



SEU PROTECTION FOR HIGH- RELIABILITY FLASH FILE SYSTEMS

Neil Perrins and Alistair A. McEwan



VFFS@le.ac.uk

MOTIVATION

- Developing a SRAM FPGA based Flash File System.
- Intended for use in high reliability, high performance large data storage applications.
- We intend to improve the reliability of the Flash File System for use in high radiation environments such as space.



SINGLE EVENT UPSETS

- What is a Single Event Upset (SEU)?
 - Soft errors.
 - Affects memory elements.
- Where do they occur?
 - High radiation environments including space.
 - Smaller silicon features mean they can occur nearly everywhere.
- What are the effects of SEU in relation to an SRAM based FPGA?



SINGLE EVENT UPSETS

```
01010101010101
01010101010101
01010101010101
01010101010101
```

Radiation

```
01010101010101
01010101000101
01010101010101
01010101010101
```

```
01000101010101
01010101100101
01000101010101
00010100010101
```

Originally this data element contains
0x55555555555555.

After one SEU this data element contains
0x55555455555555.

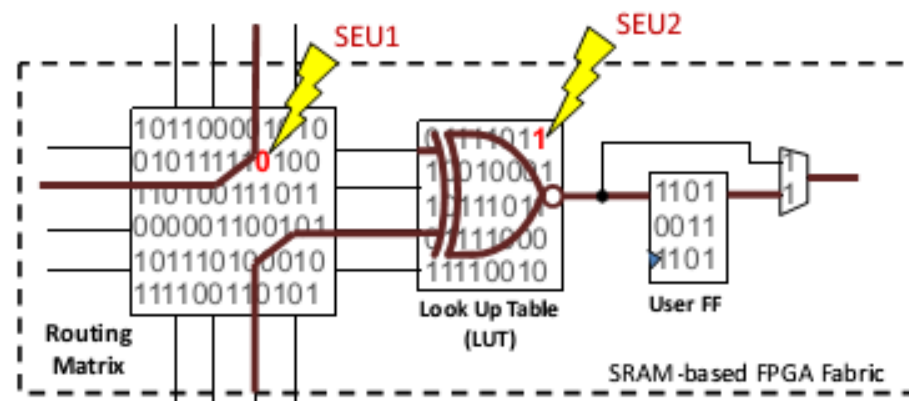
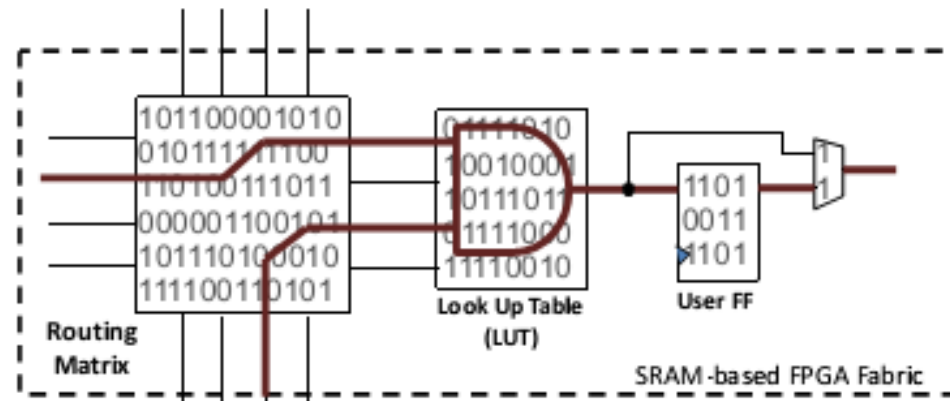
After a while this data element contains
0x55555454554515.



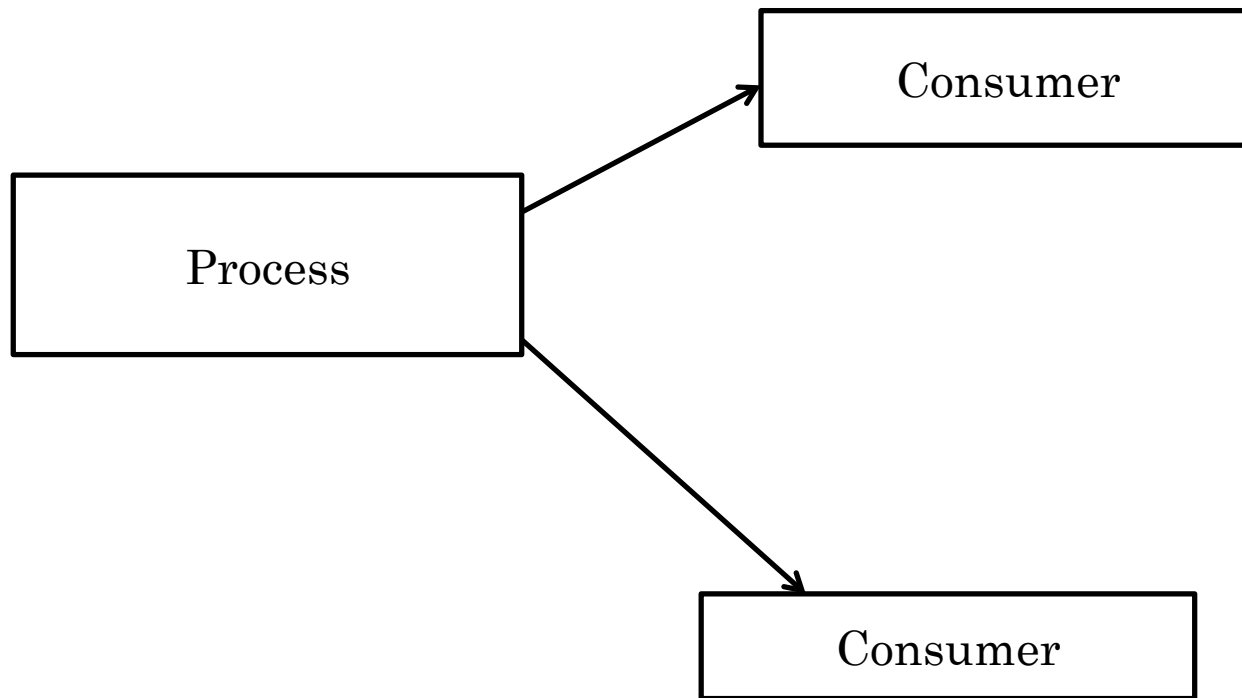
EFFECTS OF SEUS ON FGPA

Configuration bits of an FPGA are stored in SRAM.

These bits can be effected by SEU.



PROCESSES IN THE FLASH FILE SYSTEM



SIMULATOR

- Fault Injection on the bit stream.
- Partial Reconfiguration to simulate the SEUs.



PARTIAL RECONFIGURATION

- Reconfiguration is when the device is configured after start up.
- Partial Reconfiguration is when a part of a device is reconfigured and dynamic partial reconfiguration is when only part of a device is reconfigured while the rest of the device is still running its circuit.



STRESS TEST THE FLASH FILE SYSTEM

- Going to use our test bench to test the Flash File System for susceptibility to SEU.
- This should reveal parts of the Flash File System that require SEU Mitigation and give ideas for which parts need verification.



RADIATION EFFECTS ON ELECTRONICS

- Single Event Effects
- Single Event Gate Rupture
- Single Event Latch Up
- Single Event Functional Interrupt
- Single Event Transient
- Single Event Upset



SUMMARY

- Making a fault injection based test bench to simulate SEUs.
- Using a fault injection test bench to stress test our flash file system.
- This should help us find the areas we need to apply SEU mitigation.

