M), which clearly has added importance in the critical A&D market. Any failure could, after all, prove catastrophic. Today's test engineers must acquire accurate data, and therefore need correctly specified, reliable equipment that can deliver complete data integrity on a repeat basis. In turn, there is a distinct market need for suppliers that understand the A&D industry and its challenges, and offer optimised T&M instruments for the application in hand. Importantly, the availability of lease, rent and purchase options is paramount in order to meet strictly governed project timescales and budgets.

Another factor here is T&M technology itself, which is evolving almost continuously to ensure that testing can be completed more thoroughly and efficiently than ever before. In almost all cases, sophisticated yet easy-to-use instruments are required to meet the diverse needs of production and field testing.

This white paper will consider the major trends in this area, highlight their drivers, identify the popular solutions currently drawing the attention of the A&D sector, and point out the acquisition options available that can help projects stay on track.

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The Challenges

Despite the seemingly relentless march of the A&D sector, the industry is at somewhat of a crossroads. Global economic uncertainty is putting pressure on manufacturers to use their available budgets more effectively. Smaller manufacturers are also entering the A&D sector, which is causing larger organisations to rethink the way they manage their businesses.

The entire procurement process and chosen financial approach is coming under review in response to the changes taking place; companies of all sizes are moving towards a more modular strategy where the integration and verification of systems is usurping pure R&D and in-house design. It is now increasingly common to add value to an off-the-shelf solution

at a software level through proprietary IP, rather than putting the IP in at hardware level. This scenario is forcing manufacturers to reduce their capital expenditure (CapEx) and better manage Operational Expenditure (OpEx).

From a T&M point of view, there are other challenges. For instance, many of the existing systems in use are based on legacy equipment supporting long-term products. As time goes by it becomes harder to maintain this legacy equipment; the cost of maintenance can be higher than the cost of initial purchase in many cases. When the equipment does eventually fail the only option is to replace it, either with like-for-like (which is difficult, as it may now be obsolete) or with a new-for-old (which could be expensive).

The technology being used in A&D is also moving on.

This trend is particularly notable regarding solutions developed for other sectors that are becoming increasingly introduced into A&D, such as optical interconnectivity. Cross-sector transfer of solutions is a particular challenge for A&D manufacturers, due to a lack of familiarity with the technology.

Evolving Technology

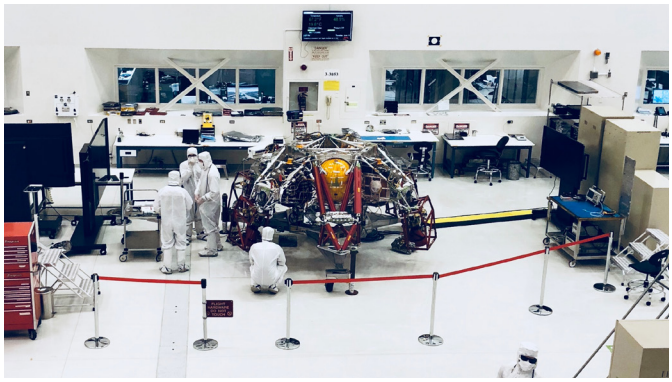
Optimised technologies should always evolve in line with market demands, solving current and future challenges being experienced by the A&D sector. T&M equipment, however, is a special case, with many arguing that it needs to evolve perhaps even faster than the industry's advanced system capabilities.

Among the most notable trends in the A&D sector is the threat to information and information flow, otherwise known as cyber security, which receives a lot of attention worldwide. In fact, cyber is now listed as a fifth domain of warfare, joining land, sea, air and space.

When it comes to cyber/network security, an end-to-end testing solution such as Spirent's TestCenter is proving highly popular across many industries, largely because it delivers high performance with deterministic answers. Growing numbers of service providers, network equipment manufacturers (NEMs) and enterprises are using it to test, measure and validate their networks. Ultimately, TestCenter is designed to deliver user confidence in all tasks, ranging from conventional performance tests to the comprehensive analysis of applications such as cloud computing, virtualisation, high-speed Ethernet and mobile backhaul.

For the network infrastructure itself, Spirent Avalanche is among the most frequently selected instruments. Also suitable for cloud and virtual environments, as well as web application infrastructures, Avalanche provides users with 1 Gbps to over 100 Gbps of capacity, security and performance testing.

In addition, solutions from Ixia are highly desirable in the current marketplace, particularly for those looking to test the robustness of a particular configuration or security set-up in the event of a cyber-attack. Offerings such as Ixia BreakingPoint validate and optimise networks under realistic conditions by simulating both good and bad traffic. Security infrastructures can also be verified at high scale.



Another stark threat to global peace is electronic warfare. In the US and some European countries there is a concerted effort to build smaller, more technologically capable military forces. RF and microwave technologies will clearly play a critical role in this transformation. Here, the budget earmarked for technology advancement, particularly for RF and microwave applications, is expected to grow significantly.

Among the many new industry demands in this area is the need to move acquired or stored RF signal data from one test instrument or sub-element to another at a minimum rate of 10 GB/s (equivalent to 2 GHz RF bandwidth). Several data transfer technologies could be considered for such applications, including 10 Gb LAN; PCIe (PXI) Gen 3 with many lanes; optical, which is a good choice for integrated boxes; or a dedicated peer-to-peer (P2P) local bus or backplane (AXIe).

Evolving Technology (cont)

Another emerging demand centres on high-speed (to real time) data reduction/analysis within the actual instrument. Different processes and methodologies might include digital down and up conversion, as well as real-time meta data or pulse descriptor word (PDW) generation from acquired raw data (or generated algorithmically for playback). In addition, simultaneous high-resolution time and frequency display, along with firmware-defined measurement science, might also be considered.

Further trends of note include those being driven by radar, electronic warfare and signals intelligence technologies, which increasingly require multiple coherent RF channels to extend performance and capability, greater wideband capabilities for better signal generation and analysis, and enhanced ease of use.

In radar and electronic warfare systems, the use of active electronically scanned array (AESA) antennas has become nearly ubiquitous for its many advantages in the application. AESA antennas allow systems to function in multiple modes, engaging multiple threats or targets, and taking advantage of, and fully utilising powerful signal processing capabilities. As the beam can be steered electronically, no gimballing is required, permitting agile beam repositioning at extremely high rates.

For satellite applications, phased array antennas deliver specific benefits compared with reflector antennas, and can thus be considered a desirable option for a GEO spacecraft. Here, a single antenna can communicate with multiple spatially distributed ground stations by agilely repositioning (hopping) the antenna beam from user to user. A phased array antenna can be positioned on a spacecraft to avoid the need for deployment. In addition, the distributed amplifiers constituting the active array provide a failure-tolerant architecture.

The principal advantages of antenna arrays over large reflectors include greater flexibility, reduced manufacturing and maintenance cost, modularity, and more efficient deployment of the spectrum. Furthermore, multi-mission stations can be developed to track various satellites at the same time by dividing the array in sub-arrays with simultaneous beam-forming processes.

There are many growing challenges associated with antenna testing. For instance, there is now a distinct increase in the element count within phased arrays to permit more simultaneous functions and a narrower focus of the main lobe in beam forming. Also of note, digital (broadband) signals are moving closer to the antenna. There is some discussion that eventually the sole connection to the transmit/receive (T/R) module for each element will be a digital bus (no analog). Another challenge relating to antenna testing is signals no longer being simply pulsed, but also being broadband modulated, which creates an increasing requirement to generate and analyse wider bandwidth signals.

Ultimately, electronic warfare can take many guises, covering everything from signal jamming and radar strikes, through to discrete signal detection. From a critical T&M perspective, engineers are turning to solutions such as the Keysight N5194A UXG signal generator and N9040B UXA signal analyser.

The N5194A UXG agile vector adaptor allows labs to simulate increasingly complex signal environments for radar and electronic warfare with greater levels of realism and confidence. Importantly, the device can be quickly adapted to offer numerous different channel and port configurations. Through the calibration of amplitude, phase and time, coherence can be assured across multiple sources.

Evolving Technology (cont)

Similarly, when it comes to achieving wider (to 1 GHz), deeper views of even highly challenging signals, the N9040B UXA multi-touch signal analyser permits users to see the real performance of their designs. It is possible to measure the design's spectral purity with phase noise and 78 dBc spurious-free dynamic range across a 510 MHz bandwidth. In addition, RF input frequency can be extended up to 110 GHz with smart mixers; and to THz using third-party solutions.

Rohde & Schwarz also offers optimised solutions in this technology area, including for RF and microwave applications up to 500 GHz, while oscilloscopes continue to be of interest.

Turning to the satellite industry specifically, where the pace of change is high, there are many current trends of note. NewSpace, for example, is essentially being coined as an emerging global industry of private companies and entrepreneurs who primarily target commercial customers, all seeking profit from innovative products or services developed in or for space. Many NewSpace businesses are planning to deploy large constellations of satellites, the majority of which will be in low Earth orbit. As requirements are much less stringent, many SmallSat designs are relying on commercial off-the-shelf (COTS) parts.

A further trend in the satellite industry is the use of higher frequencies in communications links. Traditionally, satellite communication has been performed in the C, L and Ku bands, but the spectrum in these bands is limited. Many satellite operators are using, or have plans to use, the Ka band, which is typically considered to be 27 to 40 GHz. Transmitting in this frequency range permits the deployment of smaller antennas.

One obvious challenge associated with this trend is the need for test equipment covering higher frequencies. Moving up in frequency means more atmospheric attenuation. Uplinks are at the higher frequency, because power is available on the ground. Downlinks have power constraints.

Outside the atmosphere there are no issues with absorption, which means that many mmWave frequencies are used for crosslinks between satellites, particularly those in the high absorption bands like 60 to 65 GHz. Communications using optical lasers is gaining interest, not only for crosslink communications but for links through the atmosphere.

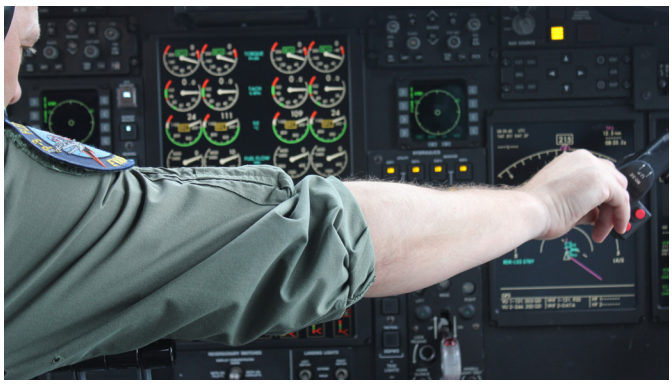
Yet another market driver is the need for higher data rates. Higher data rates are being achieved with the use of wider bandwidth signals and higher order modulation formats, which together present some test challenges. Until very recently, many of the latest signal analysers were restricted to around 100 MHz of analysis bandwidth. The combination of wide bandwidth and higher frequency signals render it difficult to use traditional wideband test equipment, such as oscilloscopes, which are perfectly capable of accommodating the wider bandwidth requirement, but not the higher frequencies.

Test equipment needs good dynamic range in order to handle the low signal-to-noise ratio (SNR) issues that are typically witnessed in satellite testing. What's more, higher order modulation formats mean factors such as compression and slight amplitude errors in the channel now have increased potential to appear as a bit error. Subsequently, test equipment must maintain the dynamic range and leave enough test margin to help identify these issues.

Evolving Technology (cont)

In the satellite industry there is a distinct shift towards smaller, more complicated payloads, which is driving the development of more complex T&M devices capable of multiple communications strategies and measurements. A case in point is the Rohde & Schwarz series of FSW signal and spectrum analysers, which are proving popular due to factors such as optimised sensitivity and low-phase noise, not to mention 2 GHz internal analysis bandwidth (5 GHz with the RTO2064 oscilloscope) and 800 MHz real-time analysis bandwidth.

Another prime pick is the N52-B series of microwave network analysers from Keysight, which measure S-parameters with tiny levels of uncertainty and maximum stability. As a point of note, these instruments can be customised to provide the right level of performance for the available budget.



When validating higher level integrated assemblies and sub-systems, Keysight also offers integrated test systems featuring both hardware and software. Some examples for satellite testing might include payload test stations, power and solar array simulator sub-systems, telemetry tracking and command sub-systems, and command and data handling sub-systems.

Also worthy of mention is software-defined instrumentation, which provides flexibility in creating a full solution for nearly any test challenge without resorting to an expensive and limited-use custom system. Some of the important attributes include: channel density and scalability; RF data throughput and streaming; flexibility in platform form factor; synchronisation infrastructure; and user-friendly access.

Elements of the full solution include stages for processing the RF signal in, to RF out; or from RF to storage or another processing engine. Software-defined instrument structures may not require all these blocks if their target function is to be a receiver for the gapless capture of signals, or to provide arbitrary waveform generation in real-time.

There are many application areas for software-defined instrumentation, including spectrum/signal monitoring, signals intelligence, surveillance, spectrum security, radar target simulation, satellite channel emulation and threat emitter simulation, to list but a few.

In the A&D sector there is also growing demand for broadband SATCOM testing. As these bands become more popular, and need to transmit more data, the tests must become more rigorous. For such applications, the Tektronix AWG70000 series of arbitrary waveform generators can produce complex simulated signals based on optimised sample rate, signal fidelity and waveform memory. The AWG70000 delivers a signal stimulus solution for simple generation of ideal, distorted and ‘real-life’ signals with up to 50 GS/s and 10-bit vertical resolution. Spectrum analysers can also be used to monitor signals in broadband SATCOM testing applications.

The Proposition

Electro Rent understands electronics designers and engineers working in the A&D sector, helping customers to acquire the right T&M equipment, optimise its use and make the most of the investment to save time and money.

Crucially, whether T&M equipment is required for short or long periods, Electro Rent can offer rent, lease or buy options across a wide range of new or used equipment. Customers can also trade their pre-owned test instruments, and benefit from the company's asset management tools to help maximise equipment lifecycle.

Among the more popular Electro Rent value propositions are lease-to-buy and short-term rental. Lease-to-buy allows A&D manufacturers to gain access to the latest T&M equipment while they apply for the funds needed to purchase the equipment, which can take many months. Short-term rental offers a short-term solution to using T&M equipment that

replaces legacy equipment which may be out of service or being repaired. Electro Rent can also provide access to legacy equipment (sometimes less than 5 years old) that is no longer available on the market but is needed to support a long-term project.

It is clear that test equipment needs to continuously adapt and improve so that engineers can fulfil their T&M requirements in line with rapidly advancing A&D technologies.

The need for ongoing innovation is notable in applications such as array antennas, which today require multiple channels of stimulus and analysis with wide bandwidth to achieve the necessary gain measurement throughput. It is also possible to conclude that the simulation of spectral environments, which include a combination of radar, wireless, wireless networking and recorded signals, require the streaming of large amounts of signal data.

Whatever the project, however, it is clear that having access to a variety of T&M equipment acquisition options – rent, lease or buy – can prove pivotal to the programme's success. Technical challenges are one thing, and this white paper has outlined a number of current trends in this area, but project delays caused by budgetary or equipment availability issues can damage businesses, both financially and through reputation. Thankfully this situation is easily avoided by making a considered choice of T&M equipment supplier.

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