Hybrid Emulation: Accelerating Software driven Verification and Debug
Issac P Zacharia (issac.Zacharia@arm.com) Jitendra Aggarwal (jitendra.Aggarwal@arm.com)
Arm Ltd Cambridge

**Existing Platform**
- FPGA based Juno Platform
- Onboard FPGA where GPU will be configured
- Runs at GHz speeds

**FPGA Platform Challenges**
- Debugging HW/SW issues using real OS Apps on FPGA is challenging due to low design visibility
- Issues reported in different verification platforms/tools typically are not cross reproducible
- Complex real OS App issues could take weeks to generate the stimulus and reproduce at unit level simulation platforms
- Mali® GPU HW and SW live debug was challenging in present platform setup

**Proposed Methodology**
- A high-performance transaction-level model of the CPU subsystem running on Virtual Platform with RTL for the rest of the SoC running on the emulator
- Enables the software to execute at virtual platform speeds
- Higher performance for software-driven hardware verification even when RTL for critical blocks isn’t available
- Early architecture validation and software development
- Easier platform upgradability and Much better design debug visibility
- Supports different debug methods over FPGA platform such as waveform, Smart memory debug tools, memory dump, tarmac, capture replay, monitors etc

**Integration Block Diagram**

**Platform Integration**
- Replaced RTL CPU and GIC with Arm Cortex A55 and GIC 600 fast model on the virtual platform
- Converted RTL memory to smart memory to enable the CPU to access it via backdoor
- Smart memory acts as shared memory which is visible to both virtual and RTL platforms
- CPU access the memory within the virtual platform and other peripherals in the RTL through TLM bridge connected to the CCI550
- GPU access the memory through CCI550 bridge

**Performance results**

<table>
<thead>
<tr>
<th>Platform</th>
<th>Test</th>
<th>Runtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux Boot</td>
<td>Hybrid</td>
<td>62 sec</td>
</tr>
<tr>
<td>Android 10</td>
<td>Hybrid</td>
<td>240 sec</td>
</tr>
<tr>
<td>Debian Buster 11</td>
<td>Hybrid</td>
<td>185 sec</td>
</tr>
</tbody>
</table>

**Cube application on Debian Buster 11**

**Cube Application on Android 10**

**How to order your poster for printing**
- Helped reproducing the hardware and software issues captured in FPGA platform which enables much better turnaround time for the debug and corresponding patch validation
- Caters an effective co-ownership of FPGA based challenges in Software development, therefore it is certainly not a replacement of our existing FPGA platform
- Observed significant gain with Hybrid usage in Emulator which led us to explore and deploy it on bigger ecosystems of Arm

**Reference**
Developer, Arm tools-and-software/development-boards/Juno-development-board