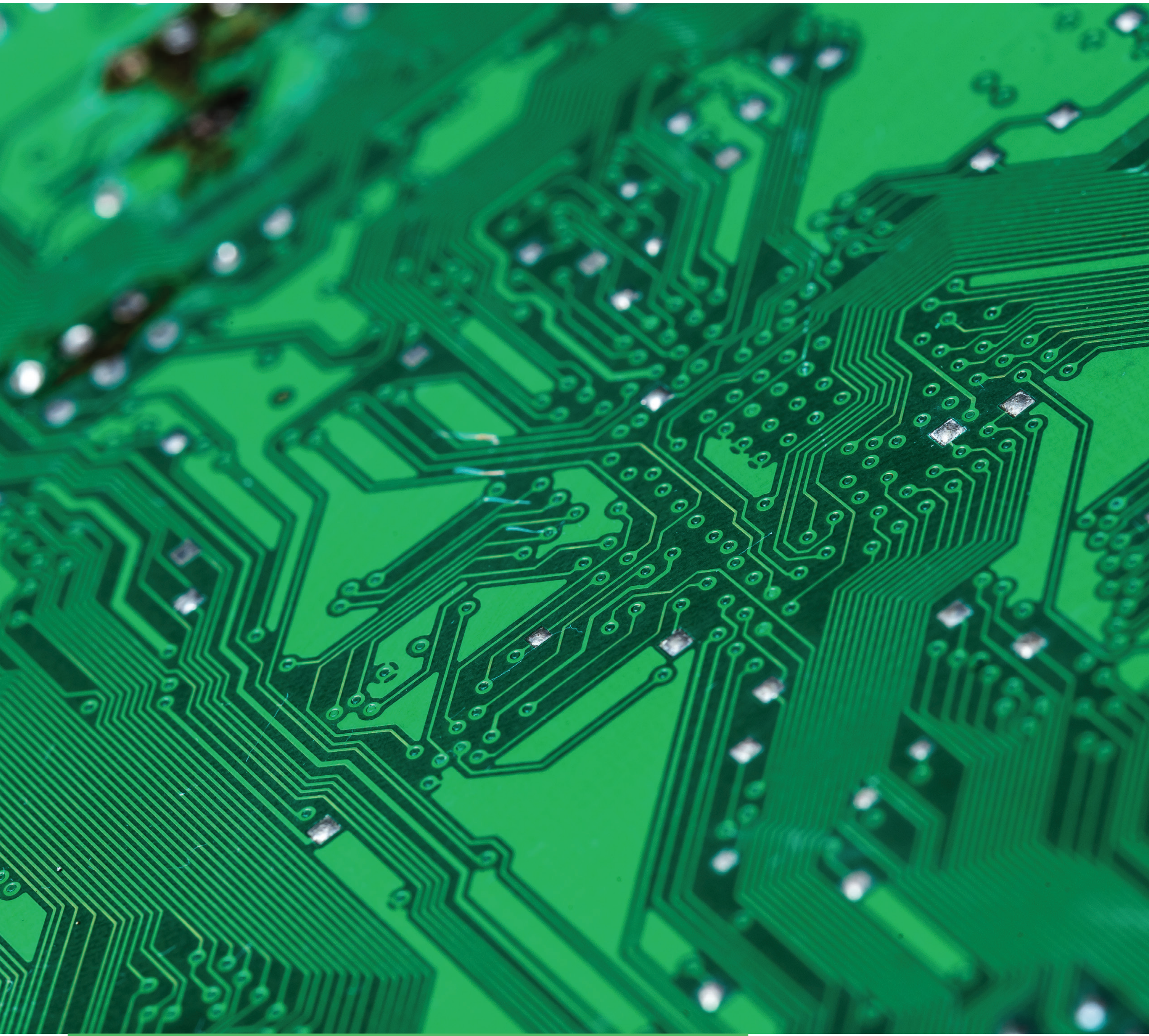


Xilinx®-Based SOMs to Accelerate Solutions

Table of Contents

INTRODUCTION

Designers face several engineering and non-engineering challenges when it comes to developing high-performance electronic solutions. Successful development requires technical finesse, significant development time, and financial resources. Any solution development also introduces both technical and programmatic risk.

Current development windows are shrinking to meet today's aggressive market demands and increased performance requirements over previous generations.

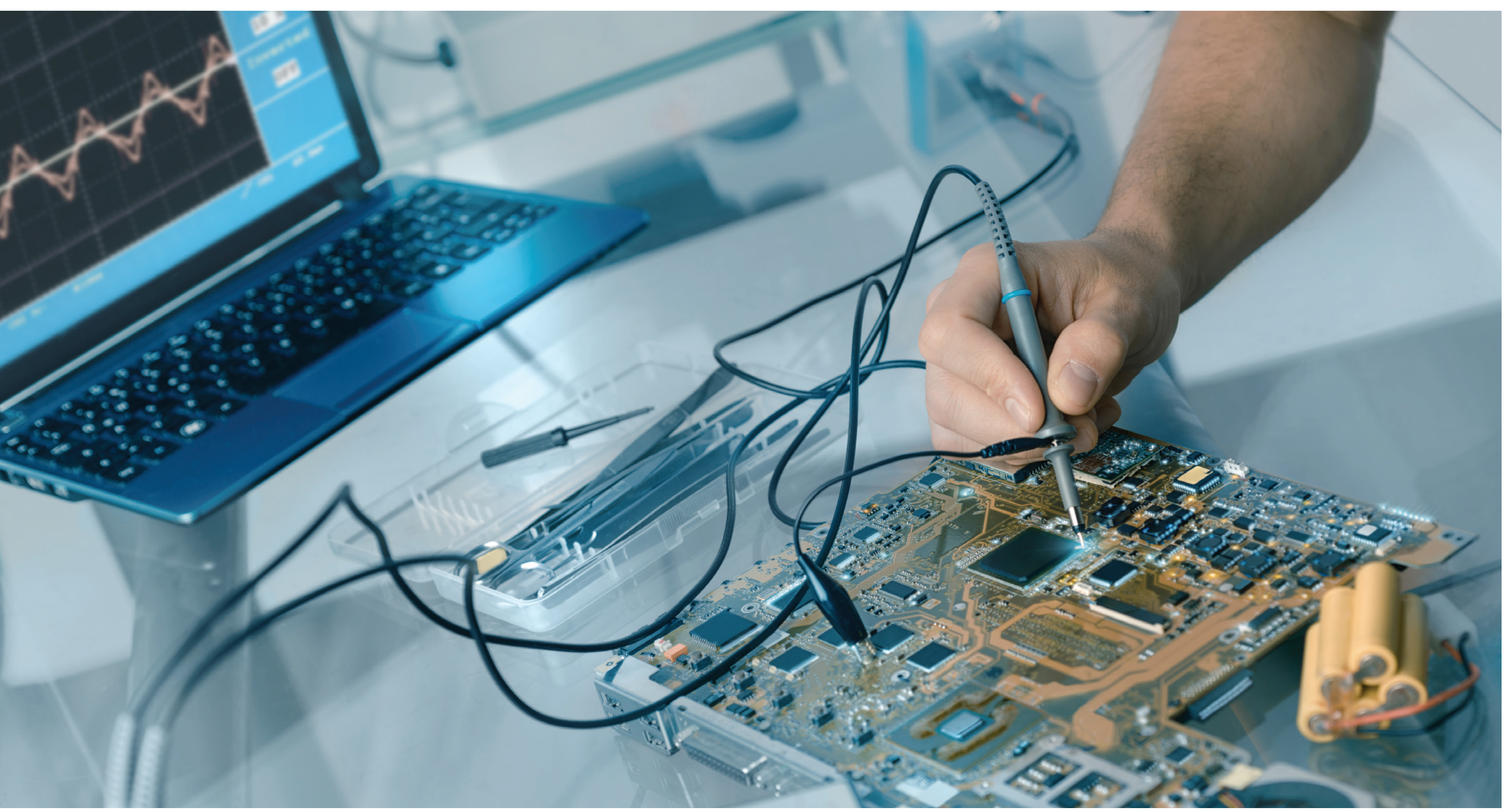
Utilizing a System-on-Module (SOM) is one way to manage technical and programmatic risk while at the same time enabling engineering teams to focus on the value-added activities of the solution and get started with the development earlier.

A SOM combines a high-performance processing solution with its associated non-volatile and volatile memories, clocking solutions, and power solutions. SOMs are packaged in a compact footprint, with most of the processing solutions' I/O broken out to the mating connectors. This makes the processing solutions' I/O directly available for use by the development engineering team.

Since SOMs contain the majority of the high-performance solution (e.g., processor and DDR memories), there is a lower technical risk because risk and qualification of the performance have already been retired by the SOM manufacturer. Using a SOM also reallocates responsibility for obsolescence and product warning notices of components used by the SOM manufacturer.

Avnet and Xilinx® SOMs feature a range of heterogeneous System-on-Chip (SoC) devices, such as the Zynq®-7000 SoC or Zynq UltraScale+™ MPSoC. These devices combine high-performance Arm® processor cores with programmable logic.

By combining high-performance serial and parallel programming, Avnet and Xilinx® SOMs are suitable for various applications ranging from embedded vision and machine learning inference to robotics, motor control, and industrial IoT sensors and gateways.



SELECTING THE RIGHT SOM FOR APPLICATIONS

Identifying and selecting the right SoM for an application can be daunting. However, Avnet and Xilinx® provide engineers with a scalable range of SOMs to choose from, depending on the application demands.

The Xilinx® Zynq-7000 SoC devices are provided on the PicoZed and MicroZed SOMs. These SOMS provide devices in the 7010 – 7030 range in both commercial and industrial grades, with a range of interfacing and configuration memory solutions.

The Zynq UltraScale+ MPSoCs featured in the Kria™ K26 SOM and UltraZed-EG and -EV SOMs offer significantly increased computational resources. Each SOM contains quad-core Arm Cortex®-A53 processors with increased logic resources and dedicated logic functions, such as the video codec available in the Kria™ K26 SOM and UltraZed-EV SOM.

The very highest end of the SOM market is Avnet's UltraScale+ RFSoC SOM, which provides Xilinx® UltraScale+ RFSoC devices on a SOM. Not only do RFSoC devices include high-performance Arm processor cores and programmable logic, but also giga sample ADC and DAC converters. Developers have a choice of four RFSoC components from generations two and three.

At a high level, the type of SoC required, such as a Zynq-7000 SoC, Zynq UltraScale+ MPSoC, or Zynq UltraScale+ RFSoC, will determine which SOM should be used. Once the SoC has been identified, the next step is to identify interfacing requirements. A simple differentiator at this stage is the requirement for gigabit serial links. If this is required, this will further drive the selection criteria. Additional selection criteria include the configuration memory type (e.g., SD Card or eMMC), DDR capacity, and the availability of DDR connected to the programmable logic, along with the processing system. For the RFSoC-based SOMs, the selection criteria can be determined by the need for 12- or 14-bit ADCs and the presence (or not) of the SD-FEC.

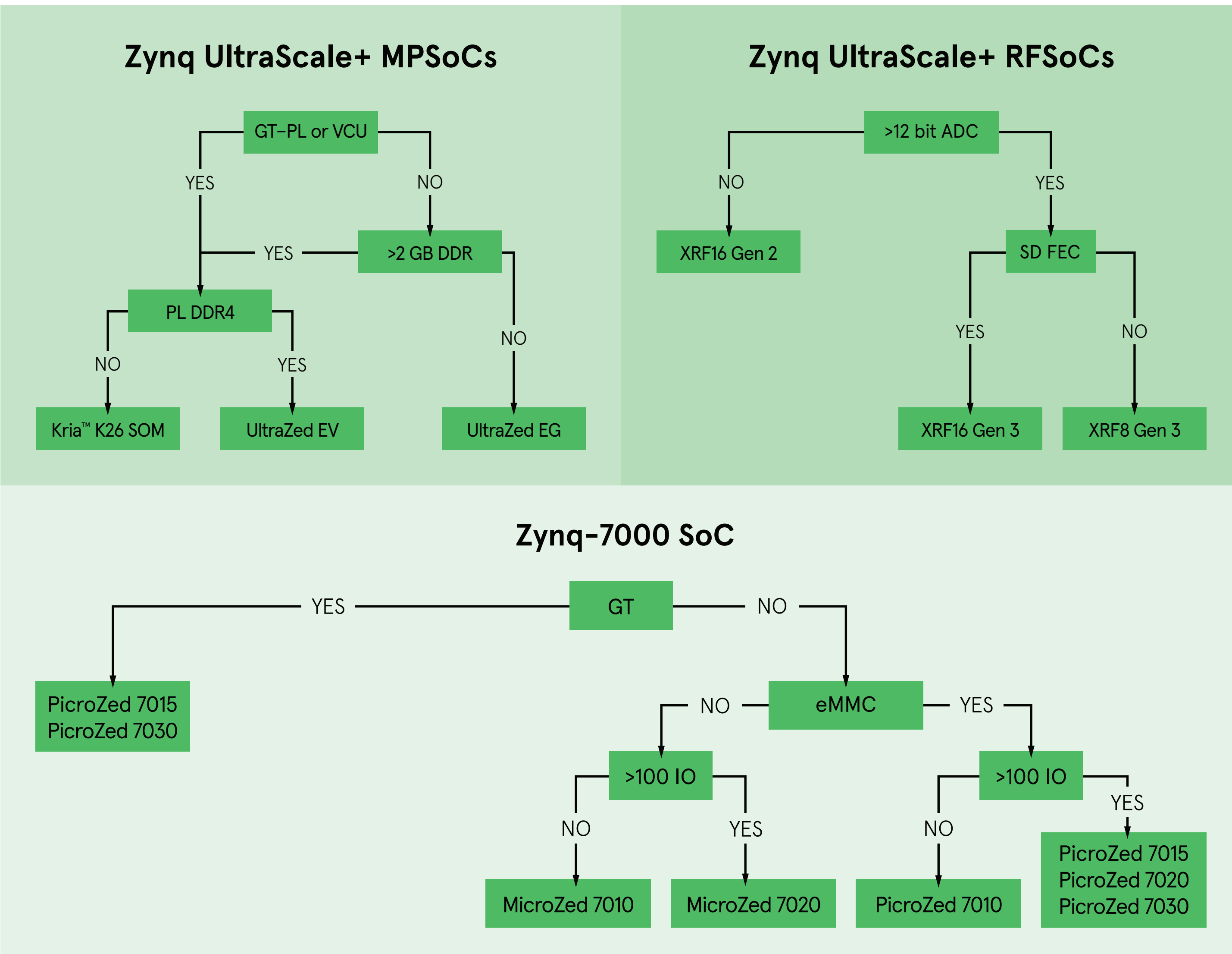


Figure One — Selection Criteria for Different SOM Families

USING A SOM

Once the preferred SOM has been identified, the engineering team can start designing it into the end application. Normally, this means developing a carrier card that will carry the SOM and provide the additional interfaces and circuits required. The design of this carrier card is typically where a SOM user implements their value-added knowledge. To begin this development, the SOM provides a range of additional material that aids in creating the carrier card.

The most important of these is the SOM designer guide. This provides detailed technical information about the onboard SOM capabilities, the SOM interfaces, and how these interfaces may interact with the onboard SOM circuits like reset and configuration, for example. This designer guide will provide all the necessary interfacing information for carrier card developers to successfully use the interfaces provided by the SOM.

Avnet and Xilinx® both designed their SOMs so the carrier card provides power to the I/O bank. This enables the carrier card development team to provide a bank voltage that is compatible with the needs of the carrier card circuits. The SOMs can also support high-speed communication and the selected connectors for the SOMs, to provide a controlled impedance designed for high-frequency operation. The I/O on the SOM is implemented where appropriate for differential tracking. This allows the carrier card development team to leverage either single-ended or differential signaling. To further support the use of the SOM I/O at higher speeds, net length reports are also provided for the SOM to enable accurate overall length matching.

The carrier card design team can also use the complete schematics and BOM to aid component selection and provide reference circuits. Teams can leverage breakout carrier cards created by Avnet and Xilinx® for appropriate carrier cards.

At the mechanical level, the SOM manufacturer provides all the necessary 3D and step files to enable successful location and mounting of the SOM on the carrier card.

DEVELOP FROM DAY ONE

One of the key benefits of using a SOM is the ability to start testing solutions and retiring technical risk from day one of the project. This is possible because Avnet and Xilinx® provide breakout and prototype cards that enable the development team to create full or partial system solutions. Careful selection of the prototype card enables the engineering team to reduce technical risk and increase the technology readiness level of the solution.

For developers who choose to use Avnet development boards, a range of carrier cards are available that support I/O breakout, FMC connectivity, PCIe expansion, and an Arduino shield. The Kria™ KV260 Vision AI Starter Kit is available for the Kria™ K26 SOM, which supports most video-based interfaces, including MIPI and USB.

Avnet and Xilinx® provide a range of demonstration applications to accelerate development and confirm the capabilities of both the SOM and the prototype carrier cards. These range from AI/ML on the Kria™ K26 SOM to SATA testing and PCIe endpoints on the UltraZed-EG and video transcoding using the UltraZed-EV. These demonstration applications provide a good starting point for similar applications in the final deployable system.

However, it is not just the availability of the physical prototyping carrier cards on the SOM that enable the development team to accelerate their development. Several diverse design resources such as Vivado®, Vitis™, and PetaLinux also help with design development.

Setting up a heterogeneous SoC with associated DDR3/4 and clocking solutions can be time-consuming and iterative, as the Zynq-7000 SoC / Zynq UltraScale+ MPSoC require significant configuration. When a SOM is selected, the manufacturer provides all the necessary board configuration files that automatically set up the Zynq-7000 SoC / Zynq UltraScale+ MPSoC clocking and DDR memory solutions. This significantly eases the engineer's task in getting started with the development.

Similarly, deploying heterogeneous systems like the Zynq-7000 SoC and Zynq UltraScale+ MPSoC using embedded Linux solutions is common. Establishing an embedded Linux solution from scratch for a heterogeneous device can be a time-consuming endeavor. This is because the image, rootfs, device trees, and packages are configured to enable the embedded Linux OS to work correctly on the deployed configuration. Like the board files provided with Vivado®, both Avnet and Xilinx® provide SOM users with PetaLinux board support packages that provide a base configuration for the SOM in use. This enables software developers working with SOMs to run up an embedded Linux solution on day one. It also enables them to start creating applications and customizing the operating system to support the additional functionality designed into the carrier card.

The provision of these elements enables developers to start creating both the prototype and deliverable solutions from a solid foundation -- a foundation that can take considerable time to achieve in a complete bespoke development.

Developers want to leverage the parallel structure of programmable logic to accelerate performance from bottlenecks that may arise in software. Heterogeneous SoCs, as deployed on the Avnet and Xilinx® SOMs, are ideal platforms for this when combined with the Xilinx® Vitis™ tool. Vitis™ enables developers to leverage OpenCL to accelerate functions from the processor system to the programmable logic. Both Avnet and Xilinx® SOMs provide Vitis™ acceleration platforms that allow the creation of OpenCL applications so that engineers can leverage this capability. SOMs allow developers to leverage an existing base, thereby reducing technical risk compared to building a bespoke Vitis™ acceleration platform.

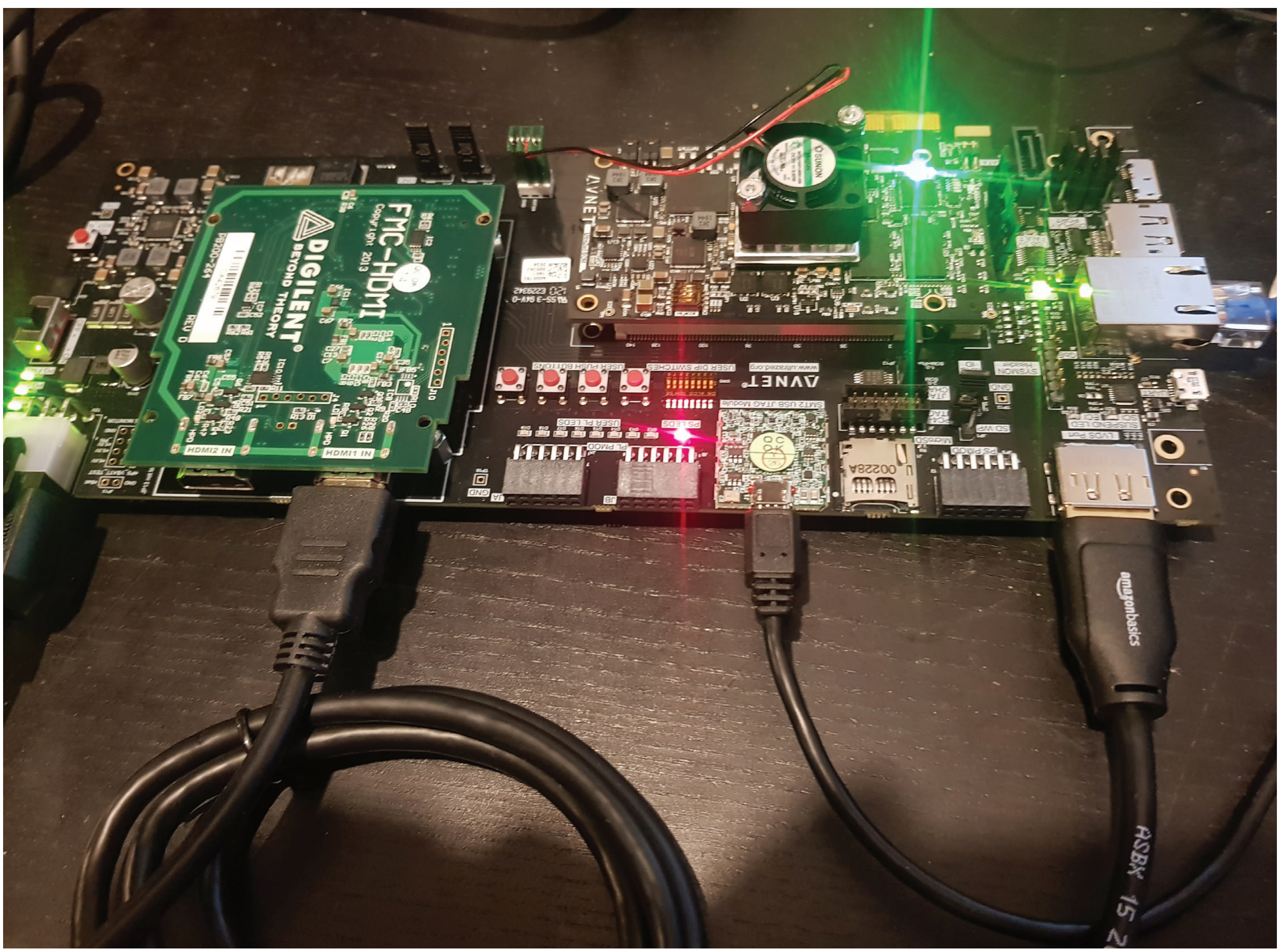
USE CASE

Due to their flexibility, SOMs can be deployed across a range of applications, from the deliverable equipment deployed in the field to test systems used for validation and qualification of components or systems.

The main use case of SOMs is for deployment in the final system. In this use case, the SOM is included in the stack of cards used to create the overall solution. SOM size is important in these applications because a smaller footprint enables more flexibility, especially when deployed at the edge. One example application would be embedded vision, which uses the UltraZed-EV to receive the video stream from one or more MIPI cameras as part of an airborne imaging solution. This video stream can be received and processed by the Zynq UltraScale+ MPSoC on the UltraZed SOM. The programmable logic element of the Zynq UltraScale+ MPSoC can implement several MIPI DPHY interfaces, and the video packets received over these DPHYs can be post-processed by the MIPI CSI-2 IP core in Vivado®. If the system requires longer runs than MIPI can provide (30 cm), HDMI, Camera Link, or Coax Express can be used alternatively.

Prototyping these solutions is critical because the development of higher-level algorithms can take considerable optimization to achieve the desired performance. For these applications, the UltraZed-EV SOM can be used in conjunction with the UltraZed PCIe carrier card or UltraZed-EV Starter Kit to prototype the application. Both the PCIe and UltraZed-EV starter kit provide an FMC, which enables a wide range of interfaces to be prototyped with the UltraZed from the HDMI to Coax Express and MIPI breakouts.

Just as with SOMs, the PCIe carrier card and UltraZed-EV Starter Kit are provided. This also includes a range of supporting material from constraints and user guides to deployable applications embedded in Linux. Prototyping the system with the PCIe carrier card and UltraZed-EV Starter Kit enables developers to start prototyping and kickstart the demonstration of higher-level algorithms rapidly. This retires the technical risk and concepts demonstrated before the arrival of the deployable solution. To help developers save time, they can leverage the SOM Vitis™ acceleration platforms to make use of the Vitis™ acceleration libraries that support vision, security, BLAS, and AI.



CONCLUSION

Developing electronic systems is complex and presents a considerable technical and programmatic risk. The correct selection and development of a SOM can help the development team significantly reduce risk and accelerate development. The integration of SOMs with supporting interfaces and memories also reduces development risk. Additionally, the supporting material provided with SOMs eases the development of the carrier card (or cards). The availability of existing carrier cards enables developers to begin prototyping solutions and applications not only at the hardware / electronic level but at higher levels of the development stack, including embedded Linux and AI/ML solutions.