SOLUTIONS BRIEF

Electronic Support's shifting size

Can RFSoC radically improve your ES system?

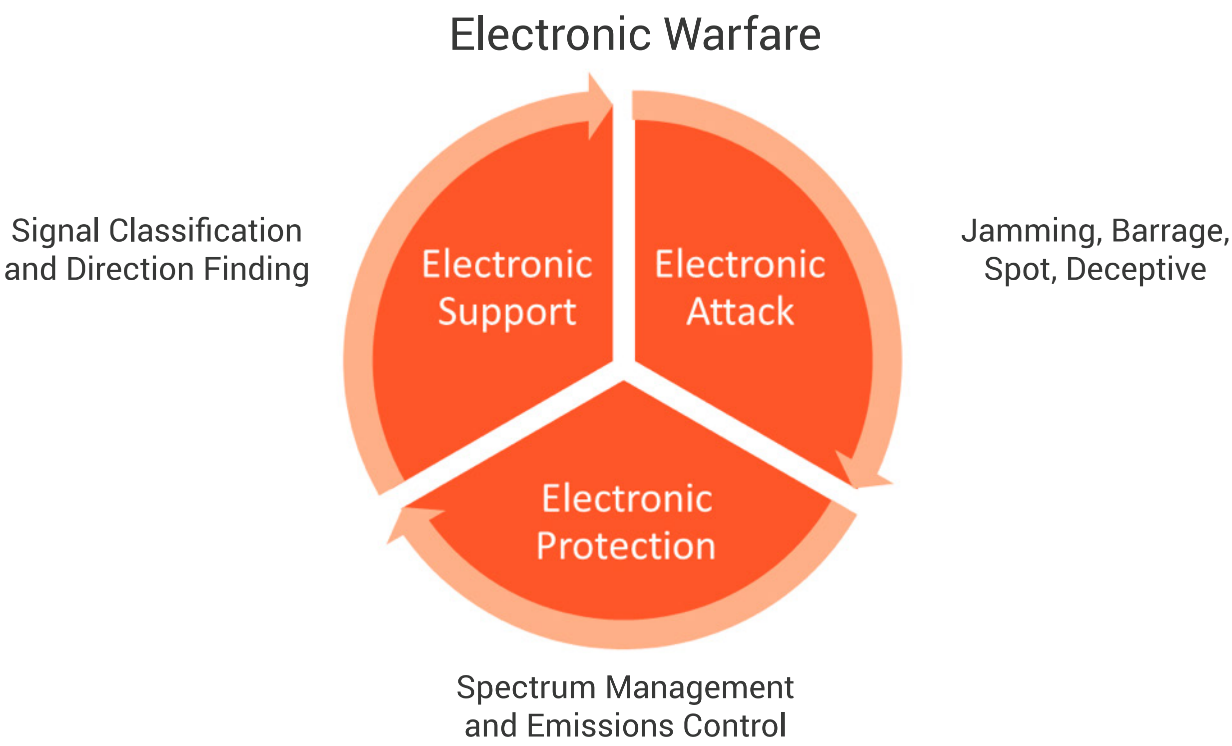
Pedja Mitrovic,
Systems Architect

abaco SYSTEMS

Electronic Support’s shifting size

Can RFSoC radically improve your ES system?

Rather than use a one-size-fits-all approach to accommodate an ESM and SIGINT system, how do we right size and optimize our approach?



What is an Electronic Support System?

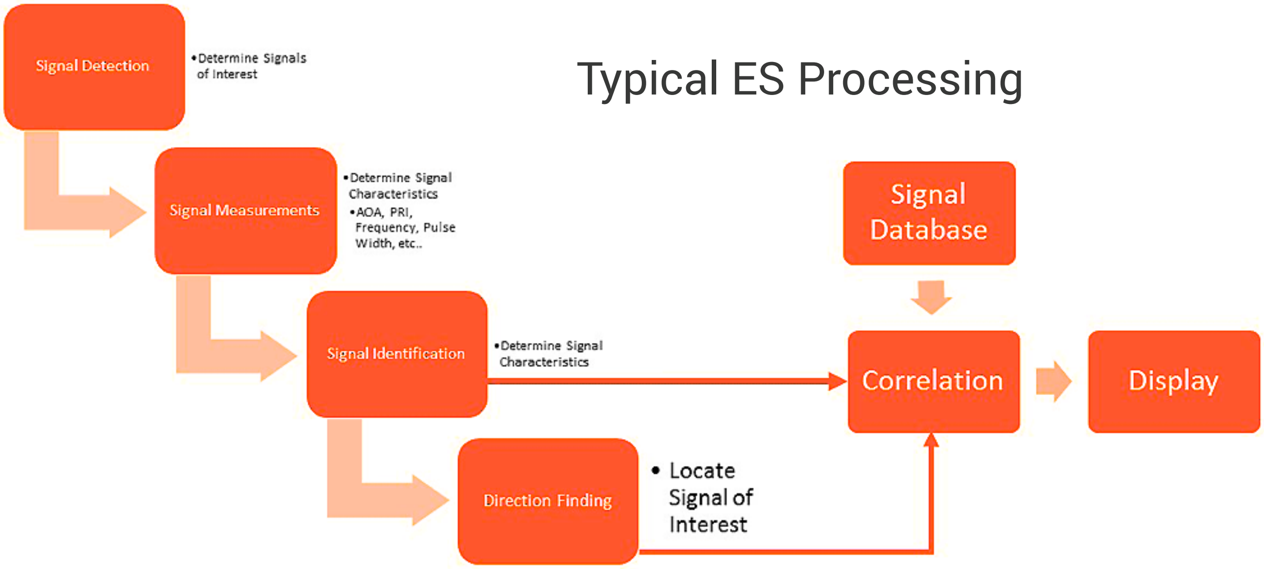
Electronic Warfare has been a critical part of modern warfare since 1904 when the British ship the HMS Diana made the first wireless signal interception in support of the Japanese during the Russo-Japanese War. Since those humble beginnings, Electronic Warfare has progressed from signal interception to offensive signal attacks. Today, Electronic Warfare has three main components: ES (Electronic Support), EA (Electronic Attack), and EP (Electronic Protection). Considered here is Electronic Support (formerly referred to as ESM (Electronic Support Measures)) and how emerging technologies can be utilized to improve the capabilities of systems performing ES roles.

Very much in line with the origins of EW, Electronic Support (Measures) (ES(M)) and Signal Intelligence (SIGINT) systems create an ecosystem designed to receive hostile signals and provide situational awareness and understanding of the electromagnetic battlespace. These items of interest will be signals from enemy communications, radar, and/or enemy Electronic Attack systems that are being operated in a specific area of interest. The key function of these ESM/SIGINT system is to receive, analyze and then provide some information about those signals such as direction or origin, signal type and, if possible, insight into the signal content.

Looking close at ESM and SIGINT systems, there are subtle, but key differences to be considered. Where SIGINT systems - which are divided into Communication Intelligence (COMINT) and Electronic Intelligence (ELINT) - are used in a development of the broader library of the militarily-significant information, their timeliness in processing of the hostile signals is not as critical as for ES(M) systems.

Electronic Support's shifting size

Can RFSoC radically improve your ES system?



Element of ES(M)

ES(M) systems, on the other hand, are the tactical cousin of SIGINT systems and are necessary when timely detection and processing of hostile signals are critical to the mission. As such, the use case and functionality may be similar between the two, but the architectural needs are slightly different. The ES(M) is used to intercept, identify and locate radiated electromagnetic energy with the minimum amount of information for immediate threat recognition, as opposed to the signal post-processing, analysis and classification. Specifically, where a SIGINT system may utilize larger processing capabilities to examine a signal in greater detail, an ES(M) system will need to focus on response time and actionable information. Practically, what that often means is additional processing and signal classification beyond known signals will have to be sacrificed for the sake of rapid actionable information.

To understand this difference, consider a notional ES(M) system; at its core, it is simply an antenna, receiver, processor, and display mechanism. As systems progressed from simple Direction Finding (DF) applications, able to detect higher power radar or communications system, to more complex systems providing classification capabilities on Lower Probability of Detect threats, the architectures and capabilities increased in complexity. It's this additional processing capability that drives much of this capability to timeliness trade-off. Where a SIGINT system may have racks of processors chewing away at information, a deployed ESM system will have just enough to get critical information to a user.

Technologies impact on ES(M)

Enabled by advances in digital signal processing and associated FPGA (Field Programmable Gate Array) technologies, the processing side of these systems became more capable as the processing elements became smaller in size. As edge computing paradigms pushed processing and classification further out and closer to the threats via unmanned aerial vehicles (UAV) and other smaller form factors, size, weight and power (SWaP) constraints became increasingly important.

These mounting SWaP and processing pressures did obtain some relief in relation to ES(M) systems, specifically due to the tactical nature of the systems. For example, while processing is moving further out in theater, the requirements of that processing are more limited in scope compared to a SIGINT system, and thus the processing capabilities can be focused and limited to perform a specific function.

Consider the use case of an ES(M) system that is receiving and classifying a radar signal to provide the type and location information to an electronic protection (EP) or electronic attack (EA) system. In this use case, the functionality is limited to detection, identification and information dissemination - which is all possible. Now: put that system on a midsize UAV platform and let it compete for power and space with other ISR (Intelligence, Surveillance, and Reconnaissance) equipment - and every bit of space savings becomes critical.

Electronic Support's shifting size

Can RFSoC radically improve your ES system?

Figure A

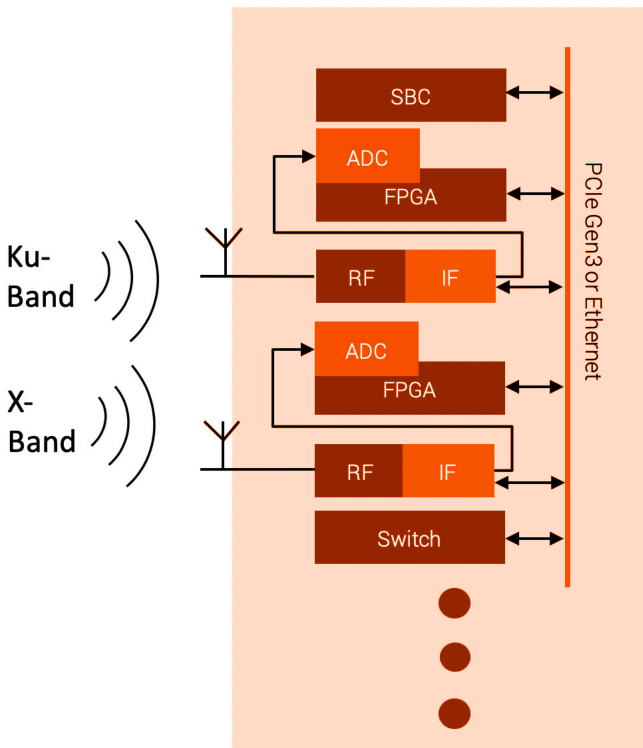
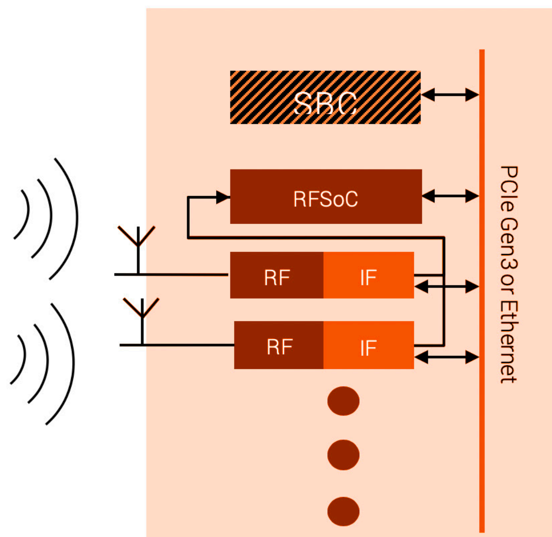


Figure B



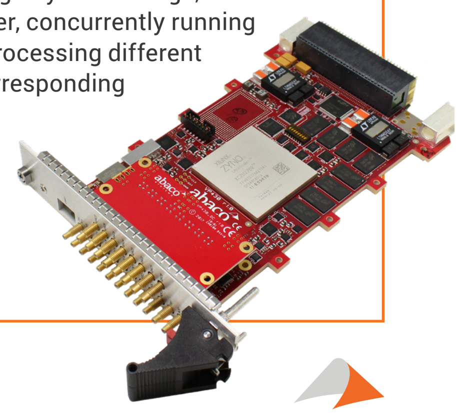
This challenging environment is where the Xilinx RFSoC (RF System on Chip) really shines. The density of analog-to-digital converter (ADC) inputs into a single device is a significant improvement for the current state of the art in ADCs. Couple that with ARM cores and an FPGA fabric integrated into a single device, and such combination becomes an ideal, compact platform for a specifically focused tactical ES(M) system. Consider the architecture in Figure A. It features two FPGA carriers with FMCs; a switch and an SBC would be required to do what can now be done in a consolidated product designed around the RFSoC with a system architecture shown in Figure B where the SBC may not even be required.

Even though the system in Figure A will ultimately be more powerful from a digital signal processing (DSP) perspective, it cannot be deployed on certain platforms due to the SWaP requirements to host such a system. This is where the tradeoff between available performance and SWaP really is highlighted; the RFSoC goes from a good way to achieve the goal, to the leading candidate for the system.

VP430

When these systems need to be supported in rugged environments with higher thermal constraints, the Abaco Systems VP430 is an ideal COTS (commercial off-the-shelf) solution for many of today's most challenging ES(M) systems. With a very wide input bandwidth, and a sensitive front end with high dynamic range, it can act as a multi-function receiver, concurrently running multiple missions while processing different signal structures from corresponding antenna(e) inputs.

Consider the use case in Figure B; this full system can be moved directly to the VP430.



Electronic Support's shifting size

Can RFSoC radically improve your ES system?

Trends impacting ES(M)

The final influencing factors that must be considered are the impacts of some of the open technology standards. SOSA (Sensor Open System Architecture) for example, and efforts associated with product alignment or full compliance, should ease concerns around new technology introduction. SOSA should enable revolutionary technologies to be utilized in a common footprint and system interface, thus reducing integration risks. Further enabling the concept of edge processing is the increased push for VITA 49.2 and Virtual Radio Transport protocols. These protocols enable post processing of time-stamped RF data by a larger system, physically dispersed from the data collection mechanism.

By enabling a method for the RF data to be transmitted via a digital network and processed further off board, it is possible to enable the data collected and operated on by an ES(M) system to be utilized for additional analysis. This almost turns the ESM system into the front end of a SIGINT system without losing the tactical functionality required by that ESM system. It really enables a system to serve multiple functions without losing the core capabilities required.

Again: this is where the RFSoC shines, as it provides full ES functionality while supporting interfaces that allow implementation of the VITA 49.2 protocol to transfer that precious data to larger processing nodes on ground and continue to mine the collected information for valuable content.

Conclusion

For more than a hundred years, adversaries have been trying to find new ways to utilize RF signals to provide battlefield advantages and, over that same period of time, groups have been trying to develop technology to minimize the effect of those systems. Electronic Support is just one of those areas in the greater space of Electronic Warfare, but it's one where new technologies can provide significant advantages.

By focusing on the mission at hand and utilizing new technology to further that mission, there are advantages to be gained. Shrinking system hardware to push capabilities closer and closer to threats is key. Then, further enabling reuse of that information through modern transmit standards enables maximum utilization of the information ESM systems can provide.