Reconfigurable Hardware Adapts to Changing Mission Demands

A new class of computing architectures and processing systems, which use reconfigurable hardware, is creating a revolutionary approach to implementing future spacecraft systems. With the increasing complexity of electronic components, engineers must design next-generation spacecraft systems with new technologies in both hardware and software. Derivation Systems, Inc., of Carlsbad, California, has been working through NASA's **Small Business Innovation Research (SBIR)** program to develop key technologies in reconfigurable computing and Intellectual Property (IP) soft cores.

Founded in 1993, Derivation Systems has received several SBIR contracts from NASA's Langley Research Center and the U.S. Department of Defense Air Force Research Laboratories in support of its mission to develop hardware and software for high-assurance systems. Through these contracts, Derivation Systems began developing leading-edge technology in formal verification, embedded Java,™ and reconfigurable computing for its PF3100,™ Derivational Reasoning System (DRS™), FormalCORE IP,™ FormalCORE PCI/32,™ FormalCORE DES,™ and LavaCORE™ Configurable Java Processor, which are designed for greater flexibility and security on all space missions.

The PF3100 is an ultra high-density reconfigurable module using Xilinx® Virtex®-II Platform Field Programmable Gate Arrays (FPGAs) in the rugged, compact, industry standard PC/104+ form factor. The module is a multi-function, single-inventory device. Hardware algorithms can be stored in on-board Flash memory or downloaded from a host system to configure the module for a specific mission requirement. These algorithms can be dynamically loaded onto the FPGAs to change the PF3100's function.

Derivation Systems developed the DRS through a 1994 Langley SBIR contract. The system allows an engineer to develop hardware algorithms using formal verification methods. Upon receiving a subsequent SBIR contract with Langley, the company adapted DRS as the underlying technology for its FormalCORE IP product line to develop a library of IP cores targeted to reconfigurable hardware.

FormalCORE IP components are pre-defined, pre-verified system functions in the form of a netlist that serves as building blocks for new designs. Design teams can quickly incorporate these building blocks into their designs while maintaining a high degree of assurance from formal verification tools. Engineers within the computer, networking, and semiconductor markets can manipulate these pre-designed components to develop reusable designs with reduced errors and design cycle times, as well as reduced time-to-market for electronic products and systems.

The FormalCORE IP family includes FormalCORE PCI/32—a 32-bit/33Mhz PCI interface core, FormalCORE DES—an implementation of the DES encryption algorithm, and the LavaCORE Configurable Java Processor—a 32-bit processor that executes Java byte code directly in hardware.

With the introduction of the PF3100 and its FormalCORE IP technology, Derivation Systems has launched itself as a leading supplier of PC/104-based FPGA boards and IP for the embedded systems market. The company ships its products to a variety of aerospace, government, telecommunications, and industrial customers. The PF3100 has been adopted to provide a comprehensive solution to a broad range of applications including data acquisition, hyper-spectral imaging, engine control, three-dimensional bio-imaging, software radio, robotics, power conditioning, telecommunications, and prototyping fault-tolerant bus architectures.

Derivation Systems' customers include the U.S. Air Force, Northrop Grumman, Ericsson, General Dynamics, Lawrence Livermore National Laboratory, Lockheed Martin Corporation, and NASA.

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