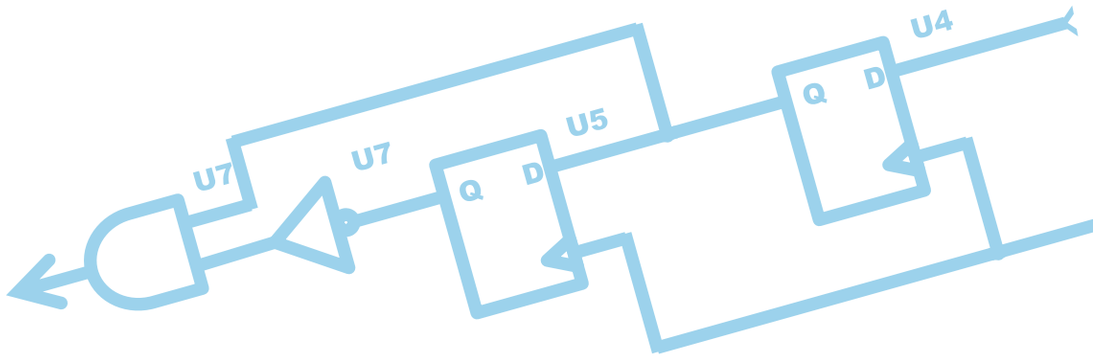


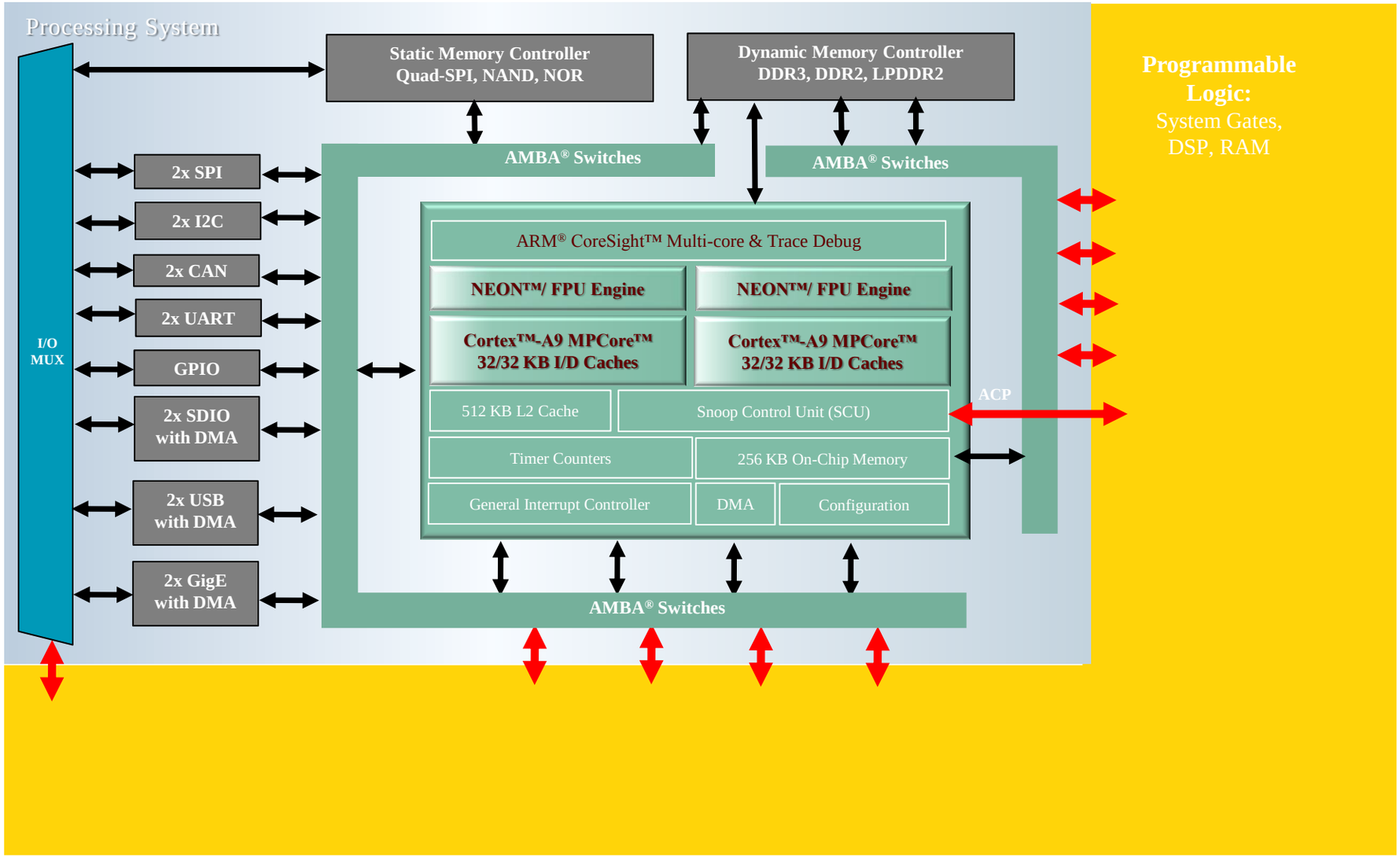
Embedded Systems Realization with Hybrid Apps
- Open Source ANDROID Meets Dynamic Partial Reconfiguration

- Endric Schubert, Ph.D.
  David Epping
  Fabian Zentner

missing link electronics

Extensible Processing Platform Example: Xilinx ZYNQ

1800 signals between PS and PL lead to a complex HW / SW integration

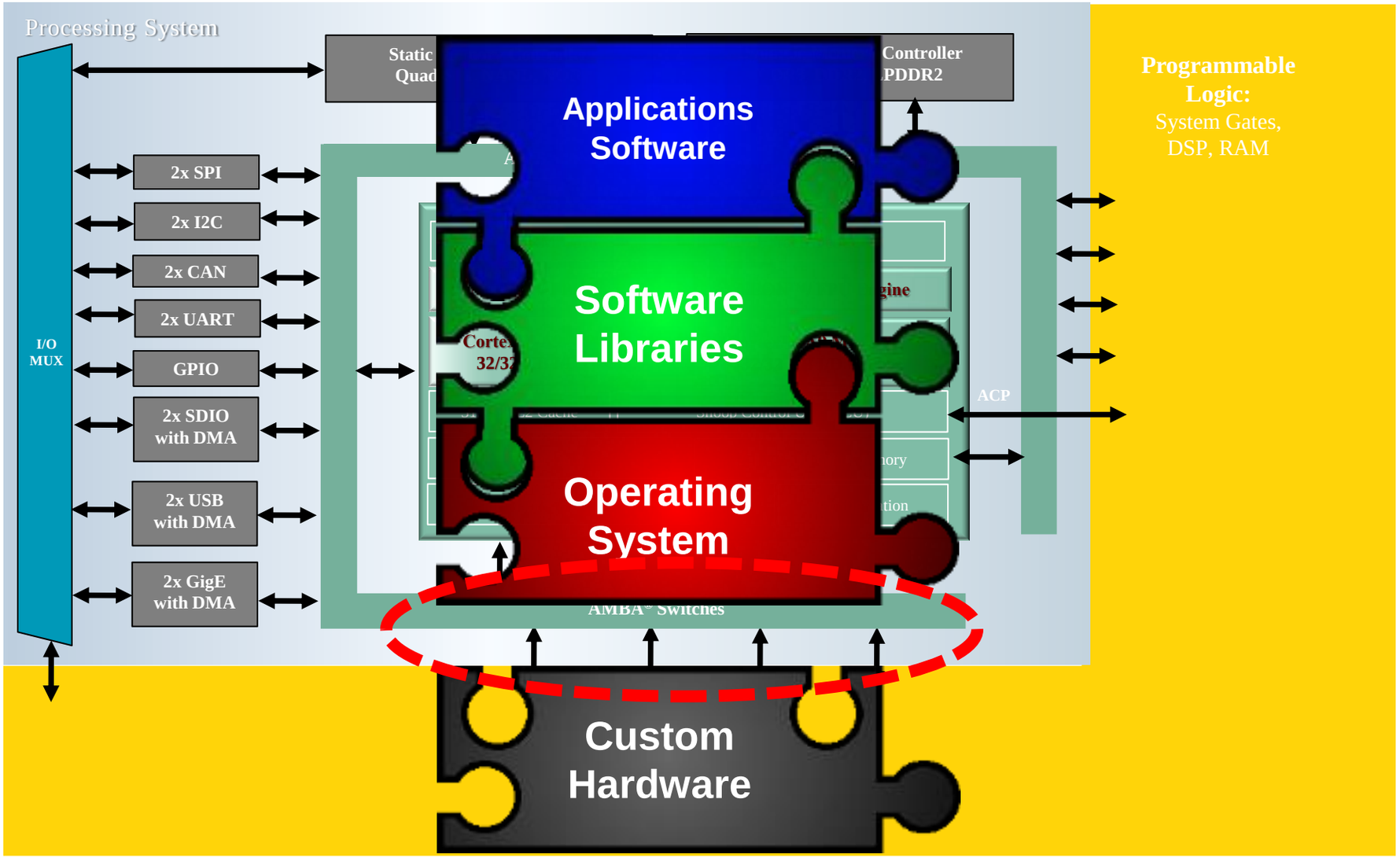


Embedded Systems Functionality is Software-Driven

Embedded Systems have a SW focused design flow,

mostly top-down with re-use of existing OS functionality and 3rd party SW libraries.

Custom HW unfortunately requires custom device drivers and OS modules.



The HW / SW Interface Design Challenge

Protocol Acceleration

Scatter-Gather DMA

First-Party DMA

Interrupt Coalescence

Custom Instructions

Solutions From the Open Source Economy

- Open Source economy:
  - Not limited to ROI
  - Can strive towards perfection

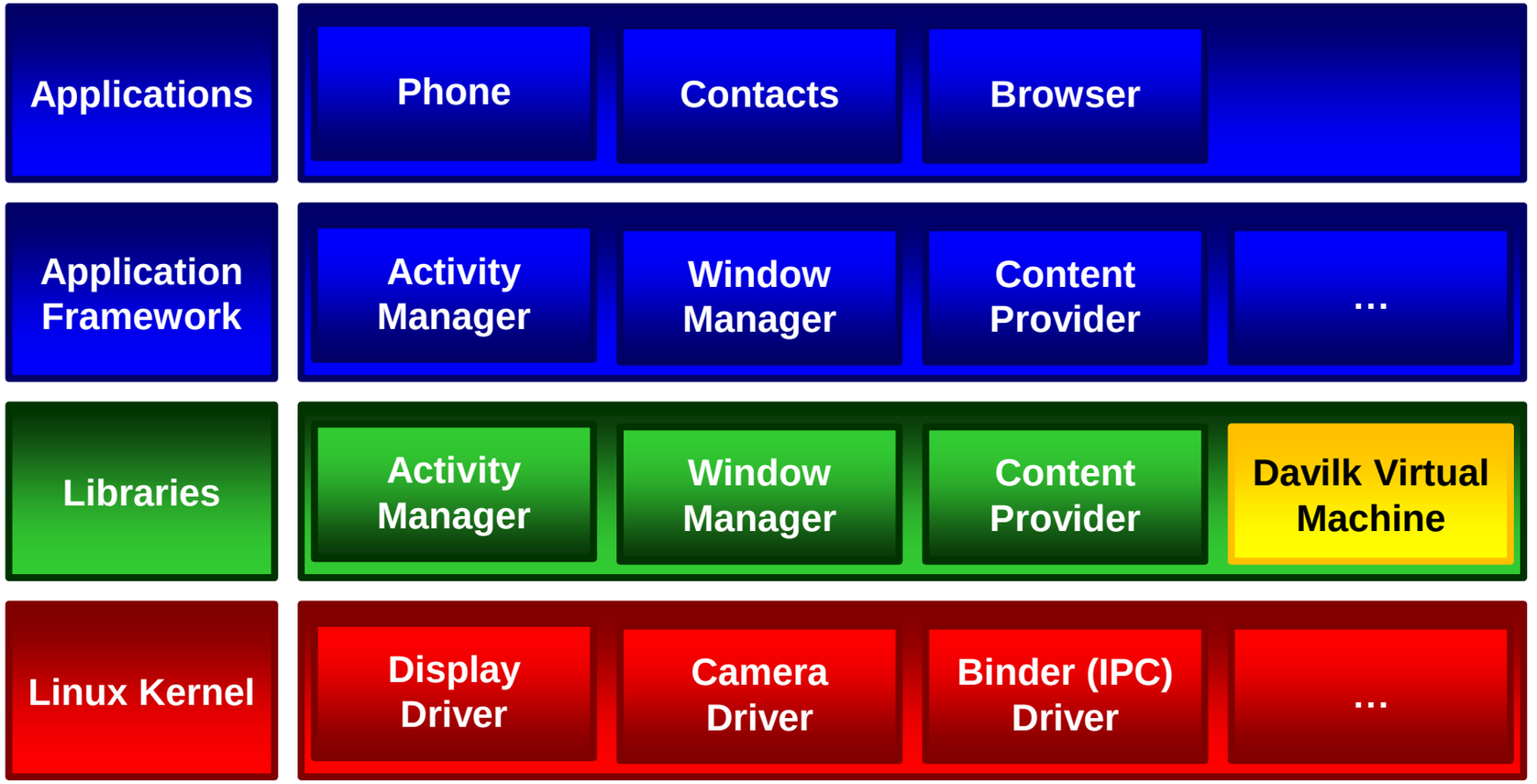
- IEEE 1275 Device Tree standard
  - Description of device hardware resources
    - register addresses
    - interrupt numbers
    - Hierarchical interdependencies between other devices
  - “Magic” strings for compatibility and consistency checking

```
 1 /dts-v1/;
 2
 3 / {
 4         model = "Xilinx Zynq ZC702";
 5         compatible = "xlnx,zynq-zc702";
 6         #address-cells = <0x1>;
 7         #size-cells = <0x1>;
 8         interrupt-parent = <0x1>;
 9
10         memory {
11                 device_type = "memory";
12                 reg = <0x00000000 0x40000000>;
13         };
14         chosen {
15                 bootargs = "console=ttyPS0,115200
   root=/dev/ram rw ip=:::::eth0:dhcp earlyprintk";
16                 linux,stdout-path =
   "/amba@0/uart@E0001000";
17         };
18
19         soc {
20                 compatible = "xlnx,zynq";
21                 clock-frequency = <33333333>;
22         };
23
24         amba@0 {
25                 compatible = "simple-bus";
26                 #address-cells = <0x1>;
27                 #size-cells = <0x1>;
28                 ranges;
29
30                 gic: intc@f8f01000 {
31                         interrupt-controller;
32                         compatible = "arm,cortex-a9-gic";
33                         #interrupt-cells = <3>;
34                         reg = < 0xf8f01000 0x1000 >,
35
```

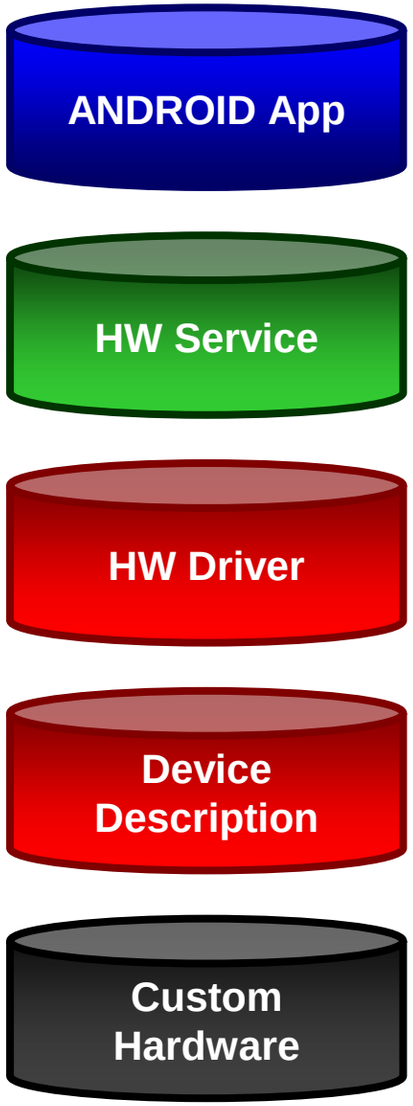
Taking ANDROID Beyond the Mobile Phone

Apps concept offers

- HW abstraction
- SW delivery
- SW life-cycle management
- No more reboot



Hybrid Apps – (Software) Apps + All Their Custom Hardware



The “App” software function,

The special service routines it my require,

The device driver for the custom hardware,

The IEEE 1275 Device Tree “blob”,

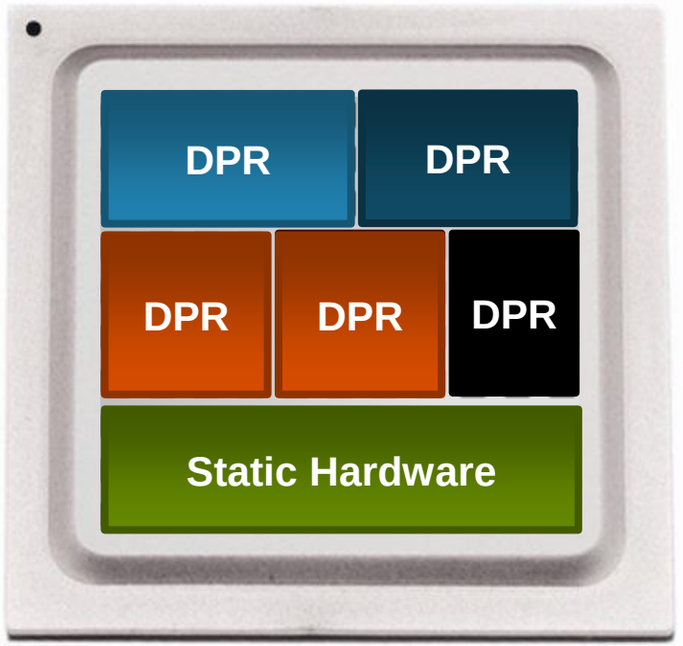
The custom hardware for special I/O or co-processing.

Dynamic Partial Reconfiguration (DPR)

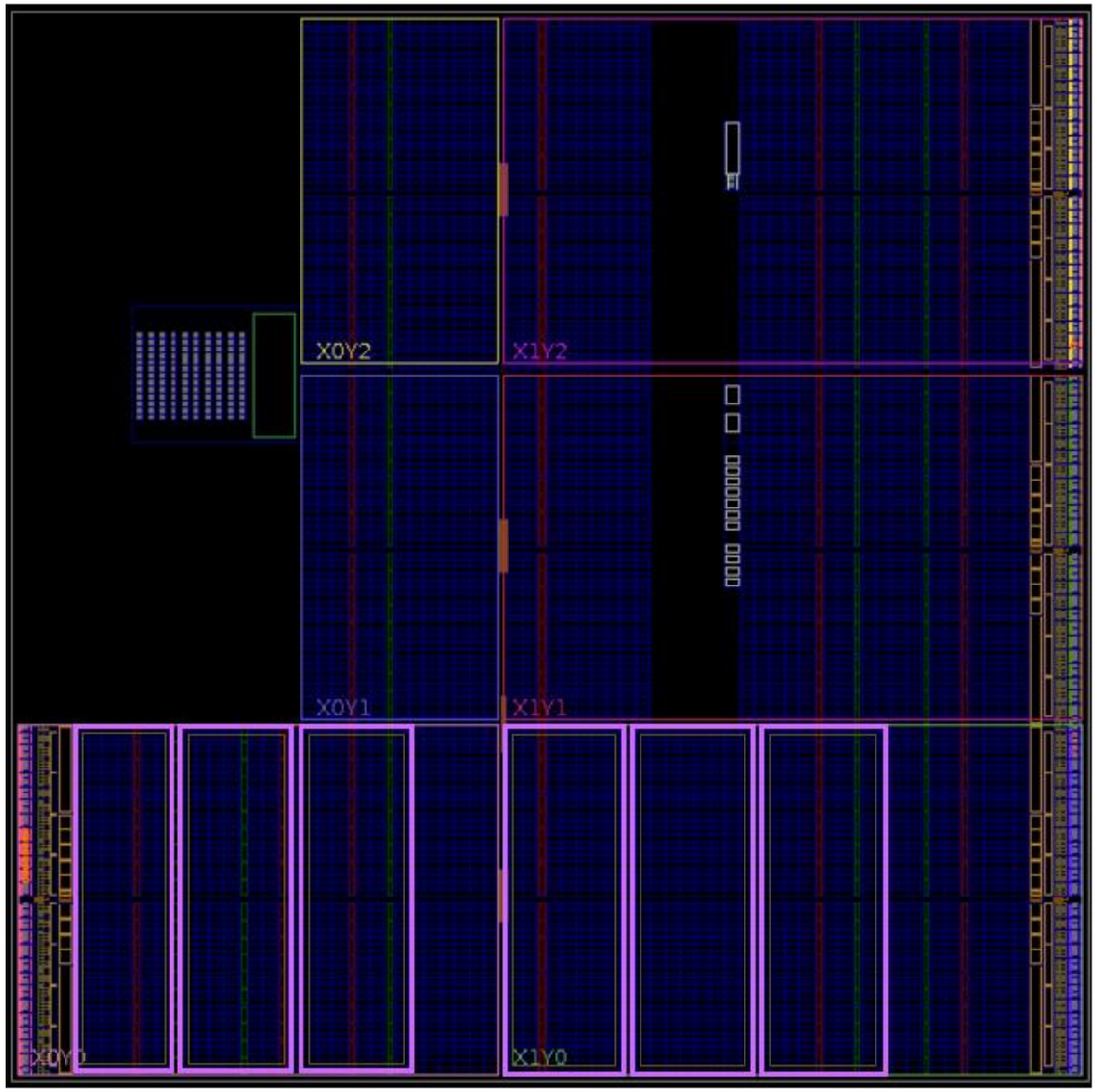
- DPR is Reconfiguration of an FPGA
  - at “run-time” (i.e. dynamic)
  - of portions of the system (i.e. “partial”)

- Supported by most modern FPGA devices

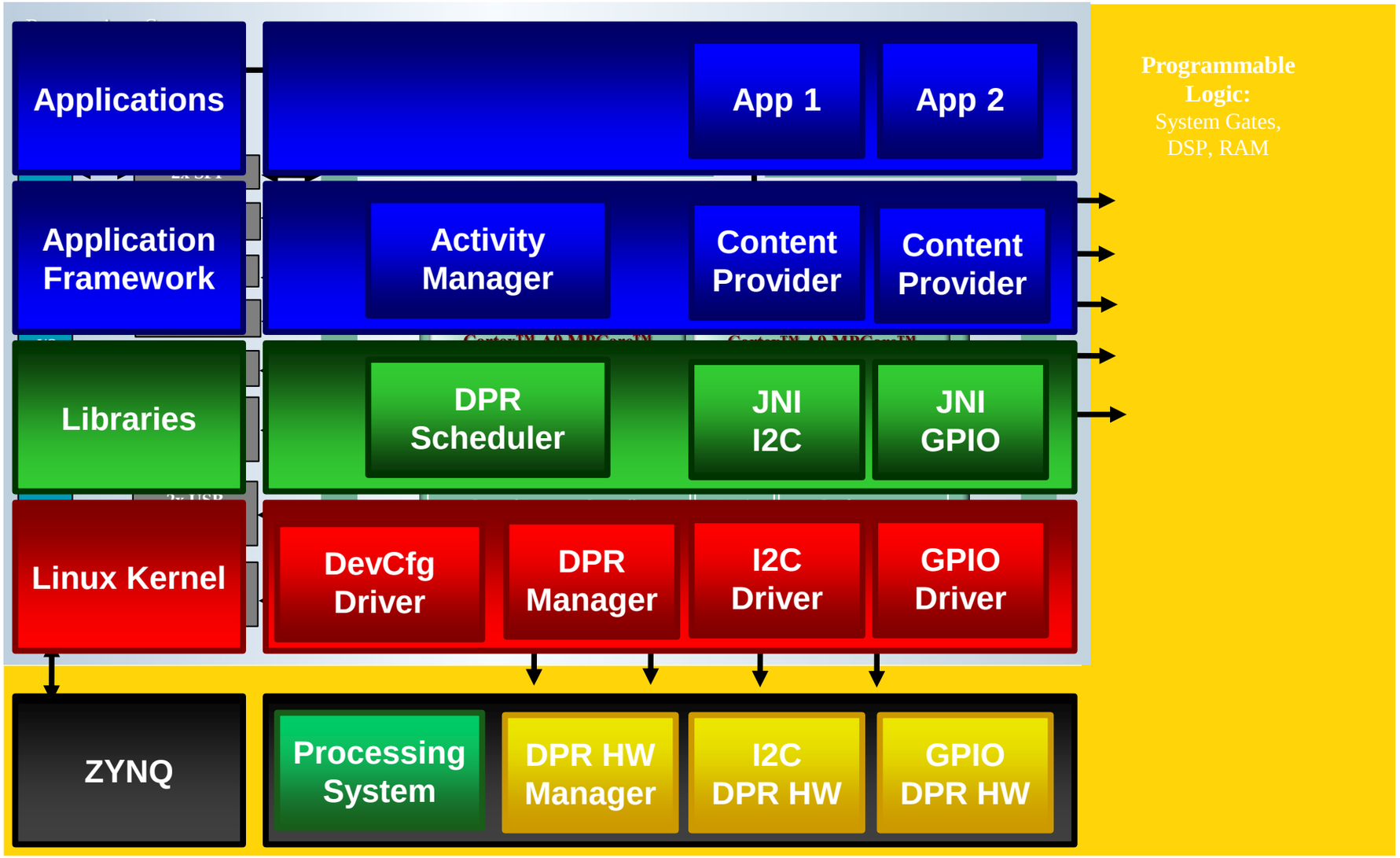
- Applications are in
  - SEU resilience (CERN)
  - Faster device boot (automotive)



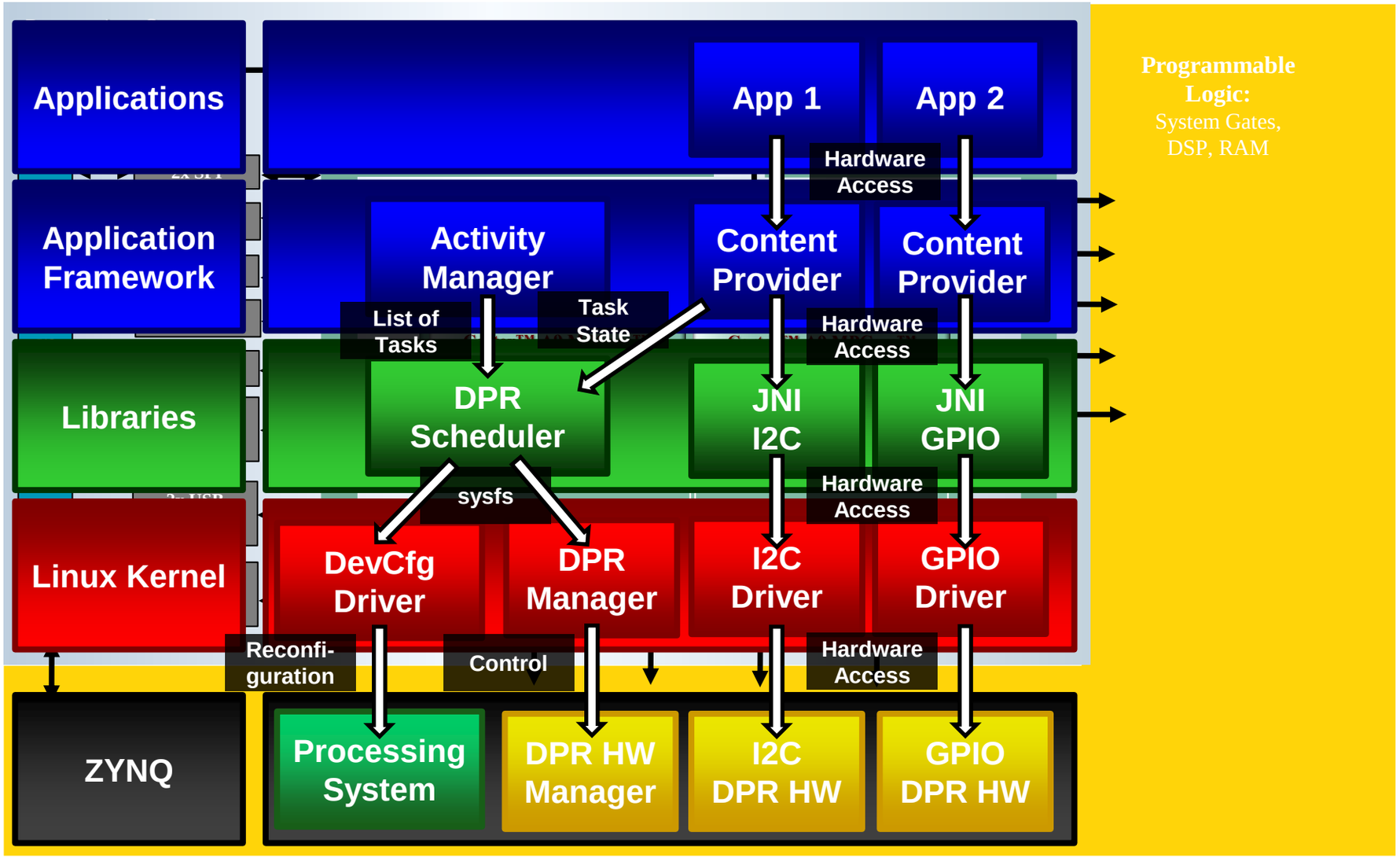
Dynamic Partial Reconfiguration for Xilinx Zynq EPP



ANDROID + DPR: Architecture



ANDROID + DPR: Example Use Case



Conclusion: ANDROID + DPR = Develop & Run Hybrid Apps