# Rad Hard By Software for Space Multicore Processing

**David Bueno, Eric Grobelny, Dave Campagna,**
**Dave Kessler, and Matt Clark**
**Honeywell Space Electronic Systems, Clearwater, FL**

**HPEC 2008 Workshop**
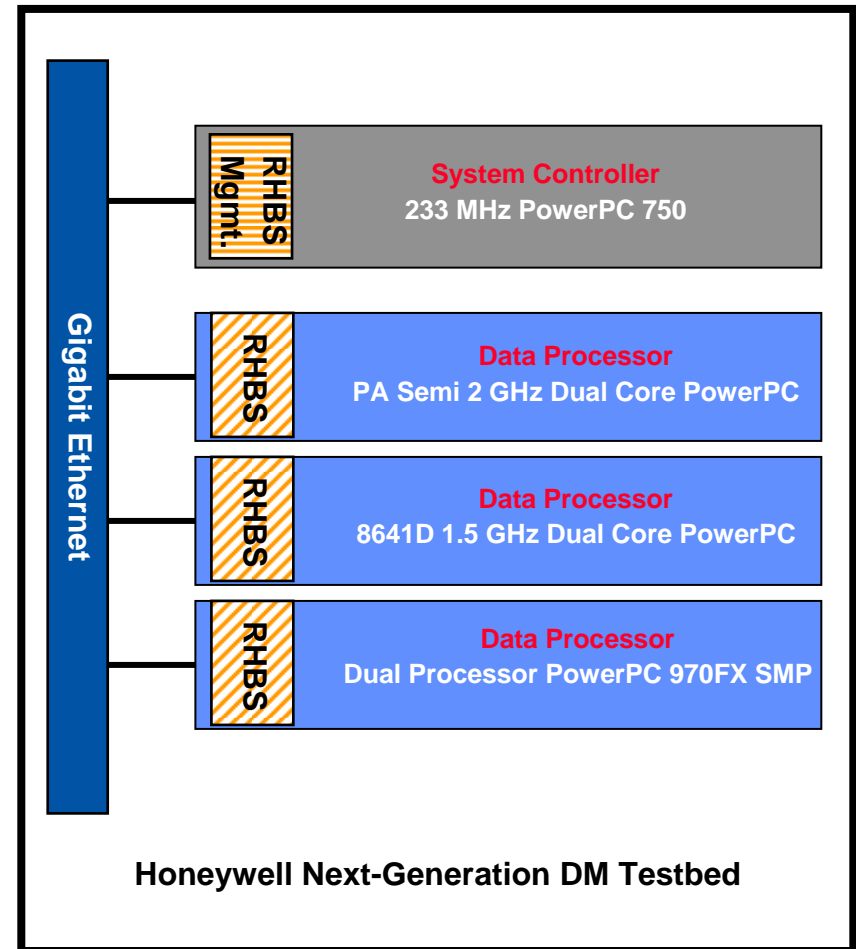**September 25, 2008**

**Honeywell**

# Why Rad Hard By Software?

- **Future payloads can be expected to require high performance data processing**

- **Traditional component hardening approaches to rad hard processing suffer several key drawbacks**
  - **Large capability gap between rad hard and COTS processors**
  - **Poor SWaP characteristics vs. processing capacity**
  - **Extremely high cost vs. processing capacity**
  - **Dissimilarity with COTS technology drives high-cost software development units**

- **Honeywell Rad Hard By Software (RHBS) approach solves these problems by moving most data processing to high performance COTS single board computers**
  - **Leading edge capability**
  - **Software fault mitigation = less hardware = reduced SWaP**
  - **Inexpensive**
  - **No difference between development and flight hardware**

# What is Rad Hard By Software?

- **Dependable Multiprocessor (DM) is Honeywell's first-generation Rad Hard By Software technology**
- **Coarse-grained software-based fault detection and recovery**
  - **Similar to the way modern communication protocols detect errors at the packet rather than the byte level**
  - **Rad Hard By Software detects errors at the "operation" rather than the instruction level**
- **Typical system**
  - **One low-performance rad-hard SBC for "cluster" monitoring and severe upset recovery**
    - ◆ **Could also serve as spacecraft control processor**
  - **One or more high-performance COTS SBCs for data processing**
    - ◆ **Connected via high-speed interconnects**
  - **One or more fault-tolerant storage/memory cards for shared memory**
  - **Dependable Multiprocessing (DM) software stack**

**Gigabit Ethernet**

| RHBS Mgmt. | **System Controller** <br> **233 MHz PowerPC 750** |
| RHBS | **Data Processor** <br> **PA Semi 2 GHz Dual Core PowerPC** |
| RHBS | **Data Processor** <br> **8641D 1.5 GHz Dual Core PowerPC** |
| RHBS | **Data Processor** <br> **Dual Processor PowerPC 970FX SMP** |

**Honeywell Next-Generation DM Testbed**

*This work applies DM to multicore/multiprocessor targets including the PA Semi PA6T-1682M, Freescale 8641D, and IBM 970FX*

# Poster Summary

- **DM provides a low-overhead approach for increasing availability and reliability of COTS hardware in space**
  - DM easily portable to most Linux-based platforms
  - 7447a processing platform selected near start of NASA/JPL ST8 program (DM), but better options now exist

- **Modern processing platforms provided impressive overall speedups for existing DM applications no additional development effort**
  - ~5-6x speedup vs. existing 7447a-based DM platform
    - Leverages optimized libraries for SIMD and multiprocessing
  - ~2-3x gain in throughput density (MFLOPS/W) vs. existing DM solution
  - ~20-40x performance of state-of-the-art rad hard by process solutions

- **Potential future work**
  - Exploration of high-speed networking technologies with DM
  - Enhancements to DM middleware for performance/availability/reliability
  - Further evaluation of future processing platforms (rad testing, etc.)

*Poster includes details on DM performance benchmarking for multiple platforms and applications*