Autonomous, On-Board Processing for Sensor Systems (A-OPSS)

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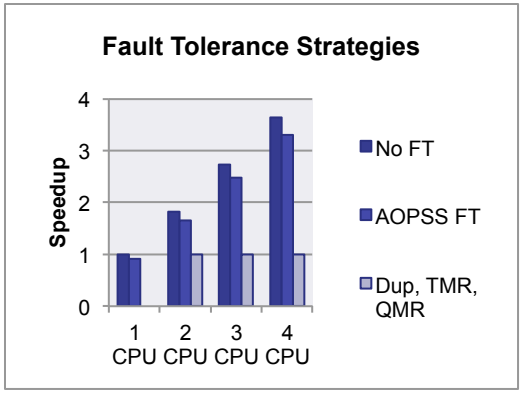
Objective

•Develop fault-tolerance processing techniques that decrease processing time by a 10-100x when integrated with current and future high performance reconfigurable processors (e.g., FPGAs). To enable:
• conducting more science experiments per day
• performing more thorough, timely analysis of captured data
• added value to most advanced FPGA-based systems such as GSFC's SpaceCube 1.0 and 2.0.
• Demonstrate autonomous on-board processing techniques that could automatically detect changes in collected data and tune the processing in a controlled manner to adapt to unforeseen events. In particular:
- demonstrate the feasibility to quickly react and adapt processing or mission objectives in real-time, by combining autonomous agents with reconfigurable computing
- Demonstrate applicability to NASA supported Earth Science missions (e.g., DESDynl, HyspIRI, GEOCAPE, and SWOT)

SpaceCube Flight Hardware



Performance Gain Using A-OPSS Software

Accomplishments

- Successfully developed, implemented, and tested a suite of Radiation Hardening by Software (RHBSW) techniques for embedded PowerPC cores within commercial grade FPGA devices
  - Eliminated processor "hangs"
  - Under worst-case HyspIRI orbit radiation conditions, mean time between data corruption events improved by 2.2X (to 1160 days)
  - Processor overhead to execute RHBSW techniques was <2%, yielding a 3.3x processing performance improvement over best-in-class rad-hardened processor
  - Validated the techniques via several laboratory software fault emulation campaigns and a laser injection campaign
- Demonstrated integration of processing algorithms with an on-board scheduler to perform autonomous reflectance conversion, atmospheric correction, cloud and flood classification. Resulting software performs at 150MPixel/sec and achieves data rate conversion from 804Mb/s to under 1Mb/s

Co-Is/Partners: Tom Flatley, NASA GSFC

TRL_{in} = 3 **TRL_{out} = 6**