SRI International®

EMULATION ZONE
MICROCIRCUIT EMULATION CENTER

Volume 4, Issue 1

Welcome to our seventh edition of the Emulation Zone Newsletter. This issue is dedicated to programmable devices. We highlight new methods for recovering/extracting programming information for non-procurable FPGAs and how these can be retargeted to existing emulation technologies to establish resupply. We are also pleased to report that we are a recipient of BAE's Gold Supplier Award for excellence in quality and on-time delivery.

SRI International, as the prime contractor for the Defense Logistics Agency's (DLA) Generalized Emulation of Microcircuits (GEM) & Advanced Microcircuit Emulation (AME) Programs, provides technical solutions for microcircuit obsolescence. Our mission is to maintain and consistently develop obsolete microcircuit manufacturing capability for DLA and its DMSMS customer base to support U.S. military weapons systems and readiness. The programs deliver a permanent solution to microcircuit obsolescence that can be utilized during any phase of the weapon systems life cycle.

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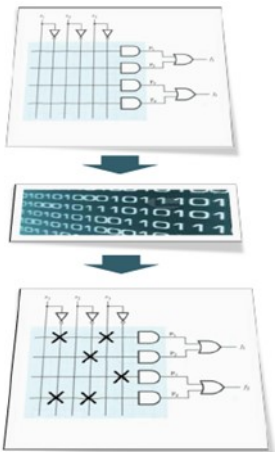
Programmable Logic Device Progression

Programmable Logic Devices (PLDs) are very popular with designers due to their flexibility and cost. PLDs start as uncommitted gate arrays containing predefined logic structures that can be programmed to create a myriad of complex designs. Designers define the interconnect between the logic structures to implement the desired functionality for their application. PLDs are then programmed with the final cell-to-cell interconnect to produce the resulting Integrated Circuit (IC). PLDs are versatile because if the design needs to change for any reason, the designer can quickly erase the current design, and keep re-programming the device until the desired result is achieved. There are several types of PLDs, but all share this same basic approach.



PLDs can be categorized as being one of three types: Simple Programmable Logic Devices (SPLDs), Complex Programmable Logic Devices (CPLDs), and Field Programmable Gate Arrays (FPGAs). There are a variety of PLD types (see table 1) and architectures can vary between manufacturers. One of the distinguishing features between the categories is the density, or gates available. SPLDs, which were first introduced in the early 1970s, used simple configurable technologies that eventually developed into more complex and larger devices of which the most popular today is Field Programmable Gate Arrays (FPGA). Unlike early PLDs which had to be hard-wired programmed during manufacturing, FPGAs allowed the designer to configure parts when the manufacturing process was complete. FPGAs could also be reprogrammed if necessary, to add features or fix bugs after product deployment.

Programmable Logic Devices - PLD			
	SPLD Simple Programmable Logic Device	CPLD Complex Programmable Logic Device	FPGA Field Programmable Gate Array
Types	PAL, GAL, PLA	CPLD, EPLD, EEPLD	FPGA
Density	A few hundred gates	500 – 12,000 gates	3000 – 10M+ gates
Program Technology	Fuse EPROM EEPROM	EPROM EEPROM Flash	SRAM Anti-fuse EPROM
Major Vendors	Lattice Semiconductor Cypress AMD	Xilinx Altera (Intel)	Xilinx Altera (Intel) Actel Lattice

Table 1

The Emulation Programs at SRI have been addressing solutions for Programmable Logic Devices (PLDs) for many years. Capabilities exist to replace each one of these programmable types listed in Table 1 with current available technology. The Emulation Programs provide hard-mask replacements to PLDs and work with customers to guarantee performance in their systems. The GEM & AME Programs have provided PLD solutions to the F-15, C-17, Patriot Missile systems and others.

Mitigating FPGA Obsolescence Using Microcircuit Emulation

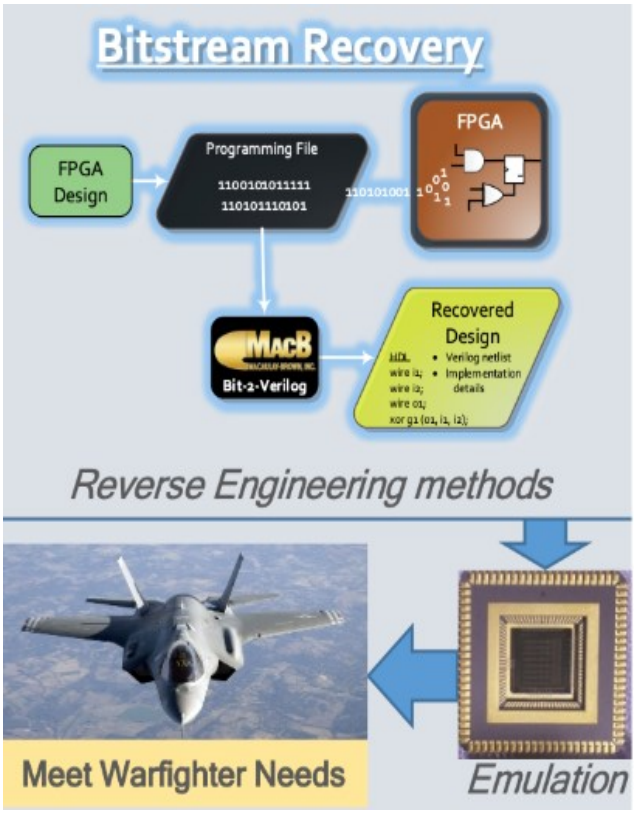
THE NEED

Field Programmable Gate Arrays (FPGAs) are widely used throughout the defense industry as a critical component in systems. These components are user programmable, allowing the engineers to program in a design tailored to the functionality of a specific board or system. These devices can support complex designs and interface with other components through various I/O standards. FPGAs also give the designers flexibility in the event of a unique requirement or unexpected design changes.

As technology advances, older FPGAs become obsolete as faster and more advanced device families are introduced. However, there are still military systems in the field that require replacement parts for these obsolete FPGAs. While FPGA vendors may recommend using a newer FPGA to replace ones that are going obsolete, they are not a suitable replacement for existing board designs as they are not Form-Fit-Function-Interface (F3I) compatible.

THE EMULATION SOLUTION

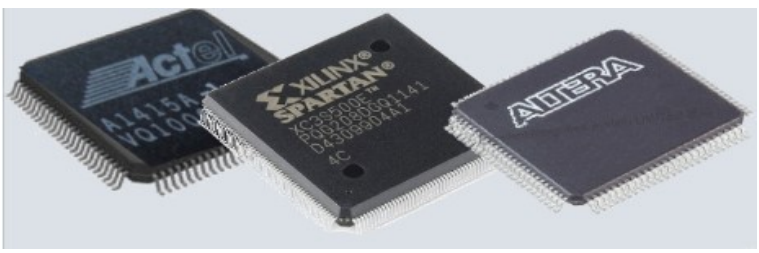
DLA and the AME Program have developed a flow to Emulate FPGAs as Application Specific Integrated Circuits (ASICs). This involves taking the exact design implemented on the FPGA and targeting it to one of the Emulation gate arrays to produce an ASIC form of the design. The resulting part is not reprogrammable, but it will otherwise be form-fit-functionally equivalent to the device as programmed for use in a specific system location.



One difficulty in Emulating FPGAs is that the customer often does not have all the design information needed to reproduce the part, and the only piece of information available is the programming file used to configure the FPGA and/or PROM. Therefore, we have established a flow utilizing the reverse engineering capabilities of Macaulay-Brown, Inc. to take an FPGA programming file and/or PROM, and extract the design information (source code or netlist). Macaulay-Brown, Inc. (an Alion company) has developed the capability to do this for several generic FPGA families. including embedded memories and math blocks. These macrocells will be implemented in the converted netlist during synthesis. Once the netlist conversion is complete, the design is run through several tools to insert testing capabilities and perform place and route. The final post route design is analyzed to verify timing and functionality before it is released to fabrication.

When a netlist is extracted, it can then be targeted to one of the existing GEM gate arrays. To help with the conversion, we developed a library of macrocell components that are common among FPGAs including embedded memories and math blocks. These macrocells will be implemented in the converted netlist during synthesis. Once the netlist conversion is complete, the design is run through several tools to insert testing capabilities and perform place and route. The final post route design is analyzed to verify timing and functionality before it is released to fabrication.

To verify the functionality and characteristics of the final part against the original FPGA device, test boards are designed for each of the components so that they can be tested using the ATE. The test team has developed a flow to convert simulation waveforms into test vectors that can then be applied to the devices. This will be essential for FPGA designs as they have more complex functionality that will need to be exercised. The test engineers can run the functional test vectors on both the ASIC and FPGA to verify that the designs are functionally equivalent and meet the required specifications before delivering to the customer.



Mitigating FPGA Obsolescence Using Microcircuit Emulation (cont.)

CURRENT CAPABILITIES

Our existing 0.8µm CMOS emulation technology is compatible with following FPGA families:

- Actel: ACT1, ACT2, ACT3
- Xilinx: XC2000, XC3000, XC3100A, XC4000, XC4000A, XC4000E
- Altera: FLEX8000, MAX5000, MAX7000, MAX9000

These families use a +5.0V supply voltage. We are also working on 0.35 µm CMOS emulation technology, which will enable us to start emulating FPGA devices that use a +3.3V supply. Stay tuned for more information on upcoming releases. Remember, GEM does not provide un-programmed "blanks." GEM provides the altered/programmed version, or a hard coded ASIC version.

BENEFITS

The FPGA Emulation solution provides a permanent source for Form-Fit-Function-Interface (F3I) programmed FPGA-equivalent components for use in Military systems. Our FPGA to ASIC design-porting strategy is a proven method to support the Warfighter.

FPGA Replacement - Getting Started

Requests for quotes may be made directly to SRI through the GEM website, www.gemes.com, or through your DLA logistics channels. When requesting assistance with an FPGA you will receive an FPGA checklist as shown in Table 2. This will help SRI determine if the FPGA is "GEMable" and the level of effort required to provide a GEM replacement. At a minimum, we will need a performance specification (data sheet), programmed sample units, and a programming file, but the more information you can provide the better as this will decrease the amount of reverse engineering necessary and improve lead-time. As you can see maintaining proper material and records (technical data package) is essential for mitigating obsolescence!!

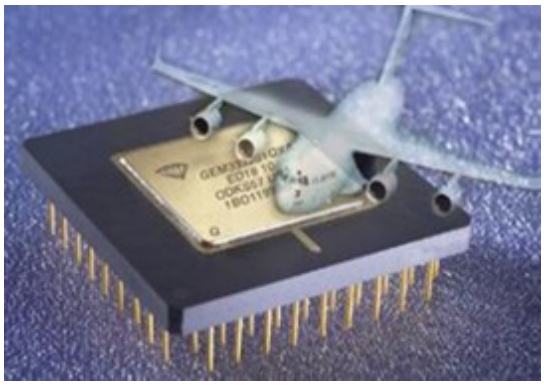
FPGA CHECKLIST

PROGRAMMING	
❑ FPGA part number:	i.e. XC2V6000-4FF1152I (Xilinx Virtex-II)
❑ FPGA programing method:	PROM, Direct Write, 3P, other
HARDWARE	
❑ FPGA/PROM programmed sample:	If available
❑ FPGA un-programmed sample:	If available
SOFTWARE	
❑ Programming File:	JEDEC Bit or other
❑ Design source code/netlist:	VHDL, Verilog, ABEL, XNF, other format
❑ Verification files:	Testbench, Test Vector patterns
DOCUMENTATION	
❑Performance Specification:	Electrical requirements (AC,DC, Props)
❑ Schematics:	If available
❑ Top level CCA schematics:	FPGA connectivity in system
❑Other technical information:	Register configuration, IP usage, etc.

Table 2

GEM EP1800 PLD C-17 Success Story

The Boeing C-17 Globemaster III is one of the largest military transport aircraft in flight today. With a cargo capacity 170, 900 lbs. it has been used to transport military vehicles (M1A2 Abrams, M-2 Bradley, AH-64 Apache helicopters, etc.) and troops throughout the world. Developed in the early 1980s-1990s, there have been a total of 279 C-17s produced for use by the United States Air Force and several of our partner nations. Although the final C-17 production build was completed in November 2015, it is expected to remain in service with the USAF though 2040. Sustaining a multi-decade service life undoubtably means microcircuit obsolescence challenges will occur. This is where the GEM Program can assist. The GEM Program has supported the C-17 platform with 27 unique GEM NSN (National Stock Number)replacements. One such example is with an EP1800 UV Erasable Programmable logic device initially produced by Altera.



The GEM Program was contacted by a supplier about this obsolete microcircuit to support the anti-skid system for the C-17. The supplier provided the SMD reference for the blank device, programmed sample parts and program data. We reverse engineered the parts to get a full understanding of the application and specification. It was determined that our 1.2µm 20K gate array was sufficient to meet all functional timing requirements. The customer performed insertion testing in their system and determined the part passed all application requirements and subsequently a new SCD drawing was created for the Emulation solution. The GEM program has delivered GEM333/EP1800 devices to the C-17 supplier continuously for the last 15 years.

BAE Awards Gold Tier Supplier Rating

BAE SYSTEMS

SRI International's DLA Emulation Programs received a Gold Supplier rating from BAE Systems' Electronics division in Nashua, NH. BAE Systems instituted the annual Supplier Scorecard program to recognize suppliers who have provided outstanding service and partnership in exceeding customer requirements. This recognizes performance throughout 2018. The BAE Systems annual supplier scorecard program measures suppliers based on several criteria including quality, and on time delivery. The Gold medal rating is the highest level achievement for quality and performance. We are honored to receive this award and look forward to supporting BAE and the War Fighter.

(L-R) Jeremy Tondreault, BAE Systems (VP, Operations), Saj Ishaq, Director SRI Microcircuit Emulation Center, Mike Lewis, BAE Systems (VP, Quality)

Have You Checked Out Our Blogs?

The Microcircuit Emulation programs are expanding their digital footprint via blogging and social media. Check our blog on the www.gemes.com website from time to time to see what's going on. Look for new posts about every two weeks. Also, stay connected with us on one or all of our social media platforms. Feel free to LIKE and SHARE any content you find valuable. We are planning on doing a social media highlight email as part of this Emulation Zone Newsletter subscription so that you don't miss out on some great content!

Recently Attended Shows

On March 25th—27th we returned to Warner Robins, GA, to attend and promote the DLA Emulation programs at the **DIXIE CROW** show. That same week we also had team attending and exhibiting at **GOMAC** in Albuquerque, NM.

On April 14th—16th we attended the **ARMY AVIATION ASSOCIATION of AMERICA SUMMIT** (commonly referred to as QUAD A) in Nashville, TN. This was our first time to attend this show.

Thanks to all who stopped by our booth!!!

Upcoming Conferences/Tradeshows

AVCOM Obsolescence Working Group Meeting
June 5-7
Emerald East Coast Convention Center
Fort Walton Beach, FL

We also plan to present and/or exhibit at:

- Tinker and the Primes, August 13-15, Midwest City, OK
- F-16 & Proven Aircraft TCG Worldwide Review (WWR), September 9-11, Ogden, UT
- C-130 TCG International Technical Program Review, October 21-22, Orlando, FL
- F-15 Technical Coordination Program (TCP) Worldwide Review, November 3-6, Miramar Beach, FL
- DMSMS, December 2-5, Phoenix, AZ

CONTACT US

Visit the Emulation program at www.gemes.com, or contact us at geminfo@sri.com. A complete GEM parts list is available at our website. Also, you can download previous newsletter editions at this site. Remember, GEM microcircuits are NEVER discontinued!

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