Dependable Multiprocessing with the Cell Broadband Engine

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HPEC 2007 Workshop
September 20, 2007
Dependable Multiprocessor Technology

- Desire - -> ‘Fly high performance COTS multiprocessors in space’
  - To satisfy the long-held desire to put the power of today’s PCs and supercomputers in space, three key issues, SEUs, cooling, & power efficiency, need to be overcome

  - Single Event Upset (SEU): Radiation induces transient faults in COTS hardware causing erratic performance and confusing COTS software
    
    DM Solution
    - robust control of cluster
    - enhanced, SW-based, SEU-tolerance

  - Cooling: Air flow is generally used to cool high performance COTS multiprocessors, but there is no air in space
    
    DM Solution
    - tapped the airborne-conductively-cooled market

  - Power Efficiency: COTS only employs power efficiency for compact mobile computing, not for scalable multiprocessing
    
    DM Solution
    - tapped the high performance density mobile market

This work extends DM to the Cell Broadband Engine and PowerPC 970FX cluster in Honeywell’s Payload Processing Lab
Cell Processor Development System (CPDS) and 970FX Cluster DM Configuration

- System Controller node mimics functionality of rad hard SBC in flight system
- Data Processors are heterogeneous mix of 970FX and CPDS
- DM runs on Cell PPE, doesn’t need to know about Cell SPEs
  - Perfect fit for Cell/PPE, since PPE typically dedicated to management tasks, and usually has compute cycles to spare for tasks related to DMM

(SC)=System Controller  (DS)=Data Store  (DP)=Data Processor

Gigabit Ethernet
Poster Summary

• DM provides a low-overhead approach for increasing availability and reliability of COTS hardware in space
  - DM easily portable to any Linux-based platform, even on an exotic architecture such as Cell
  - DM well-suited to Cell PPE, which is used primarily as a management processor for most Cell applications
  - Future Cell platforms expected to improve power consumption and will be aided in advances in cooling technology

• Cell provided impressive overall speedups in UF SAR benchmark with low development effort
  - But, much higher speedups for sections of code that primarily leverage existing optimized libraries

• Future Work
  - Augment DM to provide enhanced, Cell-specific functionality
    - Spatial replication across SPEs

Poster Includes Details on DM/Cell Performance Benchmarking with SAR Application