Towards Reliable FPGA-based Reconfigurable Satellite Systems

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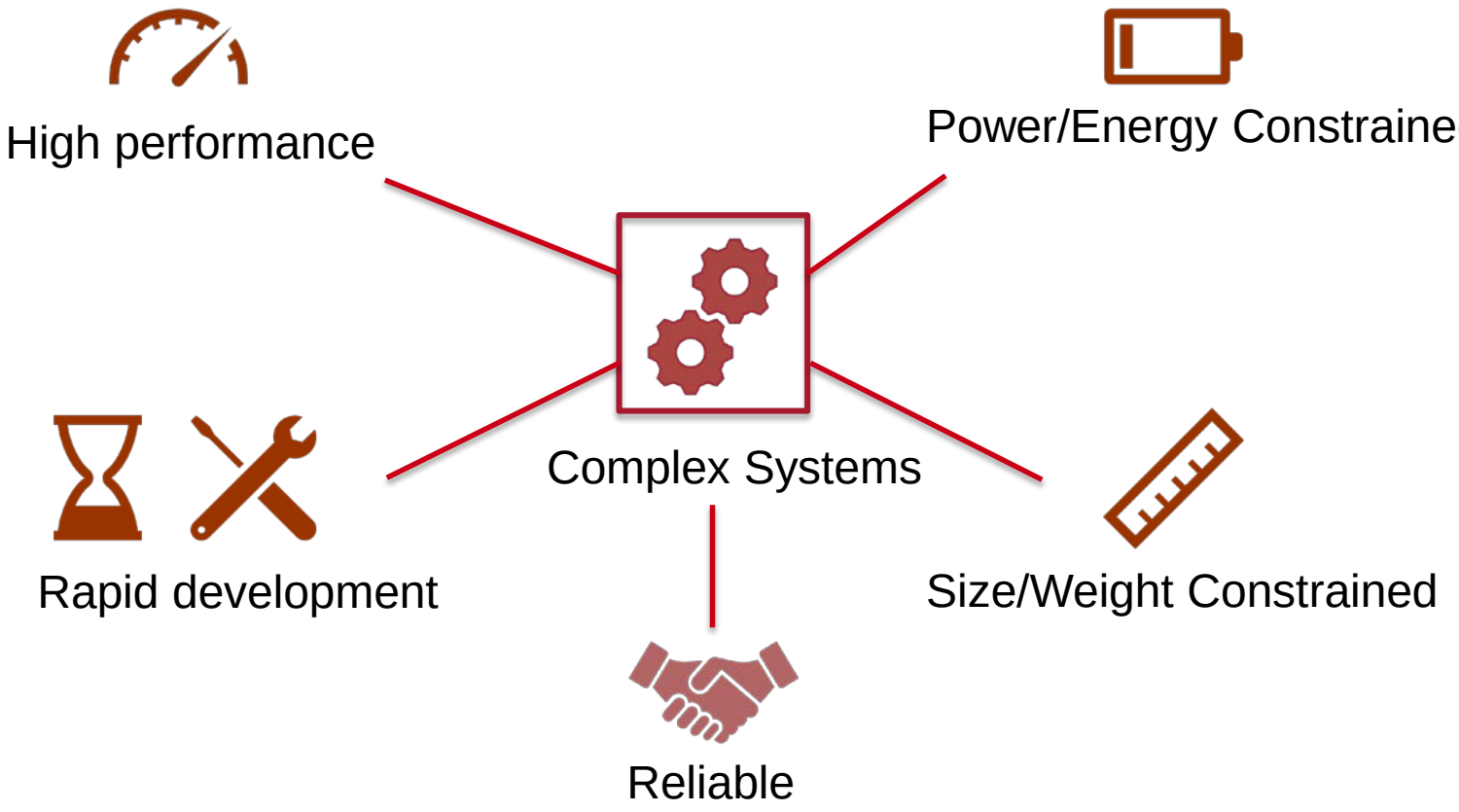
CubeSat Digital Processing Requirements



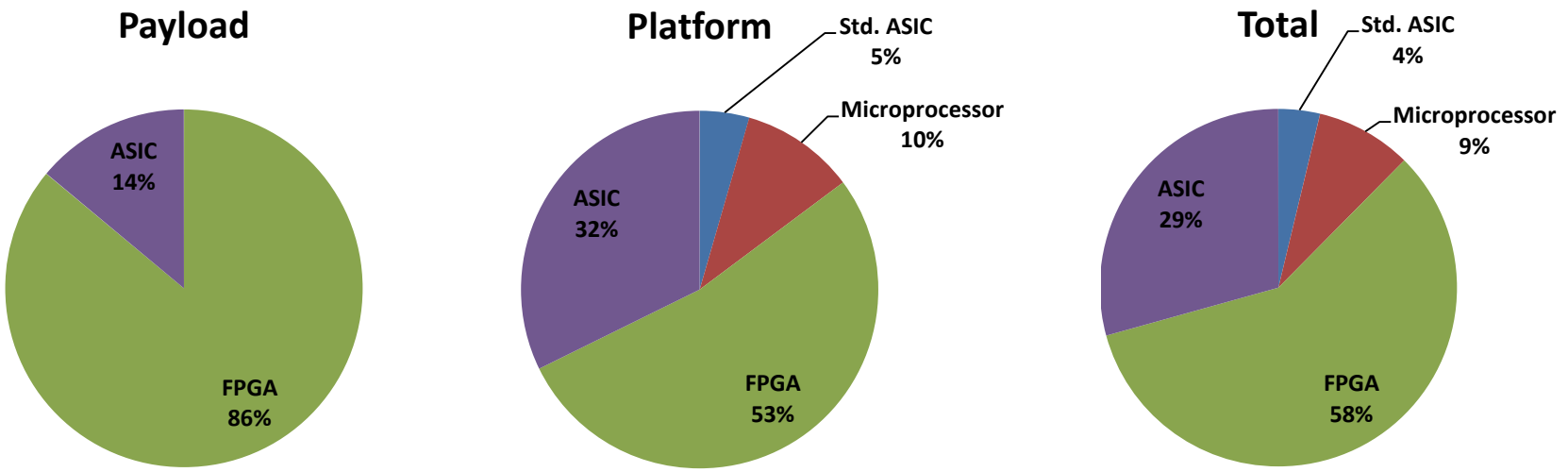
MACQUARIE University

We develop design methods for highly reliable FPGA-based digital systems in space

UNSW SYDNEY

FPGAs in Space: ESA Sentinel 2 Mission

Field Programmable Gate Arrays (FPGAs) have high performance, low power consumption, low non-recurring engineering costs and flexibility

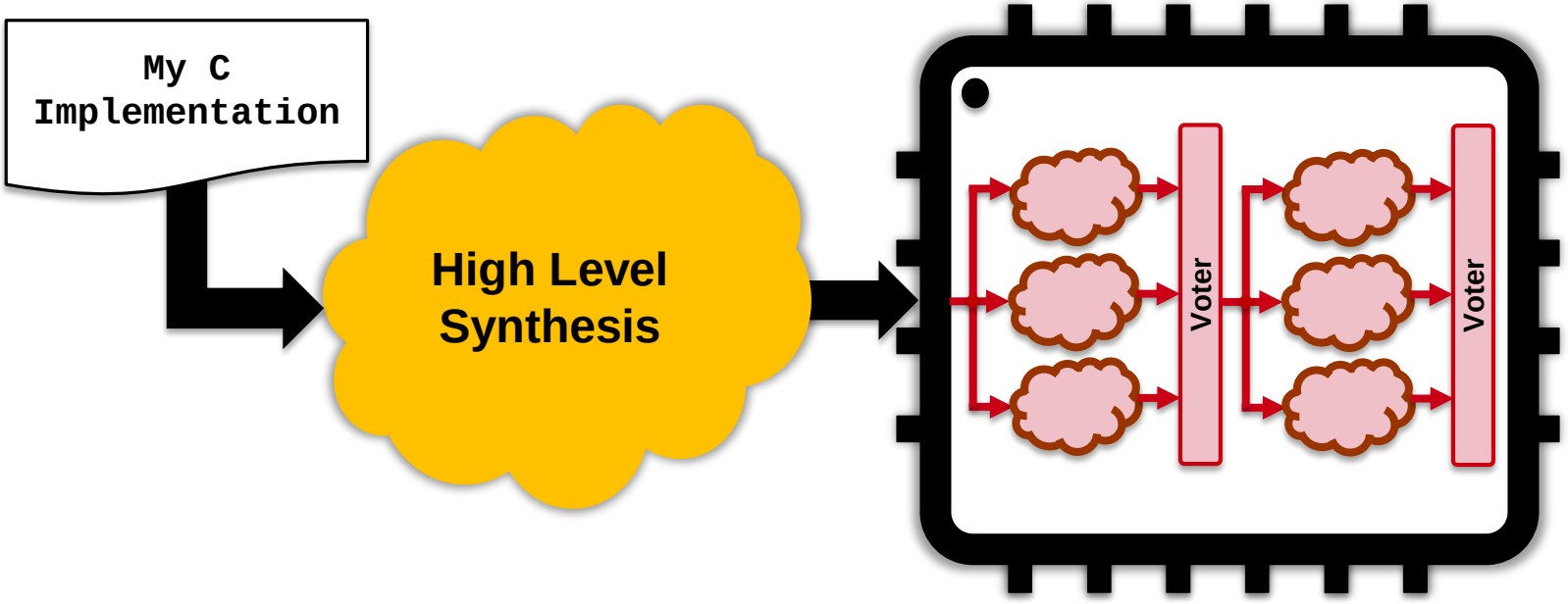


IC Type	Quantity Platform	Quantity Payload
FPGA	**118**	**37**
Custom ASIC	72	6
Microprocessor	23	0
Standard ASIC	10	0

Trends and patterns in ASIC and FPGA use in space missions and impact in technology roadmaps of the European Space Agency, Roger Boada Gardenyes, Master Thesis, T. U. Delft and ESA, 15th August 2012

From C to Fault Tolerant FPGA Implementation

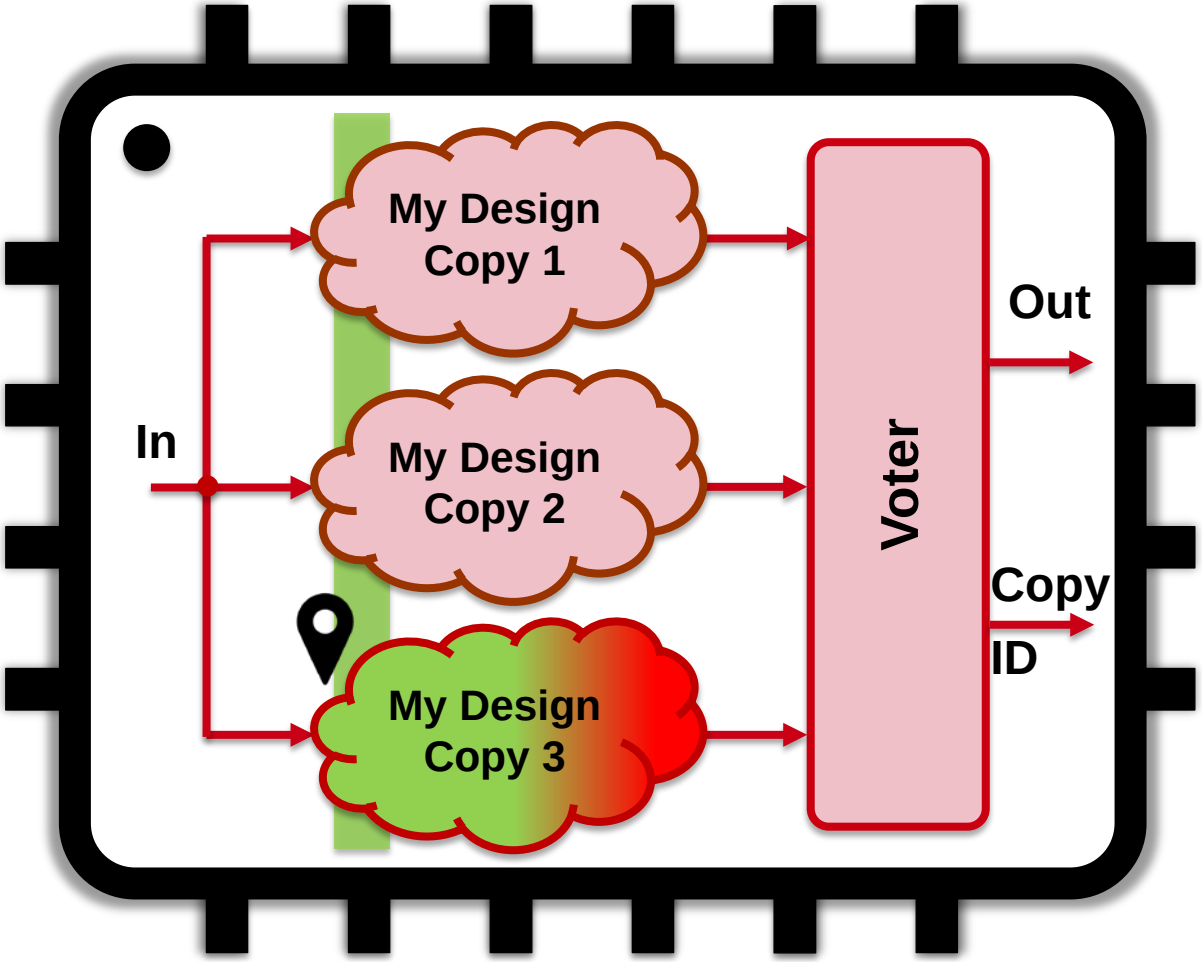
- **TLegUp** – Given high level C code, generates low level highly reliable FPGA implementations that are already triplicated and ready to deploy on FPGAs



See: Agiakatsikas *et. al*, "From C to Triple Modular Redundant Circuits - An Automated Flow", *IEEE International Symposium on Field-Programmable Custom Computing Machines* (FCCM), May 2018.

Lee *et. al*, "TLegUp: A TMR Code Generation Tool for SRAM-Based FPGA Applications Using HLS", *IEEE Symposium on Field-Programmable Custom Computing Machines* (FCCM'17), May 2017. DOI: 10.1109/FCCM.2017.57

FPGA Fabric and SEUs – Hybrid Frame and Module Based Error Recovery (FMER)



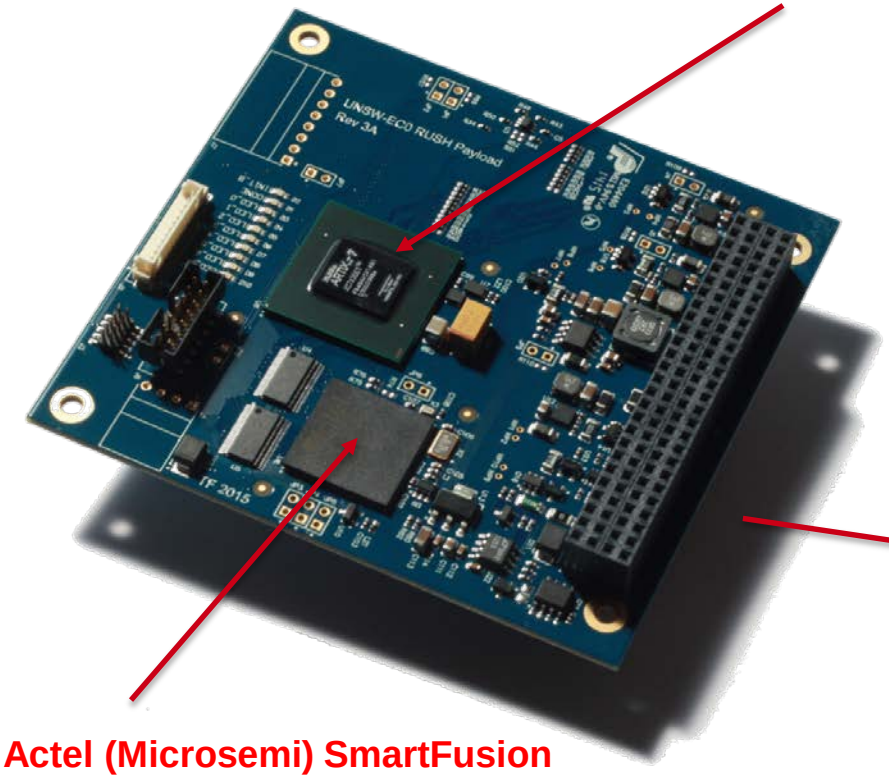
For a 2-year LEO Mission (Using 11 CHStone benchmark circuits):

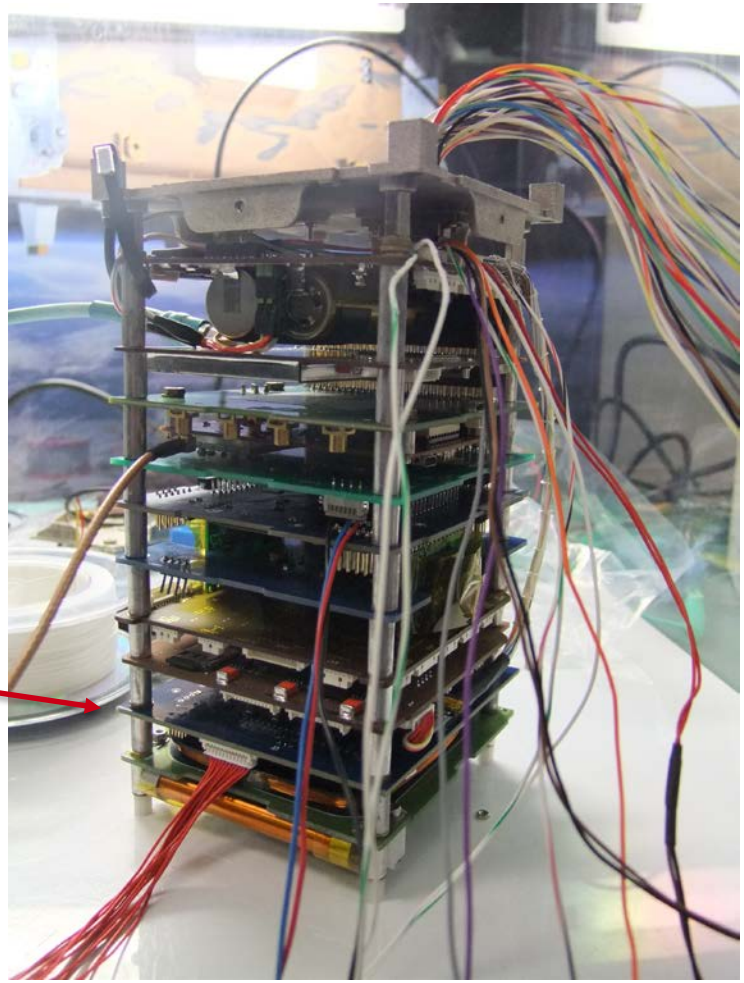
- System availability (# of 9s):
  😐 FMER (9), Scrubbing (9)
- Energy Saving (relative to Scrubbing):
  ☺ 60%

See: Agiakatsikas *et. al*, "FMER: An Energy-Efficient Error Recovery Methodology for SRAM-based FPGA Designs", *IEEE Transactions on Aerospace and Electronic Systems,* Apr. 2018. DOI: 10.1109/TAES.2018.2828201

RUSH Platform

“Rapid recovery from SEUs in reconfigurable hardware”





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Projects and Launch Plans

Sounding Rocket

Serpens-II

RUSH	RUSH	RUSH-DSP	RUSH-SDR/OBC
July 2018	Late 2018	Mid - Late 2019	Late 2019

MACQUARIE Orbital

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Exiting Times Ahead !!!!