High Performance Spaceflight Computing (HPSC)

NASA SPACE TECHNOLOGY MISSION DIRECTORATE – GAME-CHANGING DEVELOPMENT PROGRAM

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BACKGROUND

The NASA Need

There are important mission scenarios that today cannot be accomplished robustly and cost-effectively.

Space-based computing has not kept up with the needs of current and future NASA missions.

Government and industry are developing high-performance space-qualifiable processors.

NASA continues to have unique requirements:

- Deep space, long-duration missions
- Higher performance, smaller spacecraft and lower cost
- Onboard science data processing
- Autonomous operations for uncertain environments
- Extreme needs for low power and energy management, efficiency, fault tolerance and resilience

BENEFITS

Science Mission Applications

Enable new missions and increase science return

Benefits for Science Missions:

- Entry, Descent & Landing — Algorithms for reliable and safe landing in hazardous terrains (Terrain Relative Navigation/ Hazard Detection & Avoidance), benchmarked by Mars Program as requiring six RAD750s, can be performed easily on one multicore processor
- Small Body Proximity Operations — Similar real-time GN&C requirements, 5x less than EDL, but well beyond a RAD750
- Onboard Data Product Generation — Decrease downlink requirements for high data rate instruments by several orders of magnitude
- Science Event Detection and Response — Increase capture for dynamic, transient events from ~10% to ~75%, with <5% false positives, for increased and more timely science return

SOLUTION

Game-Changing Recommendation

Rad-hard General Purpose Multi-core

Best overall fit to application requirements

- 100-1000X performance of RAD750
- <7W power budget, scalable to <1W
- Support for a range of fault tolerance methods
- Interoperable with co-processors, e.g., DSP, FPGAs, GPUs
- Extensible — scalable to 10X number of cores

First design for a flight computing architecture that enables the operating point to be chosen dynamically

- Trade computational performance, energy management, fault tolerance, etc. continuously over different mission phases and scenarios

Costs

- NRE development costs of ~$25M consistent with real-year RAD750 costs
- First mission use costs also expected to be similar

Recurring costs may be less due to strategy of separating chip to enable multiple vendors to offer board-level solutions

INVESTMENT

NGSP/HPSC – Development Phase

Alignment and Infusion Strategy

Computational performance, efficiency, flexibility and scalability of multicore redefines general-purpose computing for space systems

REFERENCES