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Strategies for Providing Advanced Signal Processing on Rugged SFF Platforms

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The Need for Advanced Technology in Rugged SFF Platforms and the Challenges

The latest data acquisition and signal processing devices are critical for capturing and manipulating wideband sensor signals for real-time radar, electronic countermeasures, EW, and SIGINT systems. These include new data converter technology and advanced FPGA designs, including the RFSoc (radio frequency system-on-chip).

To maintain strategic superiority for military and aerospace platforms, embedded systems must constantly evolve to embrace the latest technologies, counter new threats, and deal with new constraints. To meet these objectives, systems engineers must exploit new architectures that deliver effective solutions.

Strong mandates to move systems closer to the antenna are driven by the

need to preserve signal integrity and minimize latency while shrinking the size and weight of the enclosures. As a result, these SFF (small form factor) systems must often be capable of withstanding extreme environmental conditions during operation, forcing designers to develop new packaging and thermal management techniques to overcome these tough requirements.

Because of the many different applications and installation platforms, each SFF enclosure must conform to a unique set of SWaP constraints. As a result, SFF system vendors now address these requirements with an extensive array of enclosures, which are often not compatible with open-standard system architectures.

This article presents the challenges and goals of such designs and offers product examples that illustrate successful strategies for meeting them. ➤



New Technology Enhances SFF Capabilities

Traditional military embedded systems often consist of sensors (e.g., antennas) mounted in locations to best capture signals (e.g., antenna masts) with coaxial cables carrying signals to and from the equipment bay. There, a common chassis often houses both the digital signal processors and the sensor interfaces, which require analog RF I/O circuitry and precision data converters to maintain the highest levels of signal fidelity and dynamic range.

It is difficult to shield and isolate these sections from conducted and radiated emissions from adjacent digital signal processing boards, graphic processors, and switching power supplies operating at several hundreds of watts. To make matters worse, analog signals flowing from remote antennas or sensors suffer signal degradation from cable losses and susceptibility to interference from powerful antenna transmit signals, inter-channel crosstalk, and power generation equipment.

Modern radar, communications, interception, and electronic counter-measure systems now rely on phased-array

antennas for steering receive and transmit signal beam patterns. These antennas are usually linear or two-dimensional flat arrays that can contain dozens of elements, each requiring separate signal processing for precisely shifting the phase to attain the desired directionality. Unfortunately, with traditional architectures, this dramatically boosts the required number of coaxial RF cables.

Removing the sensor interfaces from the equipment room chassis by relocating them as close as possible to the sensors solves the first problem of system noise contamination. New, highly-integrated monolithic devices like the Xilinx Zynq UltraScale+ RFSoc family are rapidly turning the tables on traditional architectures. Because they contain 8 or 16 RF signal data converters (ADCs and DACs), FPGA resources for DSP, and multi-core ARM processors for system management, they can perform essential functions that previously required large multi-board chassis.

Now, compact SFF enclosures holding RF circuitry to convert antenna signal frequencies to and from L-band and the RFSoc devices for data conversion and initial signal processing are small

enough to be mounted next to, or even behind, the antenna array. The FPGA resources in the RFSoc can locally apply the required phase shifts to the elements for all receive and transmit signals.

Depending on the application, additional front end processing tasks can include target tracking and identification, modulation/demodulation, or encryption/decryption. Not only do these operations deliver low latency performance, they also significantly off-load backend processing tasks. With sensitive RF circuitry and data converters inside the SFF enclosure, the link to the main system is now digital, thereby eliminating analog RF cables.

Multi-gigabit Ethernet has become one of the most popular interconnect standards between embedded system elements. The latest VITA interfaces now define 10-, 40- and 100-gigabit Ethernet across copper backplane links between system boards, and over copper or optical cables between chassis. These are implemented by using either single transceiver lanes, or four bonded lanes, each operating at 10 or 25 gbaud to achieve the higher channel rates. Multi-mode fibre optical transceivers



Figure 1. Example of RFSoc-base SFF ruggedized sub-system. The **Quartz Model 6353** provides 8 channels of remote data acquisition and generation, local ARM processor system controller, FPGA fabric for DSP, and dual 100 GbE optical interfaces with VITA-49 data protocol.

and cables can deliver these rates across distances of 100 meters.

Each 100 GbE link connecting SFF systems to back end processors carries bidirectional digitized receive and transmit signals with data payload rates up to 12 GB/sec in each direction. This strategy not only eliminates the signal degradation and EMI susceptibility associated with long RF coaxial cables, but also saves weight, vital to aircraft systems and smaller platforms like UAVs. Optical cables are also less expensive, require less maintenance, and for added security, are highly-resistant to eavesdropping.

VITA 49 Radio Transport Protocol defines how digitized RF and IF signals are packetized for Ethernet using standardized fields for channel identification, signal parameters, time and location stamps and payload data. In this way, the same digitized signal stream can be distributed across network links to support many different applications. The latest incarnation, VITA 49.2, adds control and status protocols for both receive and transmit functions, representing powerful new levels of standardized system management and data connectivity.

SFF Systems Influence New Embedded System Open Standards

SOSA™ (Sensor Open Systems Architecture), a significant DoD-inspired system initiative, will define future MIL-AERO requirements. The SOSA Technical Standard, expected to be released in 2021, draws heavily on OpenVPX to define cards, backplanes, and system interconnections. But many participants in the SOSA community recognize that 3U and 6U OpenVPX system

enclosures exceed the size constraints of many important applications.

Over the last decade, well before SOSA came on the scene, many embedded system SFF proposals have been slowly moving through the standardization process at VITA. Now, SOSA is evaluating these architectures to determine if one or more of them can be adopted to support smaller SOSA systems.

One of the main contenders is VITA 74, also called VNX, which offers small boards (89 mm x 78 mm) and two widths (12.5 and 19 mm) as shown in



Figure 2. VITA 74 VNX SFF Modules, showing both the 12.5 and 19 mm widths with two and four rows of backplane contacts, respectively. Courtesy Wolf Advanced Technologies.

Figure 2 (above). High-speed, high-density backplane connectors carry the same signals as VITA 46 (VPX). VNX boards can carry ComExpress Mini, and Mini PCIe mezzanines defined by PICMG. Extensions support optical and RF backplane I/O.

The second main contender is Short VPX, a new SFF initiative that preserves 3U and 6U OpenVPX backplane connectors and signals, except it shortens the length of the VPX board from 160 mm to 100 mm. Although Short VPX is too short to support PMC or XMC mezzanine modules, it can accommodate FMCs. To make up for the smaller board area, the module spacing (pitch) increases to 1.2 inches to allow taller mezzanine components. Optical and RF backplane I/O is automatically inherited from the many new OpenVPX standards in VITA 66 and VITA 67. Transitioning to Short VPX will be easier than VNX for current OpenVPX and SOSA-aligned product vendors because it uses the same backplane.

SFF Products and Modular Architectures

Despite the availability of these standards-based SFF enclosures, they will exceed the SWaP or cost constraints of many applications. To satisfy the growing trend towards modular, distributed system architectures, SFF products are often proprietary sub-systems that satisfy a single, well-defined application. To make it easier, these products can take full advantage of the growing shift towards gigabit Ethernet connectivity within and between embedded systems. For this reason, distributed architectures scale extremely well to support wide range of platforms from small UAVs to large naval ships.

Other tangible benefits of modular systems include easier upgradability and insertion of new technology. For example, replacing an older SFF sub-system peripheral with a more advanced one may be far easier if both share common Ethernet and VITA 49 protocol connections to the host. The same argument applies for a major upgrade to a host radar system, where expensive antenna systems are often retained to save costs. In this way, defense embedded platforms can more quickly adapt to new threats. ➤

SFF Systems: What's Inside?

Regardless of the mechanical form factor, successful SFF embedded systems draw upon the latest silicon devices, system links and interfaces, industry standard software tools and protocols, all integrated with proven packaging and thermal management strategies. Resources typically found in high-performance embedded system SFFs are listed below:

■ **System Controller:** A CPU handles local management of host communication, control, status, and health monitoring. This is usually an Intel, ARM or AMD processor with SDRAM and FLASH memory, and a limited collection of standard peripheral interfaces including PCIe, USB, Ethernet, SATA, parallel, and serial ports. Some SFF controllers use

FPGAs with embedded ARM processors or soft processor IP cores built from FPGA fabric. Linux is the dominant CPU operating system, especially in the smaller and simpler products.

- **Specialized Peripheral Interfaces:** These are application-specific sensor interfaces including ADCs and DACs, RF tuners and upconverters, power amplifiers, GPS receivers, accelerometers, power meters, and video adapters, RAID controllers, and wireless network adapters. Some of these are provided by the system controller CPU or an FPGA.
- **Signal Processor:** Unlike the system controller, this section handles real-time DSP tasks required for the digitized sensor signals. These tasks

are often locally controlled and monitored by the system controller in response to commands from the host system.

- **Wideband Data Interfaces:** Multi-gigabit serial interfaces move real-time payload data to and from the SFF enclosure, often using optical transceivers to assure signal integrity over long distances.
- **Packaging and Power:** Rounding out the SFF system is the power supply, enclosure, mounting provisions, cooling structures, and suitable connectors, all designed for compliance with the deployed environment.

As an example, Pentek's Model 6353 RFSoc SFF Processor is a complete 8-channel RF/IF signal acquisition/generation subsystem shown in **Figure 3**,

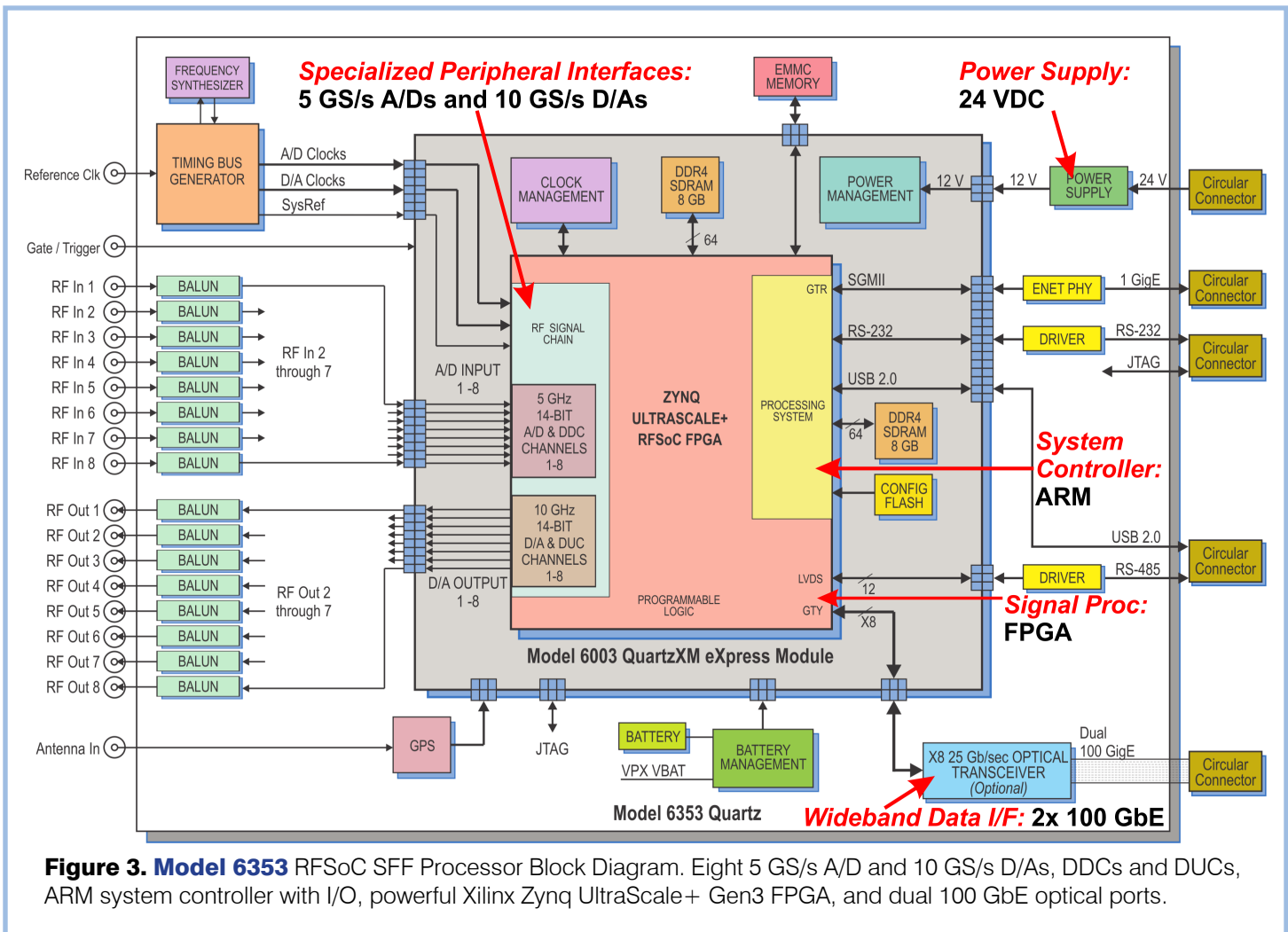


Figure 3. Model 6353 RFSoc SFF Processor Block Diagram. Eight 5 GS/s A/D and 10 GS/s D/As, DDCs and DUCs, ARM system controller with I/O, powerful Xilinx Zynq UltraScale+ Gen3 FPGA, and dual 100 GbE optical ports.

which highlights each of the SFF resources listed above. It is targeted expressly for modular embedded radar, SIGINT, communications, and electronic warfare systems. Its small size and ruggedized enclosure (see **Figure 1**) allows it to be mounted close to the antenna, and its multiple signal channels support phased-array applications.

Going Forward

By enabling distributed system architectures, SFF systems and sub-systems solve many of the toughest problems facing embedded system designers. The strong shift towards Ethernet connectivity between elements helps preserve software and firmware development efforts when repartitioning sections of a system to optimize specific applications. Additionally, this modular approach often boosts performance, especially for SFFs with local sensor interfaces, data converters, pre-processors, and high-speed Ethernet links to a remote host.

Consistent with many objectives of SOSA, SFF products help improve reusability of hardware and software, facilitate new technology insertion, foster innovation and multi-vendor competition, shorten system development cycles, and reduce acquisition costs. SFF products will continue to play increasingly critical roles in future military embedded systems.

Click below to learn more about **Strategies for Deploying Xilinx's RFSoc**



Deep Dive on Pentek Acquisition by Mercury Systems and Radar/EW Market Trends



This spring, Mercury Systems acquired Pentek, a designer of FPGA single-board computers, data-acquisition boards, recording systems, and other products for radar, signals intelligence (SIGINT), and electronic warfare (EW) applications.

In this transcribed [McHale Report podcast](#), John McHale, Editorial Director, Military Embedded Systems, interviewed Neal Austin, Vice President and General Manager of the Mixed Signal Business Unit within Mercury Systems, and Rodger Hosking, co-founder and Vice President of Pentek Systems, about the acquisition, where Pentek will fit within Mercury, and how the acquisition impacts the Mercury efforts within the Sensor Open Systems Architecture (SOSA) Consortium.

They also covered design trends in the radar and electronic warfare markets, commercial-off-the-shelf (COTS) procurement, the impact AI and 5G will have on military electronics, and the engineering recruitment challenges that defense companies face.

John McHale: I'm going to ask you both to talk about your roles within Mercury Systems and your experience in the defense industry. From there, we'll start talking about the acquisition.

Neal Austin: I started my career 30 years ago in the defense industry, in engineering, bringing surface electronic warfare systems to market. Over the years, I had roles in engineering program management, sales, and sales management. I spent about 10 years as a VP of sales for microelectronics products. And three years ago I was very pleased to take my current role, as Vice President and General Manager of the Mixed Signal business for Mercury Systems.

John McHale: Rodger?

Rodger Hosking: Well, I am now the Vice President of the COTS product facility, here in Upper Saddle River, NJ. It is part of the Mixed Signal business unit of Mercury. Before this position, I was in the business for over 40 years and 35 years of those were with Pentek. ➤

John McHale: So let's talk about that acquisition. Why did Mercury buy Pentek, Neal? Aside from you wanted to get to know Rodger better?

Neal Austin: Excellent question. So, funny you mentioned getting to know Rodger better. Because the folks here at Mercury have known Rodger, Paul, and Danny, the founders of Pentek, for many, many years. We've admired the business that they have developed over the years. Especially their ability to focus on true commercial, off-the-shelf products. Really having a clear market vision. A clear prioritization of activities. And building what we believe is the predominant, commercial, off-the-shelf product offering, for radar and EW, mixed signal, and FPGA applications.

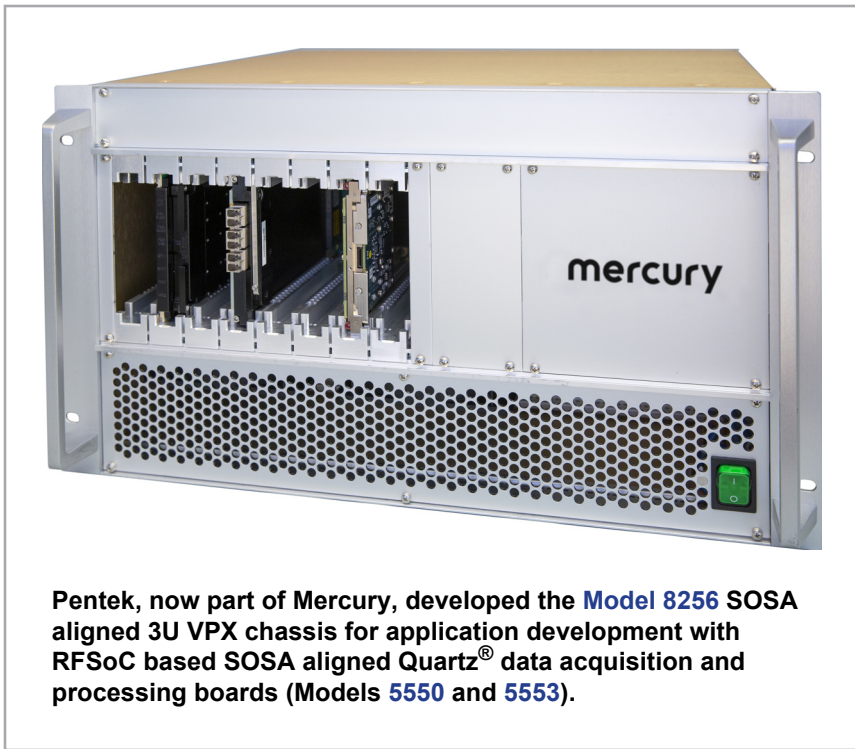
John McHale: Rodger, why did you and your partners decide to sell to Mercury Systems?

Rodger Hosking: What we wanted to do was to grow the company. And we wanted access to some larger programs that we had previously not been participating in, to the extent that we really thought we could. Mercury brings us a chance to grow by having access to larger opportunities in the defense market space that were out of our reach, or we just weren't big enough for. So growth of our company is the primary reason, but it's also about creating new career paths for our employees.

What we bring to the market are real COTS products with full product specifications and documentation published on our website. Our COTS products are

not ITAR-controlled. A lot of the similar board-level products that the rest of Mercury has are primarily program-business products, which are often ITAR-controlled. So, we're quite complementary in that way because now Mercury can offer our existing board-level COTS as well as the modified COTS products from the rest of the Mixed-Signal group, primarily in Huntsville AL.

We also have a lot of sales channels worldwide. So we're able to open up new market opportunities for Mercury by selling our products outside the US.



Pentek, now part of Mercury, developed the Model 8256 SOSA aligned 3U VPX chassis for application development with RFSoc based SOSA aligned Quartz® data acquisition and processing boards (Models 5550 and 5553).

That'll be a way for Mercury to expand its overall global market. In fact, we can help them grow and they can help us grow.

John McHale: From a structural standpoint, Neal, where does Pentek fit in? You guys have been on a buying spree for the last few years, and accelerated growth. One of the fastest growing companies in Massachusetts. So where's Pentek? What division are they in? How are they operating?

Neal Austin: The Mixed Signal business unit that Rodger and I are responsible for fits into the micro-electronics division of Mercury. From an electronic warfare and radar subsystems perspective, we're "the ham in the ham sandwich." We're where the techniques reside, where the mixed signal conversion from RF to bits actually happens. So we're a growing business unit within Mercury. And Pentek expands the products and the channels to market within the Mixed Signal business unit.

John McHale: What about overlap? Rodger mentioned a lot of different products. But there was some overlap. So you did compete with them somewhat before you bought them, like in some FPGA signal processing applications? Is that a concern or is it the overlap is so small, it doesn't really make a difference? Neal?

Rodger Hosking: I can answer that. We rarely competed with Mercury. Again, because of the different focus on the markets. The program market, primarily served by Mercury, and the true open COTS market that we serve. Because those markets are quite different, we didn't often

compete. We didn't see Mercury competing with the types of opportunities that we were trying to win and vice versa, even though there were a couple of small exceptions here and there. So that's one of the reasons Mercury wanted to acquire us and why we wanted to join with Mercury. It was a benefit to both sides. The acquisition made sense for a lot of reasons.

John McHale: Neal, did you want to add anything to that? ➤

Neal Austin: I would like to. I agree 100 percent with Rodger. We are complementary companies, if you will. Right? We have different channels to market. The Pentek channel to market was very much a commercial approach, that was really organized to get to a very broad base of customers, whereas Mercury's channel to market is very strategically focused. We're focused on the primes that really move the needle.

And so we rarely ran across each other. And in some instances, there were cases where we, traditional Mercury, had opportunities that needed a commercial, off-the-shelf product. Like an RF block, for instance. Or an off-the-shelf tuner for the data recorder products. And we would look to Pentek for help with those commercial products.

John McHale: Rodger talked a lot about COTS and for those of you out there who might not know what COTS is, commercial off-the-shelf, it's a procurement term. Believe it or not guys, it is now 27 years-old. 1994 was when Defense Secretary William Perry put out that famous COTS memo, to buy commercial, off-the-shelf wherever and whenever possible.

But it's become the way we do business now. In some ways it's used as a marketing term. But it's also a big part of a trend we're seeing today, in terms of open architecture initiatives. The most active right now is the Sensor Open Systems Architecture or SOSA, which is getting close to the first release of its Technical Standard 1.0. And Mercury and Pentek have both played a big part in the committees that are developing that standard. Will that change after the acquisition? Do you see you guys increasing participation, if one did more than the other? I'm curious how you're approaching that.

Rodger Hosking: Well, I see both of our companies, now our single company, continuing the roles that we already have. We are extremely focused on SOSA because it's become

ing very important to government procurement, going forward, and we want to continue the SOSA roles that we have.

The previous Mercury organization contributed several leadership roles in the business and technical working groups. I know that Bill Conley, who's CTO of Mercury, is involved very actively in supporting SOSA, as well as other members of the technical team. In our Saddle River division, we have Paul Mesibov, the co-lead of the hardware subcommittee, and Gina Peter, the co-lead for the outreach committee. All of us will continue in those roles, and I expect Mercury will increase its interest and participation level in the SOSA organization.

John McHale: And as you grow, and become part of Mercury as SOSA's technical standard gets released, it's also an education. There's still a lot of education to be done on SOSA.

Rodger Hosking: That's for sure. It's actively evolving, just as any good standard should. If it doesn't evolve, it's probably not worth much. Of course,

we've seen that with OpenVPX continuing to evolve. Because people are using it, they're contributing to it and extending the specification to accommodate new standards and needs. And SOSA will evolve for the same reasons. There's a lot of work left to do in the SOSA standard. And that is actively being pursued by all of the talented, dedicated people in these working groups.

Neal Austin: I would like to add a quick note, if you don't mind. Just going back to your question about the rationale for the acquisition. Pentek's leadership in SOSA and the SOSA aligned product portfolio was very attractive to Mercury. And so, in part, our acquisition of Pentek illustrates the company's commitment to SOSA and open standards in general.

John McHale: You make an interesting point. Because in a lot of the webcasts and other things I've done, Roger has been right there participating in it. He's usually at these meetings for SOSA. I've been covering it. So I'd like to ask you, Rodger, why is SOSA so different than other standards? It just ➤



Click [here](#) to view Paul Mesibov's video demonstration of the Model 8256 3U VPX SOSA aligned development platform. On September 14, 2021, Paul demonstrated Model 8256 at the U.S. Army - FACE™ and SOSA Technical Interchange Meeting.



**Quartz
Model 5553
SOSA Aligned
8-Channel
A/D & D/A
3U VPX Board
with Xilinx Zynq
UltraScale+
RFSoc - Gen 3**

**Jade
Model 71813
SOSA Aligned
LVDS with Optical I/O
Kintex UltraScale
FPGA - XMC**

of the three services to develop their own specifications, their own RFQs, and so forth, for programs. This is a big benefit for them.

Once all of that's in place, the vendor community is going to look at that and say "Well, gee, if we're not part of that, we're going to be left out." So that's what's driving a lot of the excitement within the vendor community. Looking at the participants in SOSA, which include hundreds of different vendors, you see that many of them are extremely active. It's really a very synergistic relationship from the top down.

John McHale: Neal, what has your experience been with SOSA, and actually just

So, we were active, we were engaged. But to some degree, we were very selective in the kinds of products we brought to market. The traditional Mixed Signal group did bring the first SOSA aligned EW tuner to market. It was a 3U, EW, very fast tuning, embedded tuner. That was the first of its kind to be SOSA aligned. So we have been involved. But because of the modified COTS nature of the business, we weren't nearly as involved as Rodger and Paul, and the Pentek team.

John McHale: You talk about COTS and, how long has it been – for 27 years? I like the way you guys are describing it: COTS versus modified



Pentek participated in the Tri-Service Open Architecture Interoperability Demonstration (TSOA-ID) on January 29, 2020. In the picture above, Captain McDowell and Paul Mesibov of Pentek discussed Pentek's SOSA aligned products demonstrated at the TSOA-ID event. Captain McDowell and his counterparts are key partners in the tri-service open architecture ecosystem.

seems like there's so much more enthusiasm behind SOSA. You and I have both seen a lot of standards come and go over the last couple of decades. But this one seems to have a lot of not only staying power, but momentum.

Rodger Hosking: Well, I think part of it is driven from the top. The DoD (Department of Defense) declared, in effect, "Thou shalt use open standards in all procurements". This, of course, led directly to SOSA, which inspired the three services to join together, sharing each of their visions of what open standards means to them. By combining forces, they all made major contributions to SOSA, towards defining the SOSA Reference Architecture. That'll be good for each of the services because with their combined needs, they'll be able to have a larger common requirement. That will make each of those different systems less expensive and easier to get, with shorter lead times. It also means less work for each

initiatives in general, for open architectures, that you've seen in your 30 years in the business?

Neal Austin: So, this goes a little bit to the COTS versus modified COTS mentality. Mercury has always been an early adopter and driver of open standards. Our involvement in OpenVPX is an example. But I'm going to speak for Mixed Signals specifically because historically we have been a modified COTS supplier, thereby developing products, specific products for customers based on reference designs. We weren't as engaged in SOSA activities as we would have liked to have been, just because of prioritizations of products and the program-based business we served.

COTS. I once did a slide of different acronyms for COTS. And I came up with COTS, ROTS (rugged off-the-shelf), MOTS (military off-the-shelf), GOTS (government off-the-shelf), and NOTS (NATO off-the-shelf). And a guy from Cisco once told me he sold KAOTS, which is kinda off-the-shelf. And then I heard some guys talking about QML off-the-shelf, which was Q, quotes. It was getting out of hand. But we had some fun with it.

But I'm glad we can narrow it down to just two. I think that's the best way to do it. Either it's modified off-the-shelf or it's off-the-shelf, right? It's a great way to embrace brevity, when describing this procurement term. Rodger, can you believe it's been 27 years?

Rodger Hosking: No. It really doesn't seem that long. But it's really been good for us. And I think it's been good for the industry. Especially, I would say, for the smaller vendors because they are now better able to participate. And this will be true for SOSA, as well. One major objective of SOSA is enabling smaller vendors to participate.


Prime contractors, by incorporating these SOSA products in their proposals for program business, will have bids with a higher SOSA content that will be

Learn more about SOSA


Click [here](#) to download the free ebook: **Focus on SOSA**.




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TALKS



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The Road Forward: Mercury Systems, Pentek, and SOSA

Microwaves and RF recently presented a TechXchange Talk in which Ken Hermann and Rodger Hosking of Mercury Systems discussed the technology synergies between Mercury and its recent acquisition, Pentek, and how the Sensors Open System Architecture (SOSA) fits into Mercury's future. Click [here](#) to view this TechCast.

scored more favorably to help them win. So the smaller companies wind up helping not only larger primes, but also the tier two and tier three companies, to boost SOSA content more quickly, and easily, and often much less expensively.

John McHale: How do your customers view COTS? The prime contractors, the DoD? I know the DoD reason for the primes. Do they look at it the same way you do? There are still probably flavors of those different acronyms I just shared. What are you hearing from them? This is for both of you.

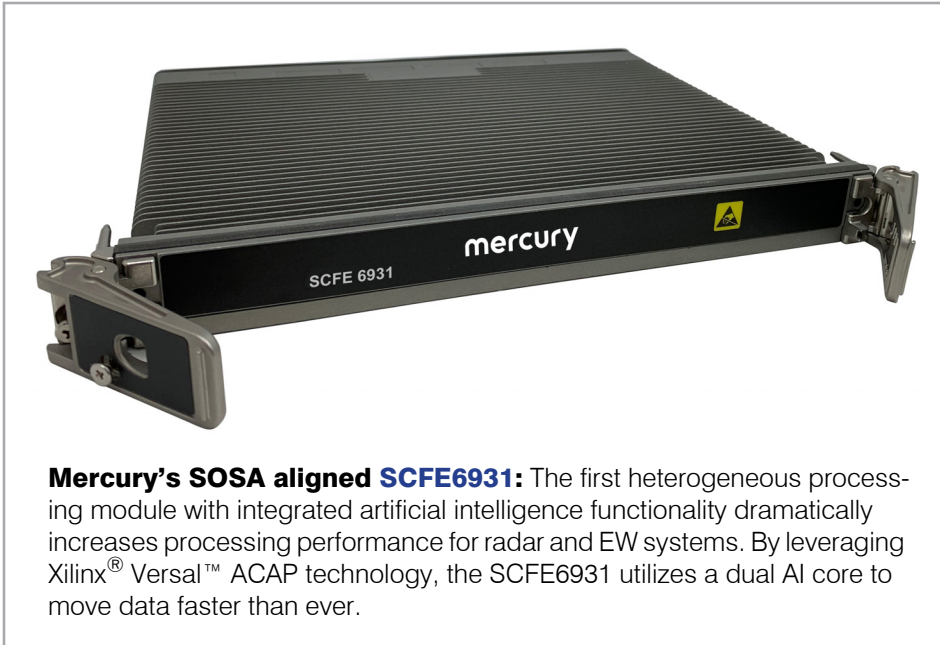
Neal Austin: I'll take a stab at that. So, from the traditional, mixed-signal perspective, we've been focused on primes primarily. So we've come up against this quite a bit. The primes like to see technology maturation, or I should say, technology introduction through commercial off-the-shelf offerings. But then when it comes down to program needs and what's actually realized, it's generally very different than the commercial off-the-shelf product that is put on the bench the first time and exercised. Because program

requirements often come into play that aren't conceptualized during definition of the commercial off-the-shelf.

John McHale: Rodger, do you want to add anything to that?

Rodger Hosking: Yes, we traditionally start with our open market COTS product offerings. Like we've always done traditionally. We use these to inspire interest from a wide range of customers, who might take the products as they are, or perhaps need something a little bit different. This is exactly what Neal just described. Then we will add options to different aspects of the product to allow the basic product to be customized or configured specifically for a particular customer's need. Perhaps it's a different style of connector on the front panel, or some different FPGA code to handle a new interface protocol, for example.

So, in this way, both Mixed Signal facilities do very similar things. But I think the starting point, in our case [Saddle River], is always with a commercial open COTS product, and then we'll ▶



Mercury's SOSA aligned SCFE6931: The first heterogeneous processing module with integrated artificial intelligence functionality dramatically increases processing performance for radar and EW systems. By leveraging Xilinx® Versal™ ACAP technology, the SCFE6931 utilizes a dual AI core to move data faster than ever.

add some options. Huntsville may normally start with fulfilling a program requirement with a specific product. Even if the starting point can be a little bit different, the engineers who work in both of our facilities really are working on the same kinds of problems. It's just a different way of getting to market.

Neal Austin: And I guess one more idea to that point is the idea of a reference design, which is really the additional value that comes with Pentek joining Mercury. Because now we have this family of commercial off-the-shelf products that really are reference designs and launch-out points for engagement with the primes.

John McHale: We've talked a lot about COTS and SOSA. Let's talk about some key market areas, application areas within the DoD, and what's going on there. What are you guys seeing when it comes to design trends? You can also say customer requirements trends. Are you seeing any radar and electronic warfare applications? And do you see funding in these areas continuing to be strong, despite changes in presidential administrations?

Rodger Hosking: Well, I can definitely say that they are strong. I think that everyone sees the growing threat from our adversaries – China, Russia, others, and we just cannot relax. We've really got to direct a lot of attention to get some resources to counter those efforts because they're not going away. They're only going to get stronger. Specifically, this will be a strong driver for radar, EW, and SIGINT.

I think those all will be very important. The shifts that we see in the kinds of threats out there means we're going to need to re-architect a little bit. Specifically, we're moving strongly towards distributed systems, which means co-location of remote sensors and the electronics for acquiring the sensor signals. In this way, the acquisition system is located right behind the antenna. Instead of cabling RF signals down from the antenna to a central acquisition point, digitized signal payloads will be distributed using optical links.

A huge number of unmanned vehicles are replacing the roles of war fighters, platforms, and vehicles. And those UAVs will require smaller, more compact, more powerful, and often more

intelligent signal processing functions to do their job.

John McHale: What are you seeing, Neal?

Neal Austin: I agree with Rodger, 100 percent. Distributed architectures and multifunction RF are the trends of the future. I believe that Mercury as a whole and, in particular, Mixed Signal, is making the right investments. The investment in Pentek is one example. To address the change in architecture, we now have RF direct digitization happening at the aperture, along with FPGA processing. And, by the way, intelligent FPGA processing with AI engines at the next level. And then radar and EW servers and processors, even further down the chain. So, we're going to continue to see these trends as 5th-Gen ISA structures really begin to get out there in the market. Multi-mission apertures are the way of the future.

John McHale: You guys both talked about how we have to invest in technologies and stay competitive. Especially with adversarial nations, like Rodger just touched upon. Should we also be investing in engineering talent? And where I'm coming from on this is: you both have been around for a number of decades in this industry, attending trade shows.

But when attending non-military trade shows, I've always seemed to see there's a lot less gray hair at those non-mil shows than at military technology events, such as the Army's AUSA show and ABC Airspace. Do you think the military electronics industry has a talent recruitment challenge on its hands? And if so, how can it be solved? Neal? I throw this one at you.

Neal Austin: Yes, it's an interesting dilemma, and one we talk about often. It has been a challenge for a long, long time. So, we're addressing it through investment in STEM, as an example. We're investing in programs with our

customers, to engage at the community college and local university level. We've even recently invested in a STEM program at a children's museum, called Early Works in Huntsville, Alabama, where we're an active sponsor. We're trying to get the mission out there.

The other place we're making a big investment is in our co-op programs, engaging with local universities and not necessarily talking about the mission. Because the mission may not align with everyone you talk to in an engineering program. But what we've seen is what does resonate with the kids – especially the kids who are in that top five to 10 percent of their class. They want to solve hard problems. And they're not as concerned about the market space for the problem. They're more concerned about “how hard is the problem?”, and “can I really exercise my knowledge?” And we've been pretty successful there, particularly at the University of Alabama in Huntsville and Auburn University, down in central Alabama.

John McHale: Making it about solving that intellectual challenge ...

Neal Austin: Yes, exactly. It's about intellectual challenge. And we have recently, I'll say in the last couple of years, collected some talent who were very early in their college careers, who I hope will be with us for the long term.

Rodger Hosking: We've also always been challenged to try to find new engineers. A lot of them come out of school without much hands-on experience. And so we have struggled. We've worked with our local schools and found some very good people. But something that we are really impressed with are Mercury's strategies, like the ones Neal has described – the STEM program and intern programs. We are going to be asking for some guidance and help in building that part of the recruitment function for us in Saddle River.

John McHale: Now, I'm going to ask you guys to put your crystal balls together and look forward a bit. What disruptive technology innovation will be a game changer in the defense electronics world, maybe five, ten years from now? We're talking to AI, 5G, something else. Predict the future. We'll dust this podcast off in 10 years and see who was right.

Rodger Hosking: Well, I can certainly start off by saying that AI is definitely going to be a game changer. We certainly see the challenge that's out there, that I was talking about before. To do things like identify and classify targets. To compute, in real-time, the countermeasure signals that will hide an aircraft from the enemy radar. Or even to untangle a very heavily-

encrypted message or signal to glean vital information for war fighters.

We're definitely going to see a great interest in the new components like the Versal devices, the latest generation Xilinx family. It incorporates AI, machine learning, and multi-processing engines, to tackle the diverse computational tasks to handle such applications more effectively than before.

And again, it's about never being done. It's an ongoing, evolving challenge to try to keep ahead of the competition, in this case the enemy, to stay on top and to maintain superiority.

John McHale: Neal?

Neal Austin: Rodger and I are quite well-aligned in our vision: the deployment of multi-function apertures that can autonomously transmit and receive radar, EW, SIGINT, even COMS data, autonomously decide what they're looking at. Deploy a technique autonomously, if needed, for an EW application while continuing to track threats. And a lot of this is going to be enabled with very, very broadband, at the aperture, mixed-signal conversion of RF-to-bits, and AI engines that are built into the FPGA processing. ➤

WEBINAR

Bringing AI to the tactical edge with Xilinx® Versal™ ACAP

Xilinx and Mercury are working together to deliver up to 20× more processing power closer to the edge. **View this recent webinar**, moderated by John McHale, Editorial Director of Military Embedded Systems, to learn more about:

- Radar and EW trends and challenges
- Xilinx Versal ACAP technology featuring the AI Core series
- Faster processing and performance than traditional FPGAs
- SWaP-focused, OpenVPX and SOSA-aligned AI Core device modules on the market

Click [here](#) to register and view the webinar.



John McHale, Military Embedded Systems

About the time this [podcast] is heard by listeners, we will have released our first AI engine FPGA card for embedded processing. And that's based on Versal FPGAs. It's what the DoD has been talking about. It's what the primes have been talking about. And Mercury is going to be first to market with the product.

Rodger Hosking: Over the years, we have seen that military customers will adopt commercial products that are useful. And AI is a natural extension of the already really huge market for driverless cars, Amazon drone delivery, and many other commercial applications. So once again, we can harness some of this technology that was inspired, mass produced, and made affordable by commercial markets.

Another example is 5G networking, which is going to be exploited heavily in military networks to keep all the war-fighting elements tied together. On ground, air, and sea it's going to be necessary to transmit a lot more information, with a lot greater bandwidth than ever before. We must deliver this "fire hose" of information to be gleaned, processed, and then delivered to the war fighters who need it immediately.

Also, we're seeing an increasing need for processing, which we'll definitely be involved in. This will be addressed by increasingly more competent, and I would say, specialized processing elements right within the node and close to the sensor – maybe entirely within the UAV or right behind the antenna. But it's definitely going to become a major theme going forward. And we're going to be there.

Neal Austin: You know, Rodger, another important theme, in addition to what you just brought up, that's very important, is embedded security. Mercury is a leader in embedded security capability, and embedded in the FPGAs, on the products that Rodger and Mixed Signal will bring to market. I think Mercury is very well positioned for

that. Especially for the autonomous systems that Rodger mentioned.

Rodger Hosking: I agree 100 percent, Neal.

John McHale: Excellent, gentlemen. I'm going to dust those answers off and see if you're right when we're on a 5G podcast in five years – and it's being performed by an artificial intelligence system!

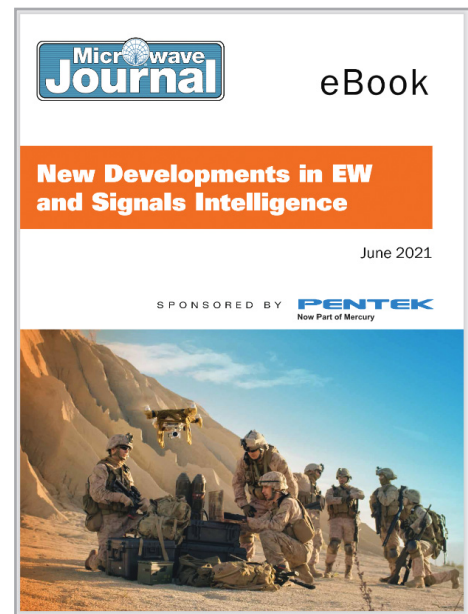
And that's bringing us to the end of the broadcast. But before I close up, I just have a quick follow-up question that goes back to one of the first points in our discussion. From your customers' standpoint, it's Pentek Systems. Now part of the Mercury Systems Mixed Signal business unit. But if they go to Pentek.com, they'll still be able to find Pentek. And from a product nomenclature standpoint, it's going to be a pretty fluid. These are questions I usually hear from customers in a transition like this.

Rodger Hosking: The transition is going to be gradual and appropriate. We want to keep the Pentek name for as long as it benefits us and our customers, for brand recognition and coming back. Our wealth of website resources will eventually transition to the Mercury domain, and the Pentek name will eventually transition over, too.

Neal Austin: Yes, there's great value in the Pentek name. There's great value in the brand that Rodger, and Paul, and Danny, and Gina, have built over the years. And we're not going to jeopardize that. The transition will be slow. We haven't

thought through it completely, because we're taking it very slowly. And we're going to listen to the market. We're going to listen to what our customers say. So TBD, John, is the message there.

John McHale: Well, that sounds good. And that brings us to the end of our broadcast. Neal, Rodger, thanks for speaking today. And good luck with the transition! □



New eBook Focuses on EW and Signals Intelligence

In the last few years, technology has advanced in Electronic Warfare (EW) and Signals Intelligence: higher power, wideband hardware has become more mainstream and artificial intelligence (AI)/machine learning (ML) have advanced on the software side. Software defined radios have also progressed, leading to lower cost, more re-configurable hardware. Meanwhile, threats to security have increased dramatically as drones and robots have become more sophisticated and easier to obtain.

This eBook reviews some of the recent advances in smarter, more flexible hardware to gather and jam signals from these emerging threats. Click [here](#) to download it.

8-Channel Phase Coherent RF Signal Recorder Extends Recording Capability for Beamforming and Radar Applications

- Rugged RF signal recorder with eight phase-coherent RF tuners
- Ideal for signal intelligence, phased-array radars, beamforming, and direction finding
- Records RF frequencies to 6 GHz with bandwidths to 80 MHz
- 3.2 GB/s real-time aggregate recording rate
- 122 TB of storage allows for hours of data recording
- SystemFlow® software GUI with Signal Viewer analysis tool



The **Talon Model RTR 2628** is an 8-channel, phase coherent, 4U 19-inch rackmount recorder with integrated RF tuners and A/D converters. The rugged rackmount system is designed to operate under conditions of vibration and extended operating temperatures. The Talon RTR 2628 accepts signals from eight antennas to provide eight channels of phase-coherent RF signal recording. Each channel is tunable up to 6 GHz and captures up to 80 MHz of instantaneous bandwidth.

"With excellent dynamic range to pick up low-level signals, the Talon RTR 2628 is an ideal choice for spectrum monitoring applications that need to accurately interpret synchronized signals. Targeted applications including beamforming, direction finding, phased-array radars, and multi-antenna diversity receivers can all leverage the phase-coherent capabilities of the Talon RTR 2628," noted Rodger Hosking, Vice President, Pentek, now part of Mercury Systems.

Each input channel includes a 250 MHz 16-bit A/D and an FPGA-based digital downconverter with programmable decimations from 2 to 65536 for instantaneous bandwidths from 80 MHz down to 3 kHz. RF signals up to 6 GHz in frequency can be tuned, sampled, digitally-downconverted, and streamed to disk in real-time at sustained aggregate recording rates up to 3.2 GB/sec. RF tuning frequencies, A/D sampling rates, DDC decimations, and trigger settings are among the selectable system parameters, providing a system that is flexible, yet simple to configure and operate.

The RTR 2628 is configured in a 4U 19-inch rack-mountable chassis, with hot-swap data drives, front panel USB ports, and I/O connectors on the rear panel. It is optimized for cooling and ruggedized to operate in challenging environments. Systems are scalable to accommodate multiple chassis' to increase phase-coherent channel counts and aggregate data rates. All

recorder chassis are connected via Ethernet and can be controlled from a single GUI either locally or from a remote PC.

The RTR 2628 includes as many as 32 hot-swappable SSDs to provide flexible storage capacities up to 122 TB. The 2.5-inch SSDs can be easily removed or exchanged during a mission to retrieve recorded data. Multiple RAID levels, including 0, 5 and 6, provide a choice for the required level of redundancy.

Ease of Operation

All Talon recorders are built on a Microsoft Windows platform and include Pentek's System-

Flow software, featuring a GUI (graphical user interface), Signal Viewer, and API (Application Programming Interface). The GUI provides intuitive controls for out-of-the-box turn-key operation using point-and-click configuration management.

Configurations are easily stored and recalled for single-click setup. The Signal Viewer provides a virtual oscilloscope and spectrum analyzer to monitor signals before, during, and after data collection. The C-callable API allows users to integrate the recorder control as a front end to larger application systems. Enhancements to the GUI support efficient configuration of the recording channels.

The data format used for storage follows the NTFS standard, allowing users to remove drives from the instrument and read the data using standard Windows-based systems, eliminating the need for file format conversion. ➤

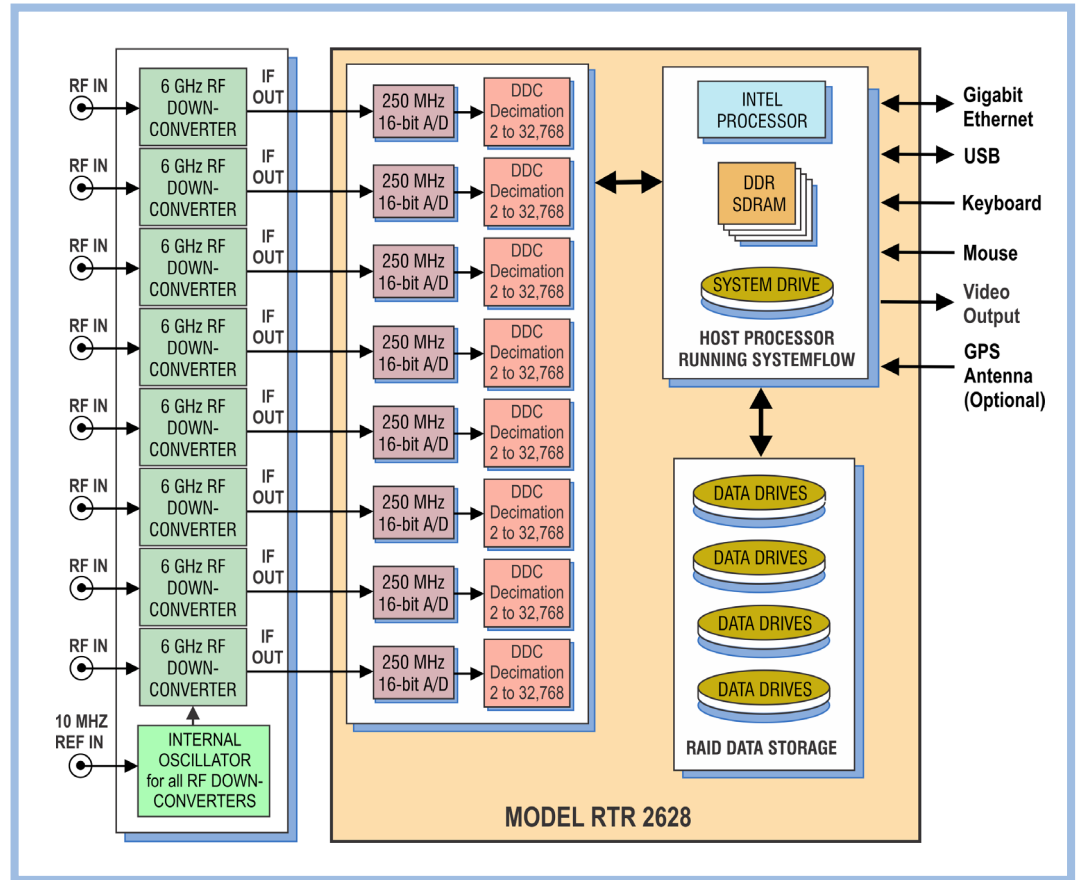
Free Demo

A Talon Recording System Simulator is available for evaluation of the SystemFlow software.

- Allows engineers to write and test their application (built using the SystemFlow API) before receiving the recorder hardware
- Demonstrates SystemFlow signal and file viewer tools
- Available for download at: <https://www.pentek.com/go/sfsimulator>.

Pricing and Availability

To learn more about this product or discuss your specific application, contact dl-sdl-techsales@mrcy.com, 201-818-5900 or contact your local representative. □



The Benefits of Using Wideband, Real-Time RF Signal Recorders for Radar, EW, and SIGINT

A 30-minute webinar presented by Chris Tojeira, the Technical Director and Chief Architect of the Recording Systems product line of Pentek, now part of Mercury



Capturing and recording radio frequency signals is a crucial tool for developing radars and communications equipment and EW countermeasure systems, as well as the collection and monitoring of SIGINT and ELINT signals. In this webinar, Chris will cover:

- Important factors for RF signal recorders and how to exploit both design time and cost savings in your development
- Capturing real-time data in a deployed SWaP environment
- The benefits of bringing the RF environment back to the lab for signal evaluation, generation, and analysis
- Other field use scenarios.

Several examples of recorders will be presented for different environments ranging from the laboratory to deployed rugged systems, including UAVs and airborne platforms.

To register and view the webinar, click [here](#).



The Open Group Sensor Open System Architecture (SOSA) Consortium Launches New Technical Standard for SOSA™ Reference Architecture, Edition 1.0

SAN FRANCISCO, CA, SEPTEMBER 30, 2021: This week, The Open Group Sensor Open Systems Architecture (SOSA) Consortium published a new Technical Standard for SOSA™ Reference Architecture, Edition 1.0.

Streamlining US military capabilities, the new standard will enable rapid, affordable, cross-platform capability advancements based upon fundamentals of system, software, hardware, and electrical and mechanical engineering best practices and Modular Open Systems Approach (MOSA) principles to develop a solution that addresses Department of Defense (DoD) needs for a cohesive unified set of sensor capabilities.

The SOSA™ Consortium aims to create a common framework for transitioning sensor systems to an open systems architecture, based on key interfaces and open standards established by industry-government consensus. The open architecture supports airborne, subsurface, surface, ground, and space. The goal of The Open Group SOSA Consortium is to reduce development and integration costs and reduce time to field new sensor capabilities.

“The future belongs to those who strive for it. The release of SOSA Technical Standard 1.0 represents a major step forward in implementing the DoD’s vision of a Modular Open Systems Approach (MOSA) for sensor systems as advocated in the Tri-Service memorandum for Service Acquisition Executives and Program Executive Officers issued on January 7, 2019,” said Dr. Ilya Lipkin, Air Force Steering Committee Chair for the SOSA Consortium. *“We are very excited about the release of version 1.0. This achievement culminates*



the collaborative efforts over the past 5 years by a team of government, industry, and academia to define a standard for sensing systems. This standard will enable rapid acquisition and fielding of state-of-the-art components to support our competitive edge in the global environment. The SOSA Consortium success is owned and shared by the community of volunteers who dedicate their expertise, effort, and long hours beyond their work responsibilities toward a common goal.”

“The much-anticipated release of the SOSA Technical Standard 1.0 marks a significant advance in MOSA within the DoD,” said Jason Dirner, Team Leader, Architecture Team, U.S. Army Combat Capabilities Development Command. *“The new SOSA Technical Standard, and its alignment with other standards such as CMOSS, lays the foundation for greater reuse, faster upgrades, increased competition, and lower costs within the acquisition community.”*

“The PMA-209 Avionics Architecture Team is thrilled to witness the release of the SOSA Technical Standard 1.0. This now available important work not only benefits the entire open architecture community, it also supports NAVAIR’s efforts to increase the speed of acquisitions to

the Fleet,” stated LCDR Whitesell, PMA-209 AAT IPT Team Co-lead. *“This new, eagerly awaited technical standard enables the possibility of enterprise-wide reusable components, reduced total ownership costs, and products that can be quickly customized, modified, and extended throughout product life cycles in response to changing user requirements. We applaud the tireless efforts of the SOSA Consortium members and look forward to many more successes in the future.”*

The Open Group is a global consortium that enables the achievement of business objectives through technology standards. Our diverse membership of more than 850 organizations includes customers, systems and solutions suppliers, tool vendors, integrators, academics, and consultants across multiple industries. Further information on The Open Group can be found at www.opengroup.org.

To keep up with the latest SOSA news, go [here](#)..

The Impact of SOSA on Military Computing

This webinar from the editors of **Aerospace & Defense Technology** highlights some of the most recent technical advances driving SOSA forward. Speakers will include **Rodger Hosking**, Vice President and Co-Founder of Pentek, now part of Mercury, **Mark Littlefield**, Senior Manager, Embedded Computing Products & Systems, Elma Electronic, and **Bob Collopy**, Technical Marketing Manager, Atrenne. Click [here](#) to register.

November 18, 2021 at 12:00 pm U.S. EST

Mercury Systems Successfully Demonstrates a Ready-to-Run SOSA Aligned Sensor Processing Platform

On September 14, 2021, Mercury Systems successfully demonstrated the Model 8256 Sensor Open Systems Architecture™ (SOSA) aligned Development Platform at the U.S. Army - FACE™ and SOSA Technical Interchange Meeting, proving true heterogeneous interoperability with SOSA aligned products from several suppliers. This Phase 2 platform highlights additional signal acquisition, time and frequency displays, and includes expanded system management capabilities.

"SOSA is about interoperability, multi-vendor solutions, reuse, and affordable solutions for the government without vendor lock," said Paul Mesibov, Vice President Engineering, Mercury Mixed Signal. *"Showing a system in action and using products from multiple vendors – all aligned with SOSA – is proof that the SOSA initiative is working. Model 8256 further solidifies our dedication to developing open standards and delivering on our commitment to Innovation that Matters."*

This Model 8256 development platform consists of:

- an Elma Electronic 3U VPX chassis
- Crossfield Technology IPMI software and ChassisBerry chassis manager
- an Interface Concept backplane switch module (ComEth4590a)
- a Concurrent Technology TR H4C single-board computer
- and one Mercury Quartz® Model 5550 (or 5553), an eight-channel A/D and D/A converter 3U OpenVPX board based on the Xilinx® Zynq® UltraScale+ RFSoc, all aligned with the SOSA Technical Standard.



Paul Mesibov, Vice President of Engineering, Mercury Mixed Signal, performed the demo at the September meeting. Click below to **view a demo of Model 8256**.



"Learning a new standard can take time to understand and implement correctly. It is much easier to start with a working system pre-configured to meet the objectives of SOSA", said Ken Grob,

director of embedded computing, Elma Electronic Inc. *"The Model 8256 being demonstrated enables engineers to immediately start working on their applications while minimizing the risks encountered when working with new technology and standards. We are very pleased to be part of the Model 8256 development platform."*

"The Model 8256 development platform not only provides access to high-performance hardware but does so with open-standards-based chassis management capabilities," said Terry Hulett, products general manager, Crossfield Technology LLC. *"We are pleased to offer the system software that delivers the common access and interfaces into system management functions for all of the platform components to be truly interoperable with each other."*

For more information about Model 8256, go to www.pentek.com/go/pipe8256 □

5G for Critical Communications

On October 7, The Association of Old Crows (AOC) presented a webinar about 5G. The webinar discussed how the 5G New Radio standard addresses mission-critical communication and how that differs, or relates to device-to-device (D2D) communication in LTE as of 3GPP Release 12.

To access the recording, click [here](#).

