Mobile Applications with Reconfigurable Hardware

Michael Coughlin, Ali Ismail, Eric Keller

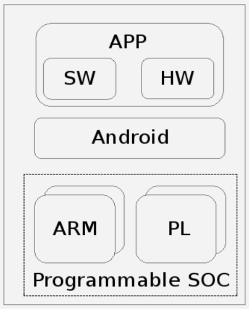
University of Colorado Boulder

Mobile Applications with Hardware

Apps today are software with no control of the hardware platform. What if apps could directly program an FPGA coupled with the processor?

-App code would include hardware descriptions for the programmable logic (PL) of the FPGA

- New functionality
  - New wireless protocols through hardware-specific radio and dedicated antennas
- Increased performance and security
  - Hardware-based traffic encryption
  - Packet processing performed in hardware
- Energy savings
  - Efficient hardware-based cryptography



Why Now? Barriers To Previous Adoption

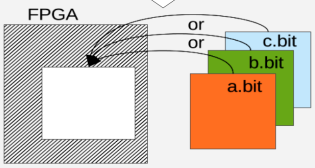
Technologies have recently matured that make mobile FPGAs feasible. They address three existing FPGA problems:

1. FPGAs are hard to program

```
void foo(......)
{
   int *A = (int *)malloc(10 * sizeof(int));
   ....
   free(A);
}
```

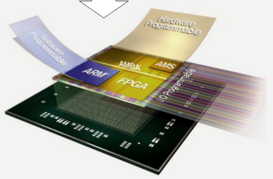
High-level synthesis (HLS) can generate Verilog hardware descriptions from C code

2. FPGAs are resource-constrained



Partial Reconfiguration (PR) is available in mainstream tools, allowing many applications to share an FPGA

3. Mobile devices are area-constrained



Modern Programmable SOCs include embedded ARM processors and FPGAs

Challenges:

1. Combining independent technologies, and doing so in a way that is accessible to app developers and fits within the app store deployment model.
2. Providing Mobile Operating System support to enable the loading and management of hardware modules with guarantees such as security and isolation.

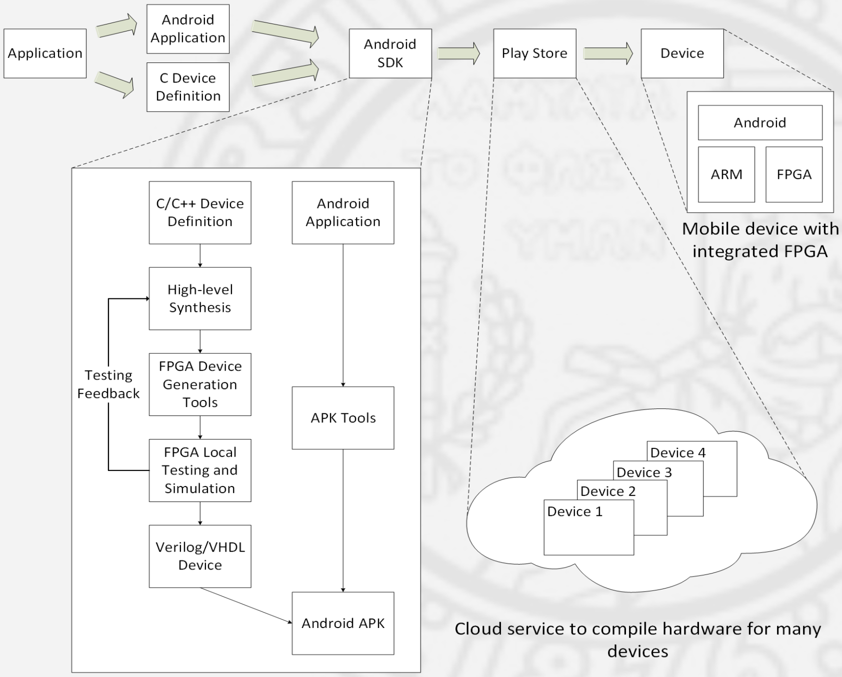
Work in Progress: Provide OS and Development Support

Solution:

- Extend Android to enable loading of apps with hardware and managing them at runtime
- Provide design flow to simplify app developer's task through integration with HLS tools
- Extend the Android packaging system and integrate with a cloud service (e.g. Google Play store)

Current progress:

- Running Android on the Zedboard with the Zynq7000 FPGA
- Automated entire HLS and PR tool flows
- Integrated device driver to enable OS to load partial bitstreams
- Working on putting it all together and developing demonstration apps


Application
Android Application
C Device Definition
Android SDK
Play Store
Device
Android
ARM
FPGA
Mobile device with integrated FPGA
C/C++ Device Definition
High-level Synthesis
FPGA Device Generation Tools
FPGA Local Testing and Simulation
Verilog/VHDL Device
Testing Feedback
Android Application
APK Tools
Android APK
Device 4
Device 3
Device 2
Device 1
Cloud service to compile hardware for many devices