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

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 Technology is Ready for a Flight Experiment
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

- Honeywell Ganymede System Controller
- Standard Compact PCI Backplane
- Ethernet Backplane Extender Cards
- XES XPedite 6031 Data Processors

DM is the path to space; DMM & COTS processors ready for flight experiment
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 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.

DM technology can take COTS to space; ready to support a flight experiment.