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Modular, Open Standards Based Software Defined Radio Solutions

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Within the embedded industry, there is over 30 years' experience of using open standards-based building blocks in defence applications. In that time, there have been many advances, including suppliers accepting that it takes a lot of trust for a defence equipment manufacturer to choose COTS components. Longevity of supply, high quality manufacture and testing, and the ability to support equipment in the field are critical attributes that suppliers must demonstrate.

Once trust is established, the benefits of modular building blocks based on open standards can be realised. For military deployment, even simple modules require significant development and qualification cycles. While there still needs to be system level qualification, each building block that can be sourced off the shelf saves time to deployment and therefore reduces development cost and risk.

Military threats are constantly evolving, and our ability to intercept, monitor and decode communications must keep pace. The rate of change has increased, and while COTS technologies are not always available, they provide a valuable choice with shorter cycles.

Modular solutions also help technology transitions. Armed forces need the most capable Software Defined Radio / Electronic Warfare (SDR/EW) equipment. As new technology and devices are introduced, it is easier to update standards-based equipment, providing the standard is widely supported. With a widely used standard, the equipment manufacturer can also choose 'best in class' building blocks from a number of qualified vendors.

Which standard?

There has been a proliferation of open standards, as more industries and markets have become aware of the advantages. They can broadly be split into three categories: those applicable for low cost, single processor systems; multiprocessor architectures driven by a small group of manufacturers; and multiprocessor architectures driven by a wide group of suppliers and end users. EW and SDR equipment needs multiple, connected processing elements, and so naturally falls into the last category.

Several open standards could be considered suitable, including CompactPCI Serial and Rugged MicroTCA from the PICMG standards body, plus VITA's VME and VPX standards. In our opinion, CompactPCI boards and AdvancedMC modules (used in MicroTCA systems) do not yet have sufficient momentum within the defence community and so are not currently the best choice, despite having some technical merits.

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A huge number of VME boards have been deployed in military and aerospace, and VME could still be a valid choice for updating an existing system. However, the obvious choice for a new design is the VPX portfolio of standards.

VPX was originally introduced as VITA 46 and then augmented with the OpenVPX VITA 65 initiative. VITA 46 offers tremendous flexibility in pinout choices, negating some of the advantages of COTS hardware by allowing vendors to create unique solutions. VITA 65 was driven by customers' need to standardise on defined profiles for interoperability, and has successfully stimulated a wave of VPX deployments. VPX has become the de-facto choice for this type of deployment by allowing 'best-in-class' modules to be selected from alternate vendors.

OpenVPX challenges and solutions

Backplane mapping within a VPX solution is important. Although governed by a set of pre-determined slot profiles within the specification, a wide variety of backplane architectures are available for implementation.

The VITA 65 specification defines profiles in an exact way, which is made clearer in the following example configuration suitable for EW. This includes a single Intel control processor mated with several DSP/FPGA cards via a PCIe and Ethernet switch.

For command and control capability, a Concurrent Technologies TR B1x/msd board, which is based on a 4th Generation Intel® Core® processor, can be used. TR B1x/msd has two x4 PCIe data plane fat pipe connections compliant with the VITA 65 MOD3-PAY-2F2U-16.2.3-3 profile. "2F2U" refers to having two fat pipes (four lanes) for data plane use plus a pair of ultra-thin (one lane) pipes for control use. The end digits identify the two fat pipes as PCIe Gen 2 compliant, and the two ultra-thin pipes as 1000Base-BX control plane interfaces.

Four CommAgility VPX-D16A4-PCIE DSP/FPGA boards are used for signal processing, and also have PCIe connectivity. The two DSPs on each board have their own x2 PCIe connection out to the backplane, and so the TR B1x/msd control board is configured with a x4 data plane bifurcated into two x2 pipes. This allows data to be sent between individual DSPs and the command and control board.

Smaller and lower cost VPX solutions can be created without the switch module, by using a backplane that has specific connectivity. A typical use case would be for a single Intel-based control processor to have a x4 PCIe connection to two DSP/FPGA boards in the slots either side of the CPU.

Rugged deployment

Providing a tested combination of boards and software for speedy development is a great start. However, many of the EW and SDR deployments must work in a conduction (rather than air) cooled environment, be capable of surviving high levels of shock and vibration and have a suitable coating to protect against factors like moisture and pollution.

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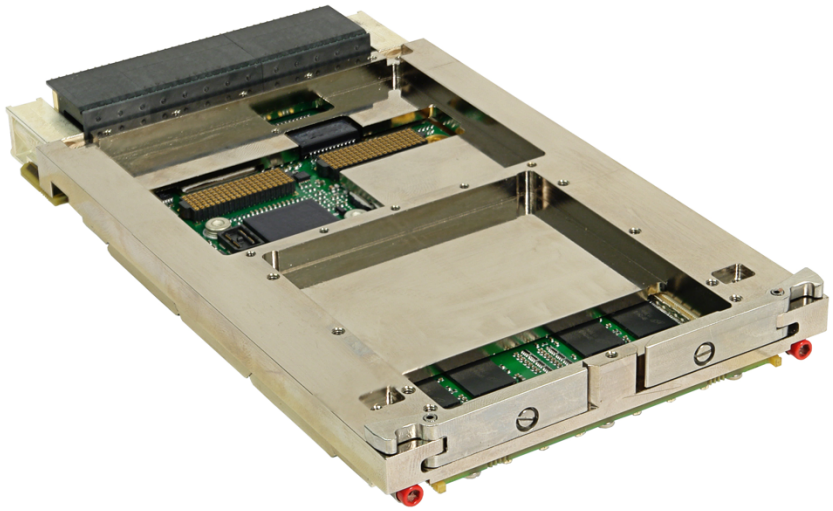

Figure 1: Conduction Cooled Board - Concurrent Technologies TR B1x/msd

The VPX-REDI specifications (VITA 48.0) provide the assurance of mechanical ruggedization in COTS based military systems. VITA 48 is also focussed on aspects that allow favourable Size, Weight, and Power (SWaP) metrics, a key requirement for many military programs.

Both CommAgility and Concurrent Technologies provide conduction-cooled variants that can be used without application software change. The CommAgility VPX-D16A4-PCIE board has exactly the same connectivity irrespective of the variant, as shown in Figure 2.

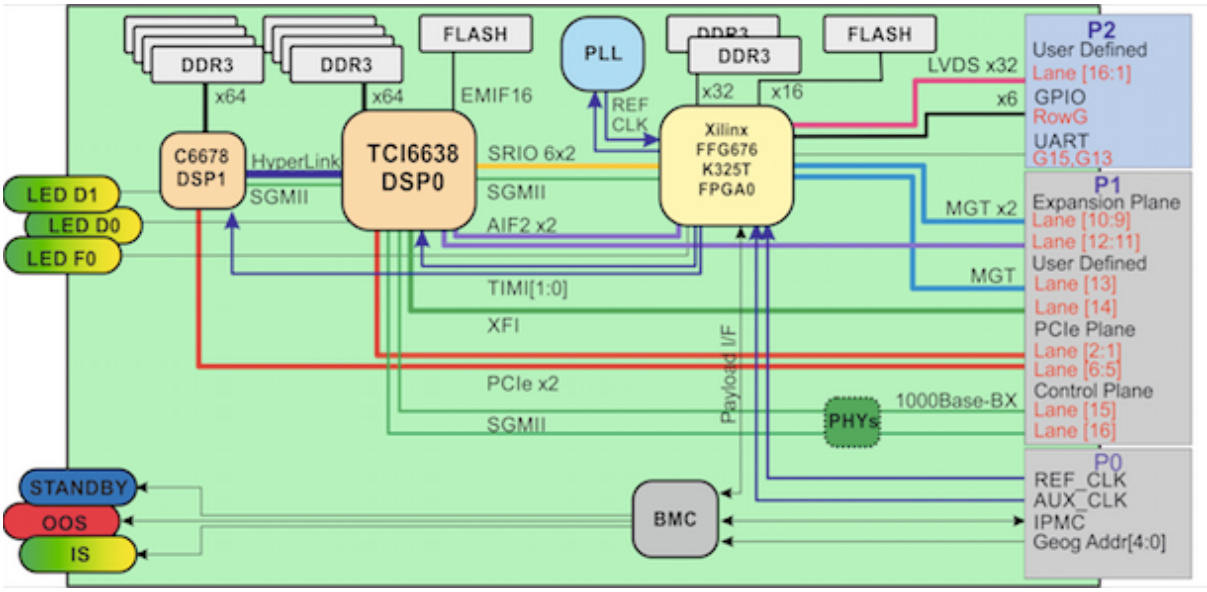

Figure 2: VPX-D16A4-PCIE Block Diagram showing rear I/O

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Software

Nowadays in EW, interception is only the beginning in combating the threat. The ability to monitor and decode communications is required, and is heavily dependent on access to standard protocol stacks. The ability to modify and optimise these stacks for surveillance is key to the equipment's success in the field.

For example CommAgility's mi!SmallCellSTACK software is available on the VPX-D16A4 hardware, thus supporting COTS-based solutions with a pre-integrated LTE protocol stack. As well as communications being intercepted, meaningful analytics can be performed on the traffic. Having access to the protocol stacks also allows customers to tailor the solution to the deployments, for example sniffing multiple channels simultaneously. Of course, none of this precludes the use of the equipment as a rapidly deployable ruggedized ad-hoc LTE network.

For more information on Concurrent Technologies, see www.cct.co.uk

About CommAgility

CommAgility is a leading manufacturer of signal processing modules. Customers around the world use CommAgility products to develop high performance applications, with a particular focus on wireless baseband. CommAgility was honoured with a Queen's Award for International Trade in 2013, and has featured in the Deloitte UK Fast 50 list of fastest growing technology companies in 2012 and 2013.

In March 2015, CommAgility acquired MIMOon GmbH. As part of CommAgility, MIMOon's team will continue developing market leading physical layer and protocol stack software solutions for LTE eNodeB and UE product developers. The two company's products are now available from a single source, allowing customers to take the individual products or as integrated solutions.

We are agile and fast to react to our customers' specific needs, offering a base technology platform that we can quickly customise. We primarily work with OEM customers who we support closely in order to ensure success of their product.

CommAgility's engineering team is massively experienced, with the four co-founders each having worked in embedded signal processing for more than 20 years. The team has worked on cutting edge DSP and FPGA technology through multiple product generations, and has the expertise to develop systems quickly and effectively, and to deliver complicated projects on time, every time.