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By Jamie Whitney

RF and Microwave Designers Take-On the Cluttered Spectrum

Systems built for low size, weight, and power consumption (SWaP) and industry standards like SOSA are dominating applications ranging from satellite navigation to next-generation 5G communications.

U.S. Air Force RF and microwave technicians rappel down a radio antenna tower during an immersion tour at Moody Air Force Base, Ga.

View Image Gallery

The presence of dense radio frequency (RF) signal traffic on the battlefield is constant, and radio silence is no longer the norm. Experts in the RF and microwave equipment and component manufacturing world say they are seeing a boost in support for open-system standards while packing more

power into smaller spaces using commercial-off-the-shelf (COTS) components.

“Military radio systems were traditionally stovepiped and had a lot of internally designed signal synthesis and baseband-to-RF conversion sections, says Dean Handrinos, co-founder and partner at Triad RF Systems in East Brunswick, N.J. “These subsystems were usually designed around a limited number of waveforms that would not change over the lifetime of the product. Adapting a legacy radio for a new signal would call for a wholesale redesign.”

Now, with a boom in software-defined radio (SDR) technology, Handrinos says mil-aero radio manufacturers are afforded a lot more accessibility.

“An engineer now has the ability to design a radio capable of generating many different signal types and modulations, without having to design a system from scratch,” Handrinos says. “When needed, they can change waveforms on the fly programmatically. This accessibility is also apparent on the RF circuit front as well. RF SoCs [systems-on-chip] now exist that can directly synthesize complex signals up to 6 GHz and can handle instantaneous transmit modulation bandwidths hundreds of megahertz wide and beyond.”

Handrinos explains that Triad RF Systems is getting requests from systems integrators to close long-distance unmanned aerial vehicle (UAV) systems radio links, as they have much higher bandwidth and throughput requirements than before.

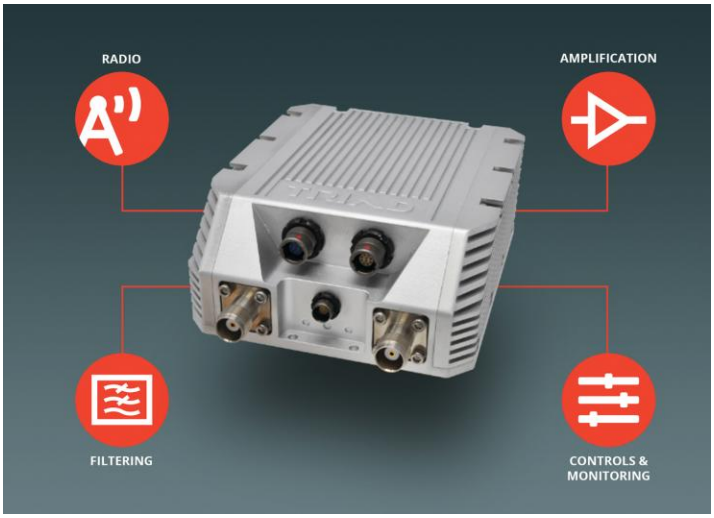
“These links are now tasked with passing data-intensive HD [electro-optical/infra-red] streams and other data from multiple payloads,” Handrinos says. “Bolting-on an amplifier to boost link distance, as was formerly done, no longer solves data link distance issues because modern radio systems with complex waveforms (like 256QAM) are much more sensitive to the signal distortion an amplifier introduces. Much more advanced amplifier products with control systems to manage this distortion and keep the link reliable are required, and that is where our specific expertise lies.”

Software-defined advantages

He continues, “Triad designs high power RF Systems, so while it is now easier for radios to generate these complex signals at the board level, it is

an entirely different challenge to transmit that signal at high output power, with sufficient signal linearity and SNR for the radios to communicate properly."

Handrinos notes the company's Triad High Power Radio (THPR) system reflects the trend of enabling high date rates across long wireless links in unmanned systems in air, sea, or on the battle field.



The Triad High Power Radio (THPR) system is a radio-agnostic solution for when extended range is needed from modern, high bandwidth military radio systems.

"Our main product line, the THPR-high power radio system, is a radio-agnostic solution for when extended range is needed from modern high-bandwidth military radio systems utilizing technologies such as MIMO and mesh networking," Triad's Handrinos says. "Our advanced amplifiers are tailored for the multitude of signals that can be generated out of an SDR. We also qualify our products to ensure that we deliver the promised data rate at much higher RF output powers than the stock radios are capable of. Internal monitoring and auto power control circuitry take nearly all the guesswork and troubleshooting out of deploying a long range, high bandwidth link. Our current product line spans 400 MHz to 6 GHz, but there are plans to develop for X and Ku bands as well."

Brian Kimball, senior product manager at Mercury Systems in Andover, Mass., says that even as platforms get smaller, performance needs to be maintained.

"We're definitely seeing a trend towards spectral density," Kimball says. "I think this is driven by the need for smaller platforms and the different

forces don't want any degradation in performance. They don't want to suffer a limited number of channels, but they're in a more SWaP-constrained envelope. I also think ruggedness is a trend because of, again, the small-form-factor nature of these newer payloads."

Kimball also says that open standards like Sensor Open Systems Architecture (SOSA) and similar initiatives are driving development in the RF and microwave sector for mil-aero manufacturers.

"We have a case now where the RFM 3U transceiver product line was in VITA 65 and we're transitioning to SOSA-aligned. And the way we did it in their modular transceivers and a digital baseboard that they sit on," Kimball says. "So, we just had to do a minor tweak to the digital baseboard to fall in line with SOSA. And we're doing that on multiple fronts with primes for both the Army and the Air Force."

The imperative for SOSA

The Open Group, which oversees SOSA standards, comprises more than 750 companies worldwide. SOSA aims to reduce development cycle time and cost, systems integration cost and risk, and sustainment and modernization cost. In addition, the group aims to increase commonality and reuse, support capability evolution, mitigate obsolescence, and isolate the effects of change.

Mercury's Kimball says that SOSA is now "sticking" in ways that it previously didn't is because of buy-in by military branches.

The Mercury Systems Spectrumseries RFT-3200 downconverter and matching RFT-4200 upconverter-broadband frequency conversion products for agile electronic warfare and electronic intelligence systems.

"It is not a 'maybe' - it is a 'must' for some of these newer platforms that we're seeing," Kimball says. "If the Army and the Navy and the Air Force have programs for it, it's a must. The industry is going to follow along. It's actually being driven from the top. The beauty of SOSA is it takes something like other open standards like VITA 65 and it takes away the

undefined pins. So, you really can have a payload slot that could be vendor A, vendor B, vendor C, take one out, plug the other one in and things will work."

Kimball continues, "That's wonderful for the forces to have that (so) they don't have vendor lock. They could even take a card out, put another card in and change the function of the mission. So, I think it's is universally starting to stick. And I think it starts at the top."

In addition to spectral density and SOSA-alignment, Kimball notes the trend of operating at higher frequencies.

"I also would say directed activation is encroaching in the RF space. You know, it was just a couple of years ago ... you couldn't see much above two gigabytes. Now we have products that can see up to eight gigs for analog input bandwidth and there are definitely some on the horizon that can even digitize a K-Band that really shifts the RF problem."

Stop the bounce back

While the military wants robust performance for its RF and microwave systems, it also aims to stop enemies' signals from bouncing back to them. In addition forces aim to minimize their own signal degradation. Laird Performance Materials focuses on mitigation of electromagnetic interference inside of electronic packages and dissipation of heat.

Laird's line of fluorosilicone elastomers, thermal insulators and electromagnetic interference-suppressing absorbers can withstand extremely high temperatures and exposure to jet and missile fuel.

Rick Johnson, aerospace and defense director at Laird R&F Products, explains that there are a trio of military uses for its performance RF materials.

"The first one is what I'm going to call 'survivability,'" Johnson says. "So, you put absorbers on things that you don't want to return energy from. And that's certainly something that is being used a lot nowadays as things try to become less and less observable to detection. So that's one of our big main areas of focus."

The second, Johnson says, is in antennas.

"Antenna pattern enhancement, reducing antenna side lobes, reducing backscatter from antennas, improving the isolation of an antenna so it performs better," says Laird's Johnson. "That is a big part of our work in both military and commercial."

Finally, Johnson says is the focus on internal high frequency electromagnetic interference (EMI).

"So, normally, if you've got a noisy chip, you can put a board-level shield around it or something else to mitigate it," Johnson says. "If you start having these problems in the microwave and millimeter wave frequencies, the wavelengths are getting so small that traditional EMI shielding doesn't work properly. So, you have to augment it by putting absorbers in there, which will then absorb the energy. So, it is not only just keeping the energy inside the box and meeting FCC requirements, but also stopping one component from interfering with another. So, it's used a lot in automotive radars between the transceiver in the transceiver assembly. It's used in high frequency EMI applications for datacom and automotive electronics. And then certainly military 5G uses the material similarly inside of an assembly to kill internal reflections."

Laird's Johnson says that microwave absorbing material is made up of two parts - one, a binder, which could be an epoxy, an elastomer or thermoplastic.

"Their function is to provide the external coating or the body of the absorber," says Johnson. "The other key factor is then the fillers that go inside of it. So, we're taking things like elastomers, and we're adding different electromagnetic fillers. And those fillers then vary as frequencies vary. What we're seeing is, on the material side, the environmental side,

we're seeing higher temperatures. We're seeing use in harsher environments that need better fuel resistance. We're seeing materials that need better corrosion resistance."

Johnson continues, "Everybody's familiar with silicones. They're used as gaskets. They're used as caulking for your bathtub. Fluorosilicones are similar, but they have this fluorine attached to them, which then gives it a much better temperature capability (but) the most important part is fuel resistance. And so, silicones are traditionally not used on aircraft and other areas because of their susceptibility to swelling by fuel or damage by fuel. So, what we have done is really focused on using these fluorosilicones in a variety of different ways."

Noise in the signal

While warfighters and commanders depend on RF and microwave equipment to transfer invaluable data that could make or break mission successes, tracking down sources of interference is also incredibly important.

Just as technology has made transferring data across the frequency faster, what was once relegated to the benchtop is now field deployable.

The Anritsu Field Master Pro MS2090A with real-time spectrum analysis.

While the traditional spectrum analyzer continue to be a workhorse for RF engineers, real-time spectrum analyzers (RTSA) offer myriad benefits for

industries and agencies looking to glean additional insights into signals across the spectrum.

With real-time analysis, experts can conduct continuous gapless capture and analysis of elusive and transient signals, which is not something conventional spectrum analyzers and vector signal analyzers can do. This allows for signal-in-signal monitoring for traffic that should not be there or may be causing interference.

Experts at the Anritsu Corp. U.S. Test and Measurement division in Morgan Hill, Calif. explain that RTSA test and measurement instruments give a much broader view compared to traditional technology of what's going on in the spectrum compared to traditional technology.

"It would be used for spectrum clearing to check to see in a base environment if there's any unknown or unwanted transmitters that could affect the security of these operations," says Anritsu Product Manager Kirby Hong. "The second use could be general maintenance of equipment. Is it performing correctly? Are they meeting their specifications? When the radar is turned off, does it unintentionally emit spurious signals? It could be a security problem. Look for illegal listening devices, especially those that have a very transient nature that isn't broadcasting all the time. If there's a bug recording conversations, and periodically it transmits to a receiver station somewhere, that could be missed by a traditional spectrum analyzer."

Scanning the spectrum

Anritsu's Field Master Pro MS2090A instrument with real-time spectrum analyzer option was selected to locate the interfering signal. According to the manufacturer, in the optional real-time mode, the MS2090A can accurately measure the amplitude of a single spectrum event as short as 2 microseconds and detect a single event as short as 5 nanoseconds. The MS2090A is a ruggedized, size, weight, and power (SWaP) optimized, field-deployable handheld spectrum analyzer that has a 110 MHz analysis bandwidth and an measurement range from DANL to +30 dBm.

Using the MS2090A RTSA, experts were able to find the cause of the interference alarms at the public safety agency: high wind caused a cable to bang up against the tower, causing passive intermodulation.

The MS2090A can help with interference hunting, spectrum clearing, broadcast transmitter analysis, monitoring microwave radio links, satellite

system monitoring, pulse radar measurements, 5GNR base station measurement, and 5G coverage mapping.

Hong and Angus Robinson, a marketing manager at Anritsu, notes that due to SWaP optimization, the battery-powered Field Master Pro MS2090A can be mounted into aircraft, vehicles, and deployed nondescriptly in cases to keep an inconspicuous eye on signals across the spectrum in real time.

“One of the government agencies we’ve been talking to is currently mounting into airframes, inside military aircraft, very large lab type instruments for exactly this application,” says Robinson. “And so, you can imagine anything that you’re putting up in an airframe in terms of weight and size is a big issue. They’re very excited about the small form factor and the ability to get that same functionality in a in a much smaller form factor. There’s also a group of people who want to leave these units in, say, unsuspicious looking Pelican cases…It’s got a big battery in the case as well, and they leave it gathering data somewhere for a day or what have you and then come back home and pick it up.”

Rugged recorder

Pentek Inc. in Upper Saddle River, N.J., recently unveiled its RTX 2684 26 GHz RF Sentinel Intelligent Signal Scanning small-form-factor recorder, which is an addition to its Talon family.

Pentek's the RTX 2684 26 GHz RF Sentinel Intelligent Signal Scanning small form factor recorder.

"The RTX 2684 Sentinel recorder is a complete antenna to disk solution with RF signals down converted directly to the A/D converters," says Rodger Hosking, vice-president of Pentek. "Its 5x reduction in packaging size over the rackmount equivalent, bandwidth performance, and storage capacity all offer huge improvements in addressing challenging SWaP constraints in mobile or space limited platforms."

The Talon RTX 2684 SFF recorder weighs in at 23 pounds and is designed for extreme operating environments. Optimized for SWaP, the rugged sealed ½ ATR recorder is available with up to 61 terabytes of removable SSD storage. The quarter-ATR chassis makes it suitable for military, security and government intelligence (SIGINT, COMINT and ELINT) applications that are mobile or very space limited.

A Pentek Model 78141A Jade transceiver module serves as the data acquisition engine of the Talon RTX 2684. One of its dual 3.2 GS/sec 12-bit A/D converters operates at a sample rate of 2.8 GS/sec. The Model 78141 is coupled to the 500 MHz bandwidth analog IF output signal of a 26 GHz RF tuner front end, delivering excellent dynamic range across its entire spectrum. A digital downconverter (DDC) in the Model 78141 provides frequency zooming for recording signal bandwidths of 500, 250 or 125 MHz.

https://www.militaryaerospace.com/rf-analog/article/14176532/rf-and-microwave-designers-takeon-the-cluttered-spectrum