Early Software Development
Successfully completing today’s and tomorrow’s challenging SoC designs, with their ever-increasing software contents, on time and on budget, requires starting the software-development process as early as possible. FPGA-based prototyping has long been a key technology to achieve that goal. However, growing complexities and shrinking time-to-market windows are making the bring-up of such a prototyping system increasingly painful and time consuming.

The Protium S1 platform addresses and solves these challenges by providing a comprehensive and productive solution to reduce the prototype bring-up from months to weeks. This speed-up is achieved by combining a hardware platform—a family of FPGA boards—with a software platform, providing a fully integrated implementation flow as well as advanced debug capabilities.

System Validation
With their high speed, small form factor, and external system connections, FPGA-based prototyping systems are a productive solution to allow design teams to validate their IP and SoC designs within the actual system environment. With its fast design bring-up and compatibility with the SpeedBridge portfolio, the Protium S1 platform offers distinct advantages over in-house-developed and other FPGA-based solutions.

Throughput Regressions
Using the Protium S1 platform, you can improve your product quality by running exhaustive regression tests on a high-performance, cost-effective platform.

The Cadence® Protium™ S1 FPGA-Based Prototyping Platform is an advanced FPGA-based prototyping solution enabling early software development, throughput regressions, and high-performance system validation. It combines high-capacity FPGA boards, based on the latest generation of FPGAs, with a complete implementation and debug software flow, providing ultra-fast design bring-up and unprecedented ease of use. Compatible with Cadence’s Palladium® platforms and SpeedBridge® adapters, it allows for the quick and smooth transition of the system-on-chip (SoC) design from an existing emulation environment into a high-performance FPGA-based prototype.

Figure 1: Protium S1 flow
When the majority of hardware defects in the design have been removed, users must be able to run regressions quickly, while preserving the integrity of the design under test (DUT) and the verification environment. To optimize the throughput of regression speed within budget, pair the Palladium XP Verification Computing Platform and the Palladium Z1 Enterprise Emulation Platform—including a common compile flow, identical language coverage, and the ability to re-use the Palladium verification environment—with the Protium S1 platform. This approach allows users to maximize throughput regressions, which requires less interactive hardware debugging.

The Protium S1 platform further extends the innovation within the Cadence Verification Suite—comprised of best-in-class core engines, verification fabric technologies and solutions that increase design quality and throughput—fulfilling verification requirements for a wide variety of applications and vertical segments.

**Benefits**

**Fastest prototype bring-up**
- Reuse of the existing Palladium emulation environment
- Automatic multi-FPGA partitioning
- Automatic memory conversion and modeling
- Support for unlimited number of design clocks

**Highest model accuracy**
- Support for complex, ASIC-style clocking
- Palladium platform-compatible clocking
- Automatic generation of a post-partitioning verification database for fast model validation

**Unparalleled debug**
- Waveform capture and storage for off-line debug and analysis
- Assertion checkers for assertion-based verification and debug
- State read-back for dynamic access to any and all design registers, without probing or re-compile
- High-performance, high-capacity data capture card (DCC), supporting 10s of thousands of signals over 10s of millions of clock cycles
- Signal force and release for interactive debug and design configuration

**Unsurpassed flexibility**
- Boards are equipped with the most common, standard interfaces
- Expansion connectors for custom and off-the-shelf daughtercards
- Compatible with SpeedBridge adapters
- Support for end-to-end encryption (e.g., to protect third-party IP)

**Features**
Complete FPGA-based prototyping system with all required hardware and software components.

**Design input**
- Synthesizable RTL (Verilog, VHDL, System Verilog)
- Synthesizable gate-level netlist
- Full support and compatibility with the Palladium language set (synthesizable constructs only)

**Scripting and setup**
- Compatibility with Palladium script files
- Compatibility with Palladium clock definition files
- Automatic ASIC-to-FPGA memory conversion

**Multi-FPGA partitioning**
- Fully automatic with FPGA interconnect optimization and FPGA utilization balancing
- User-guided performance optimization
- Black-box support for high-speed design modules and interfaces
- Automatic clock tree transformation ( gated clocks, multiplexed clocks, latches, etc.)
- Automatic pin-multiplexing insertion

**Post-partitioning Palladium model**
- Generated automatically
- For fast FPGA model validation
- Accurate representation of the multi-FPGA implementation including clock remapping, converted memories, pin-multiplexing, probing, and triggering logic, etc.

**FPGA place and route**
- Fully automatic setup
- Support for parallel place and route
- Fully integrated Xilinx Vivado Place and Route software

**Integrated Compile Engine**
Taking an ASIC design (RTL) and mapping it into a set of FPGAs is without any doubt the biggest challenge and the most time-consuming task when getting an FPGA-based prototype up and running. Unlike other solutions, the Integrated Compile Engine in the Protium S1 platform provides everything needed to take an existing RTL design, compile it, partition it into multiple FPGAs, and generate the individual bit files to configure each FPGA. This can be done fully automatically with minimal or no modifications to the original ASIC-RTL code. Various levels of specific user guidance and interaction allow further optimization, specifically to achieve higher speed.

To provide visibility into the design and interactive debug capabilities during runtime, the user can select the to-be-observed signals before compilation and define the trigger conditions to start a data capture. During runtime, the selected signals are captured and stored for off-line viewing and analysis.

In addition, several unique debug capabilities are at the user’s disposal, ranging from back-door memory upload/download over the ability to force signals into “1” or “0” to being able to start/stop the clock or run “n” cycles.
Protium S1 Hardware
To cover a wide range of design sizes and accommodate different interface requirements, multiple hardware configurations are available, ranging from two FPGAs per system to eight FPGAs per system. All FPGAs are Xilinx Virtex-Ultrascale XCVU440 devices providing up to 25M ASIC gates capacity (design dependent) and up to 88Mb of embedded memory per FPGA. The boards are mounted in a custom chassis with power supply, cooling, and all necessary interfaces and cabling included.

In addition to being equipped with a variety of on-board interfaces, the Protium S1 platform is complemented by a comprehensive portfolio of daughtercards. The Protium S1 platform is also fully compatible with Cadence’s family of SpeedBridge adapters, enabling a smooth transition from an emulation environment to an FPGA-based prototyping environment.

Requirements

**For compile**
- Linux operating system (Refer to Platform Matrix for Cadence Applications)
- Minimum of 64GB of RAM
- Minimum of 500GB of free disk space

**For control and configuration**
- Linux workstation (32-bit or 64-bit, Red Hat or SUSE)
- 64GB of RAM
- 45GB of disk space
- 1 Ethernet port
- 1 USB 2/3 port
- Multiple Protium S1 Platforms can be controlled from one workstation

Cadence Services and Support

- Cadence application engineers can answer your technical questions by telephone, email, or Internet—they can also provide technical assistance and custom training.
- Cadence-certified instructors teach more than 70 courses and bring their real-world experience into the classroom.
- More than 25 Internet Learning Series (ILS) online courses allow you the flexibility of training at your own computer via the Internet.
- Cadence Online Support gives you 24x7 online access to a knowledgebase of the latest solutions, technical documentation, software downloads, and more.

For more information, please visit www.cadence.com/support for support and www.cadence.com/training for training.

### Protium S1 FPGA-Based Prototyping Platform — Hardware Configurations

<table>
<thead>
<tr>
<th></th>
<th>39RX811K (Board Only)</th>
<th>39RX812K</th>
<th>39RX814K</th>
<th>39RX828K</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPGAs</td>
<td>1X Virtex Ultrascale XU440</td>
<td>2X Virtex UltraScale XU440</td>
<td>4X Virtex UltraScale XU440</td>
<td>8X Virtex UltraScale XU440</td>
</tr>
<tr>
<td>FPGA boards</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Approx. total capacity (design dependent)</td>
<td>Up to 25M ASIC gates</td>
<td>Up to 50M ASIC gates</td>
<td>Up to 100M ASIC gates</td>
<td>Up to 200M ASIC gates</td>
</tr>
<tr>
<td>FPGA-internal memory</td>
<td>88Mb</td>
<td>176Mb</td>
<td>352Mb</td>
<td>704Mb</td>
</tr>
<tr>
<td>On-board memory (optional)</td>
<td>Up to 32GB</td>
<td>Up to 64GB</td>
<td>Up to 128GB</td>
<td>Up to 256GB</td>
</tr>
<tr>
<td>Front-panel interfaces</td>
<td>PCIe Express® (PCIe®) Gen3 (X8) iPass, USB Host, FPGA JTAG, CPU Ethernet, CPU Serial, CPU Device, JTAG</td>
<td>2X 4-lane PCIe Gen3</td>
<td>8X SFP+</td>
<td>2X QSFP+</td>
</tr>
<tr>
<td>Back-panel Interfaces</td>
<td>1X 4-lane PCIe Gen3</td>
<td>8X SFP+</td>
<td>2X QSFP+</td>
<td>PCIe Gen3 (X8) iPASS, USB Host, FPGA JTAG, CPU Ethernet, CPU Serial, CPU Device, JTAG, UART</td>
</tr>
<tr>
<td>On-board interfaces</td>
<td>2X SATA II (1X Device/1X Host)</td>
<td>1X JTAG (14-pin)</td>
<td>1X RS232</td>
<td>8X SFP+</td>
</tr>
</tbody>
</table>
# Protium S1 FPGA-Based Prototyping Platform

Protium S1 FPGA-Based Prototyping Platform — Hardware Configurations (Continued)

<table>
<thead>
<tr>
<th>Model</th>
<th>GTH expansion connector</th>
<th>Clock generators</th>
<th>Samtec SEAM series connector</th>
<th>User I/Os</th>
<th>Board configuration</th>
<th>Power requirements</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>39RX811K (Board Only)</td>
<td>1X GTH connector</td>
<td>5 programmable synthesizers (2KHz – 945MHz)</td>
<td>24 connectors: Each connector connects to 52 I/Os that can be configured as 24 LVDS + 4 single-ended signals or 52 single-ended signals</td>
<td>576 LVDS pairs or 1,248 single-ended signals</td>
<td>Ethernet, USB</td>
<td>500W, ATX 24-pin connector, 1,2V/36A, 5V/2A, 3.3V/15A</td>
<td>381mm x 32mm x 446mm (width x height x depth)</td>
</tr>
<tr>
<td>39RX812K</td>
<td>2X GTH connectors (1X GTH connector per FPGA)</td>
<td></td>
<td>36 connectors (18X connectors per FPGA)</td>
<td>864 LVDS pairs or 1,872 single-ended signals</td>
<td></td>
<td>110-240VAC, 50-60Hz, 500W</td>
<td>445mm x 254mm x 762mm (width x height x depth); 19” standard rack mountable, 7u height</td>
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<tr>
<td>39RX814K</td>
<td>16 SerDes (16Gbps)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>110-240VAC, 50-60Hz, 750W</td>
<td></td>
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<tr>
<td>39RX818K</td>
<td>2X 4-channel Ethernet, XAUI, Infiniband</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>110-240VAC, 50-60Hz, 1,500W</td>
<td></td>
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<tr>
<td>39RX828K</td>
<td>16X SFP+ 10GbE et. al.</td>
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