

Dependable Multiprocessor (DM) Support for Diverse and Heterogeneous Processing

Précis Presentation

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DM: A COTS-Based High-Performance Payload Cluster Computing Platform

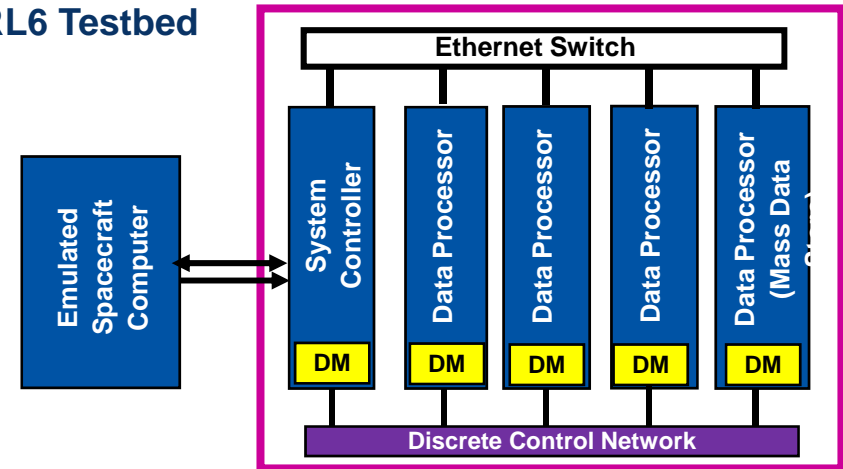
What is DM?

- A high-performance, COTS-based, fault tolerant cluster onboard processing system that can operate in a natural space radiation environment
- High throughput density (>300 MOPS/watt), scalable & software based
- High system availability >0.995
- High probability of timely and correct delivery of data >0.995
- Technology independent system software that manages cluster of high performance COTS processing elements
- Technology independent system software that enhances radiation upset tolerance

Why is DM important?

- Flying high-performance COTS in space is a long-held NASA and DoD objective
- DM is bringing this objective closer to reality
- Enables heretofore unrealizable levels of onboard data and autonomy processing
- Enables faster, more efficient application development
- Enables users to port applications directly from laboratory to space environment
- DM is a significant paradigm shift
 - provides ~ 10X – 100X throughput density available with current RHBP & software-based RHBD processing at much lower cost
 - software-based technology allows space to keep pace with COTS

TRL6 Testbed



Status?

- NASA NMP ST8 has invested >\$12M in the development and demonstration of DM technology through TRL6
- Demonstrated DM predictive Availability, “Computational Consistency,” and Performance models
- Demonstrated ability to meet NASA Level 1 requirements/goals
- Successfully completed system-level radiation testing
- DM project has further developed, refined and demonstrated the process for migrating COTS high performance computing to space
- DM technology has been demonstrated on wide variety of platforms
- DM technology is applicable to wide range of missions
- Seeking a ride to space to achieve TRL7

DM TRL6 Testbed System

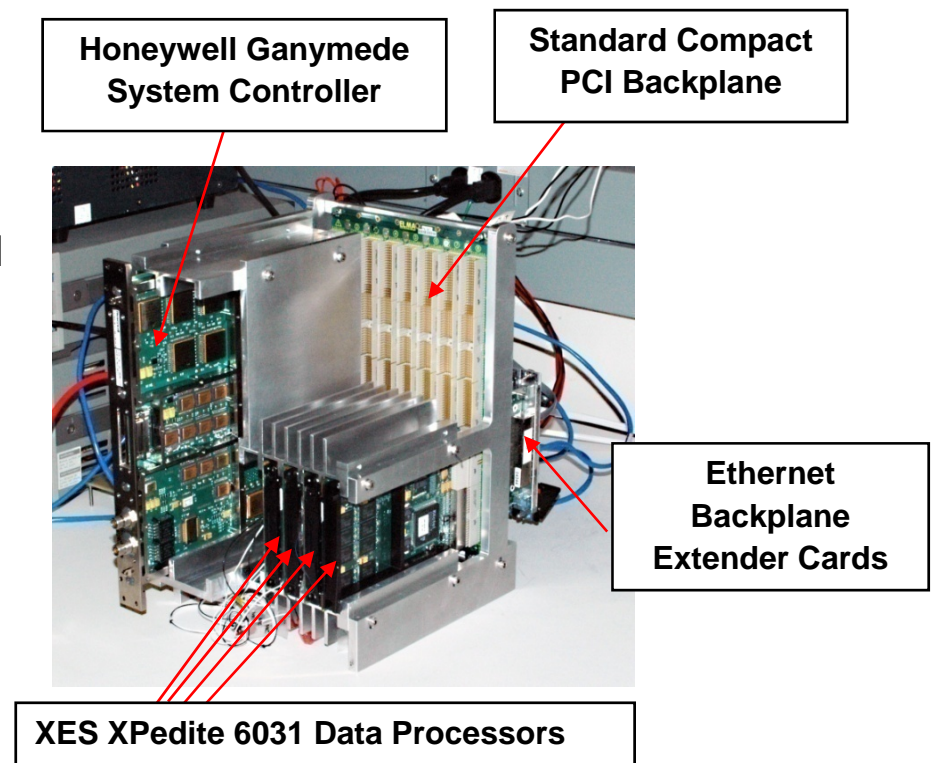
- **TRL6 Testbed Configuration**

- **System Controller (SC)**
 - Honeywell Ganymede (PPC603e)
 - VxWorks 5.5
- **4x Data Processing Nodes (DP)**
 - XES XPedite 6031 (PPC7447a @ 800MHz with AltiVec) ruggedized, conductively-cooled COTS SBCs
 - Wind River PNE-LE CGL 1.4 (Kernel 2.6.14)
 - 1 DP emulates rad-hard “mass memory” device
- **100BaseT Ethernet Network**
- **Spacecraft Communication Interface over RS422 on SC**
- **Dependable Multiprocessor Middleware (DMM)**

- **Critical Design Review**

- **ruggedized, conductively-cooled, COTS boards can fly in space**

DM TRL6 Testbed



The Next Steps in Diversity and Heterogeneity

- **To enhance DM's diversity and heterogeneity, efforts are being made in the following areas:**
 - **Hardware**
 - **Additional COTS (SOI) processing architectures with path to space for improved throughput density**
 - **Additional high-speed interconnects with path to space for improved bandwidth, reliability, fault tolerance**
 - **Software**
 - **Additional POSIX compliant operating systems to expand supported data-processing platforms**
 - **Newer versions of VxWorks (6.x)**
 - **Wider variants of Linux (e.g., linux-rt)**
 - **Non-monolithic kernels (e.g., QNX)**
 - **Add support for Open MPI to expand the types of user applications that can be transparently migrated to DM environment**
 - **Upgrade current HAM software foundation to a Service Availability™ Forum (SAF) compliant suite**

Summary & Conclusion

- DM is as an architecture and methodology that enables COTS-based, high performance, scalable, multi-computer systems, and accommodates future technology upgrades (HW & SW)
- DM can rapidly incorporate new techniques/technologies to overcome performance gaps with regards to throughput, power, mass and cost
- **DM technology is platform-agnostic middleware**
- **DM is a significant paradigm shift**
 - for applications that only need to be radiation tolerant, DM can provide 10x-100x throughput density (MOPS/watt) over current software programmable RHBP & RHBD processing capability with reduced cost, risk, and schedule
 - software-based technology allows space to keep pace with COTS
- **DM technology enables more onboard processing, faster onboard processing, faster frame processing, lower downlink bandwidth, and data/information direct to the war fighter**
- DM was developed by NASA as flight project
 - extensive ground testing
 - predictive models
 - ready to fly