Fault Recovery Method of Modular Systems based on Reconfigurations

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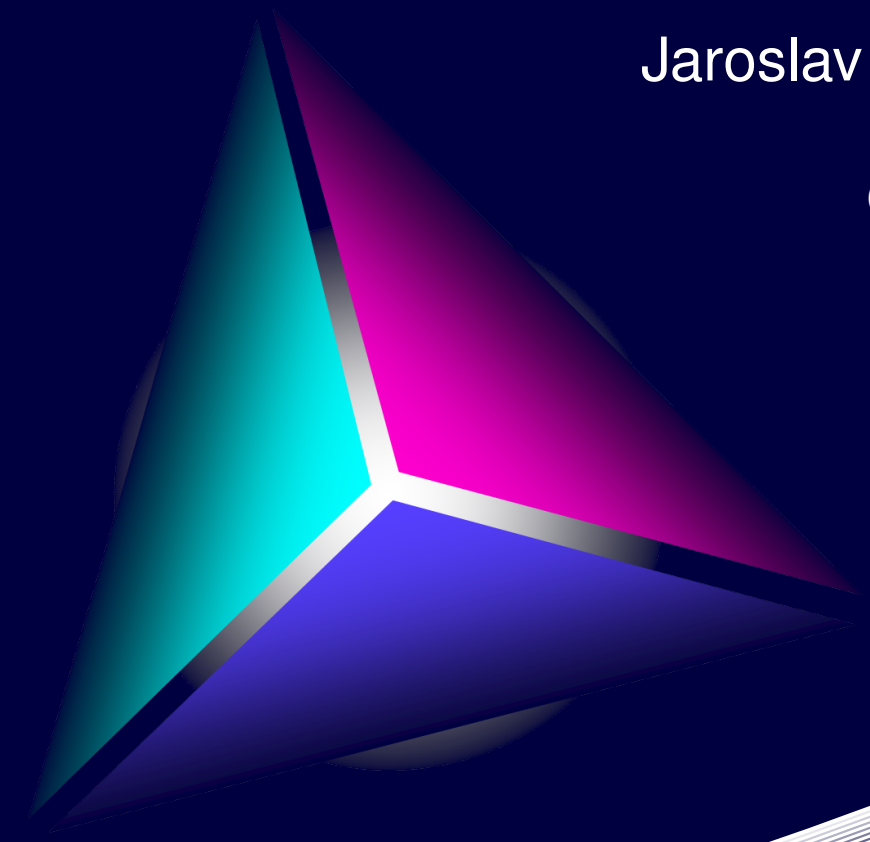
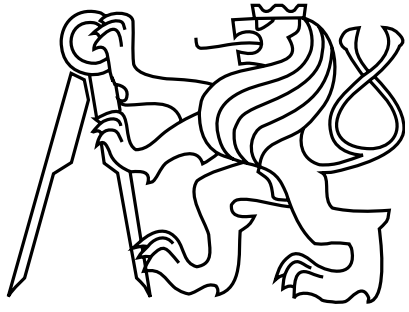


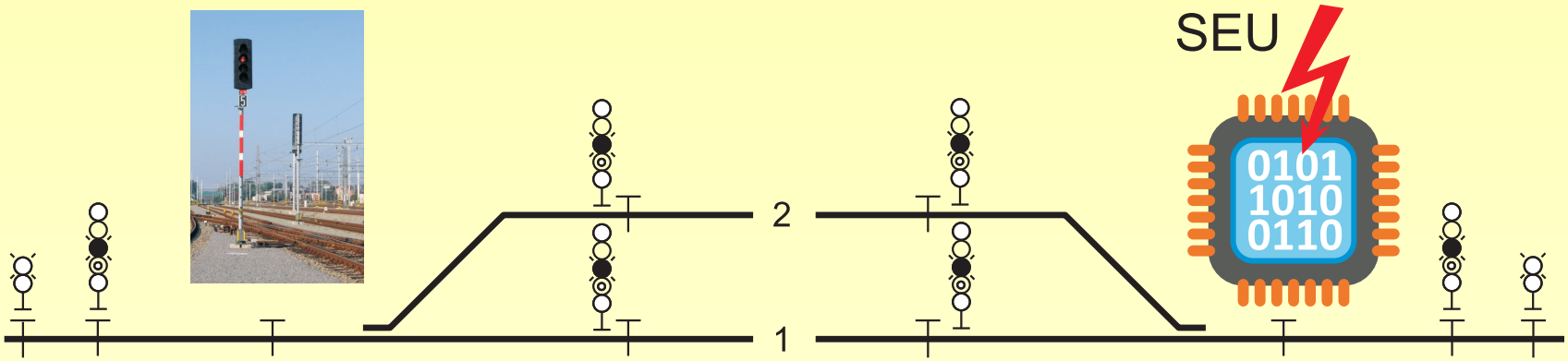


Outline

Introduction

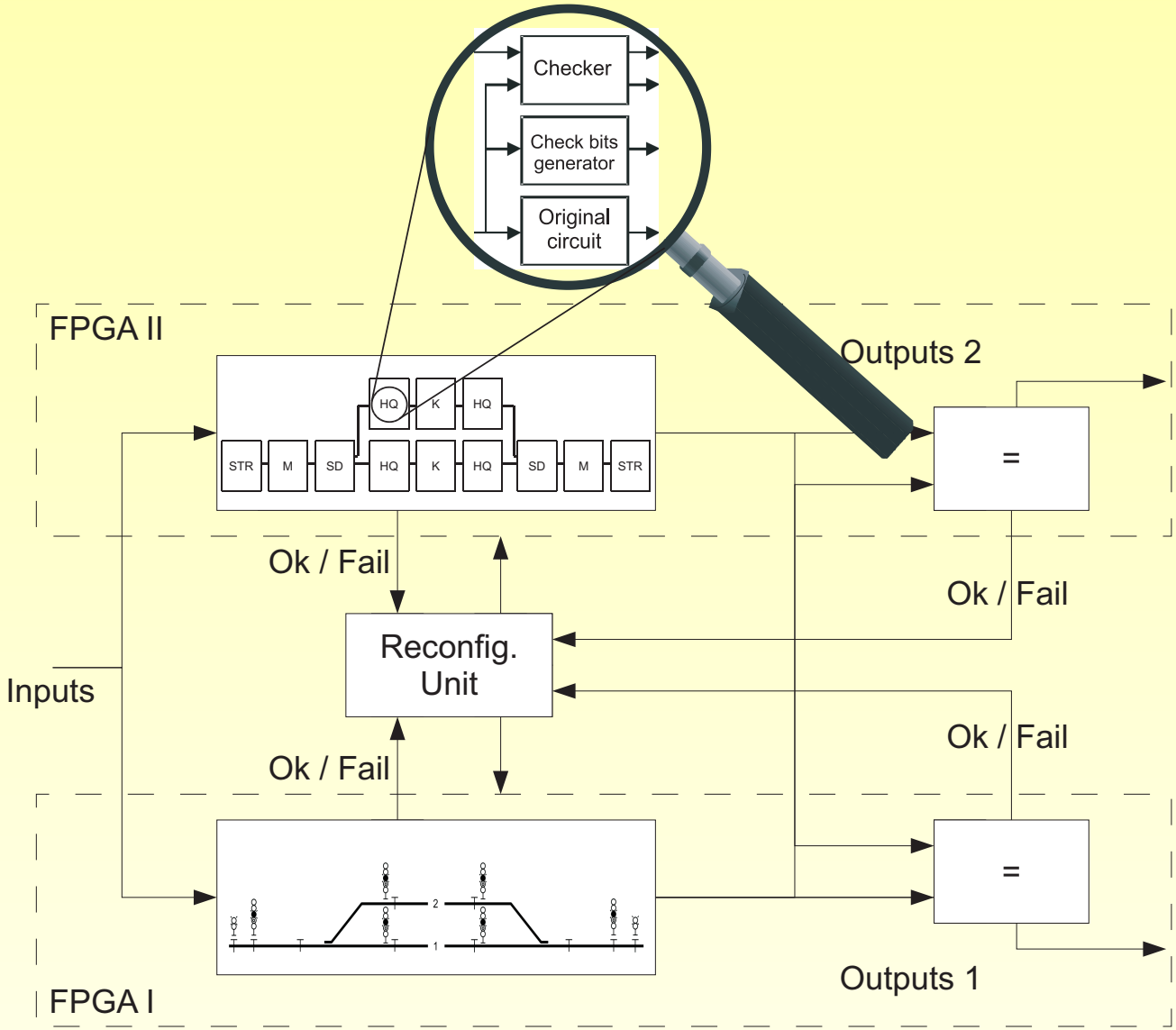
- Mission critical applications
  - Space missions
  - Public transport
- SRAM-based FPGAs are sensitive to the radiation (SEU)
- Undetectable by off-line tests
- Design a high reliable modular system on unreliable components

Simple Railway Station Safety Device



- Inovation of a czech railway station safety device
- Converted from modular system of relays into modular system in one FPGA

Modified Duplex System – initial design



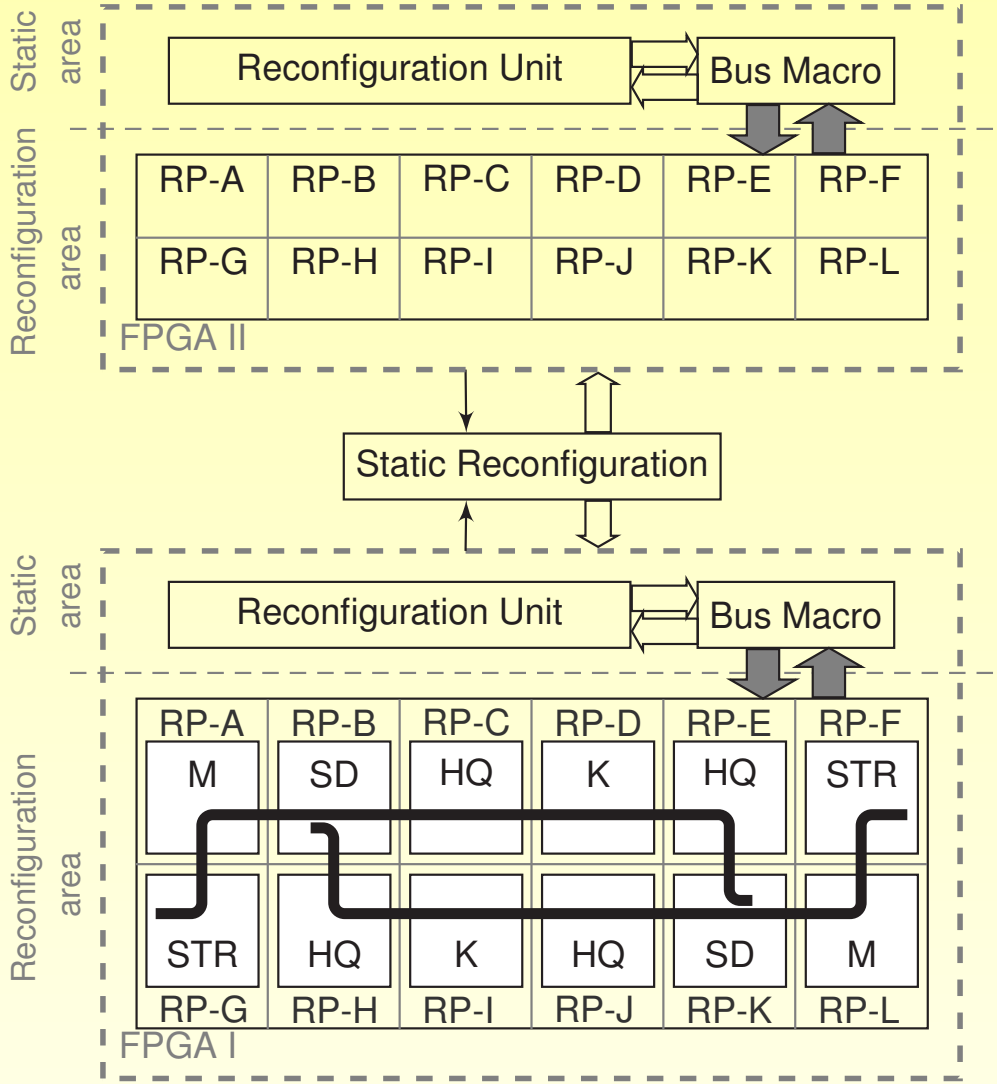
Modified Duplex System – properties

- Uses two same FPGA boards with the same design
- Error is detected by TSC block and/or by comparators, which initiate reconfiguration
- Static reconfiguration of whole FPGA
  - Full reconfiguration is a time demanding process
- Lower area overhead in comparison with TMR

Partial Reconfiguration

- Only small part of FPGA – short time
- Repairs detected soft error
- Higher availability of whole system
- Rest of the FPGA still properly works
- Easy synchronization of the reconfigured part

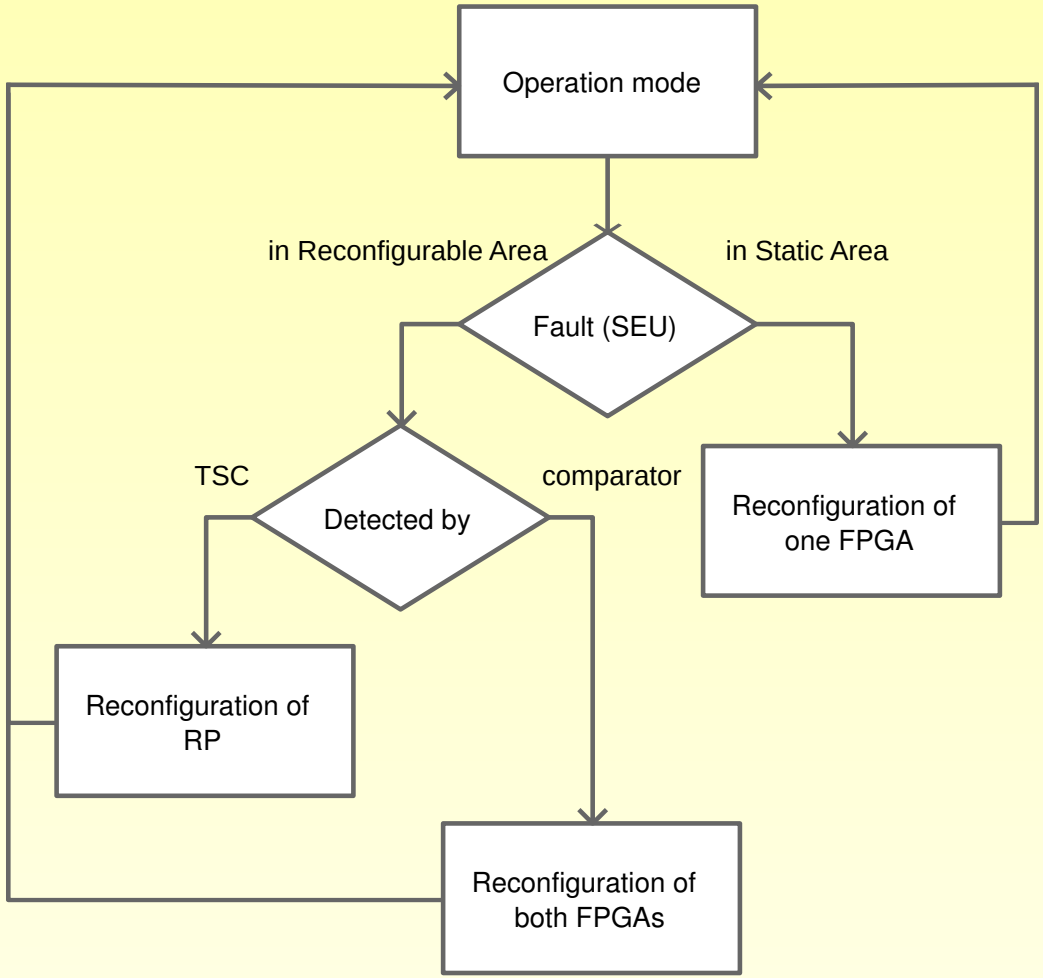
Schema of UMDS



Description

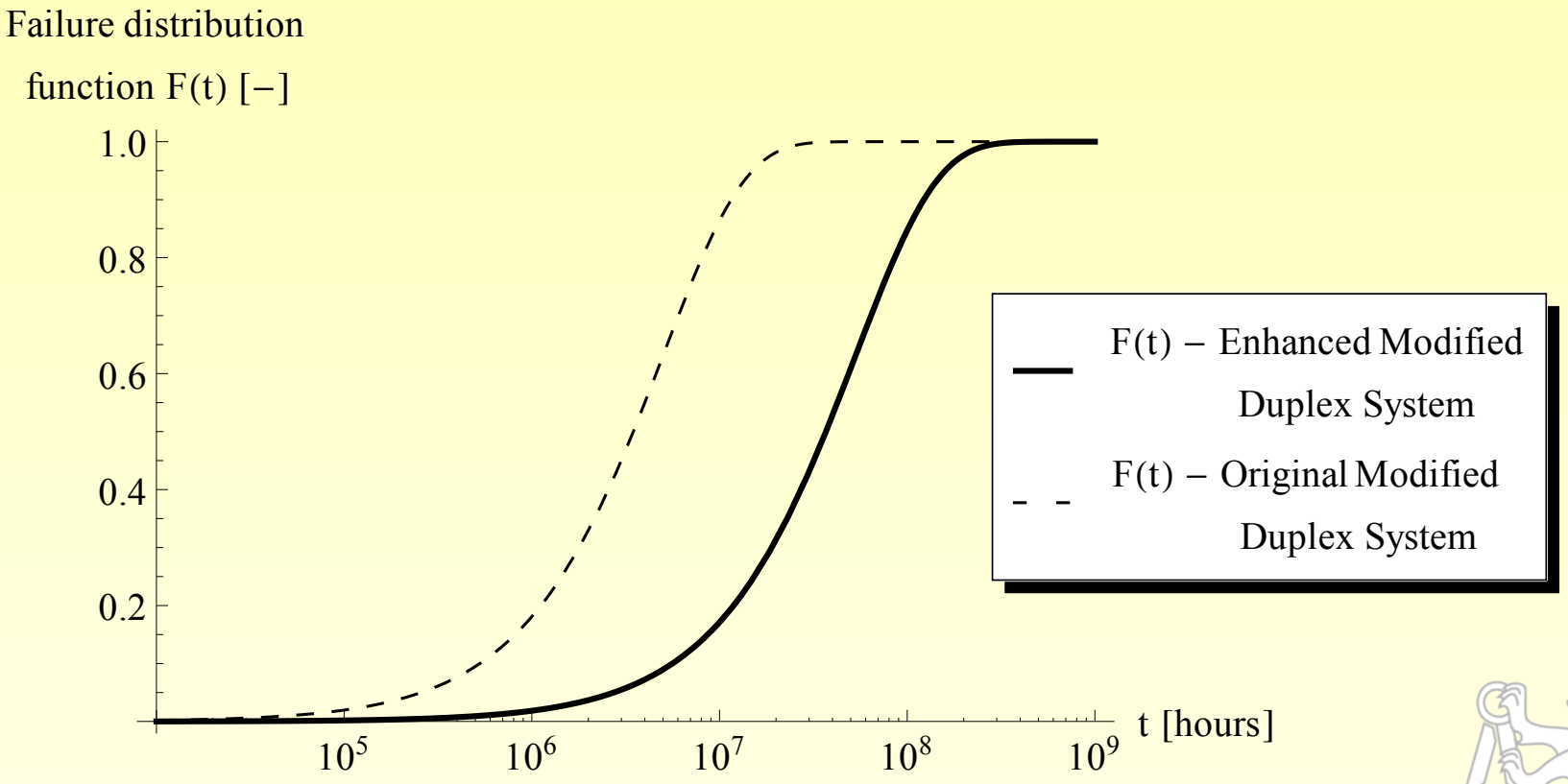
- Reconfiguration area (RA)
  - Divided into Reconfiguration Partitions (RP)
  - Partitions areas are able to perform partial reconfiguration
  - The number of RP depends on used application
  - The size of one RP depends on the specific architecture of an FPGA
- Static area
  - The Reconfiguration Unit controls the status of each TSC block in the RA
- Static reconfiguration
  - Performs reconfiguration of the whole FPGA
  - The reconfiguration is initiated by comparators

Behavioural Model



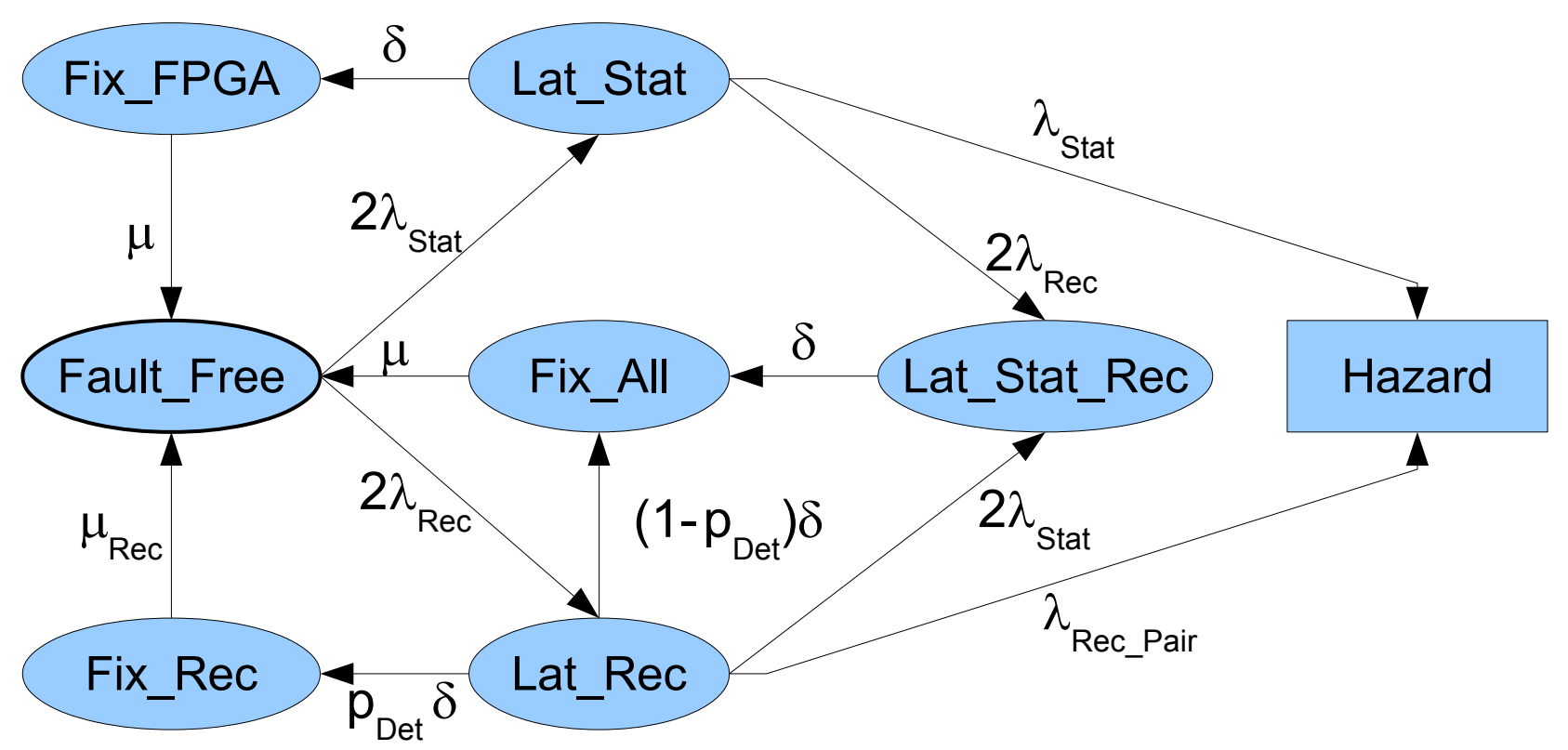
Failure Distribution Function

- Failure distribution function was calculated using Markov model



Failure Distribution Function

- Dependability model used to calculate the failure distribution function.



Conclusions

- Two independent FPGA boards with the same design
- Whole system is reconfigurable and repairable from soft errors
- Static area checks failure signals and repairs errors
- Ability of faster detection and correction of faults
- Availability and security were increased
- Method designed with respect to minimal area overhead
- Both FPGAs load same design, the systems development time was reduced