Quest-V – A Virtualized Multikernel for High-Confidence Systems

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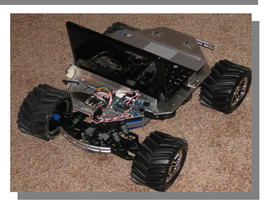
BOSS
BU Operating Systems and Services

Objective

- Operating system for high-confidence systems (NCO/NITRD):
  - Predictable
  - Resistant to component failures & malicious manipulation
- Self-healing system
  - Online recovery of software component failures
  - Avoid impact on other functional components

Applications

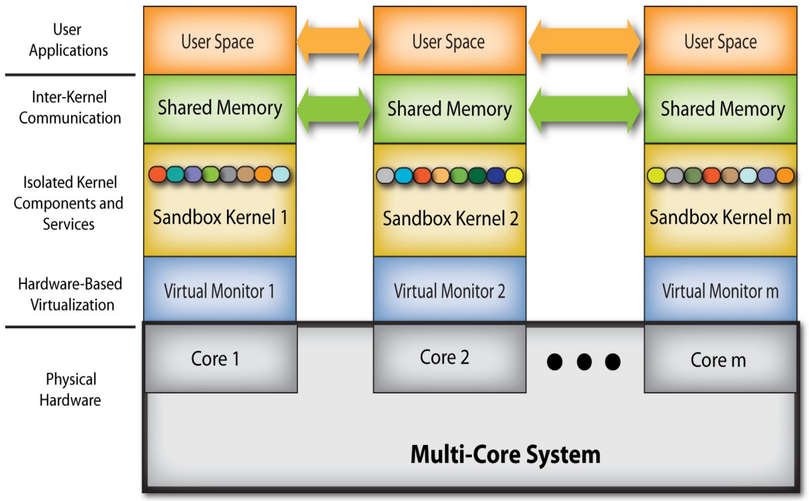
- Healthcare
- Avionics
- Automotive
- Factory Automation
- Robotics
- Space exploration
- Other safety-critical domains



Approach

- Quest-V for multicore processors
  - Distributed system on a chip
  - Time as a first-class resource
  - Sandboxes sub-components using hardware-assisted memory virtualization (e.g., Intel EPTs)

Architecture Overview



Isolation

- Memory virtualization using shadow paging isolates sandboxes and their components
- Dedicated physical cores assigned to sandboxes

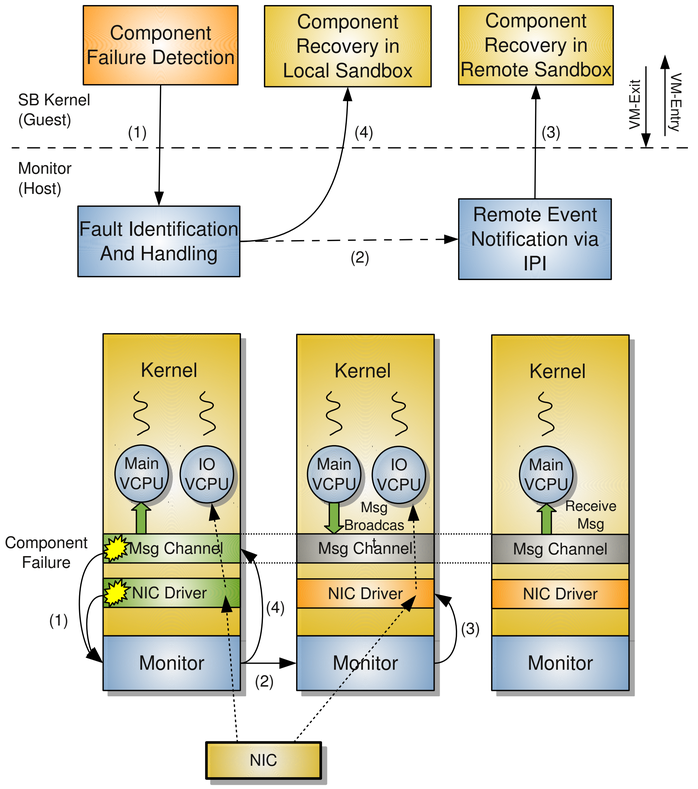
Predictability

- Virtual CPUs for time budgeted real-time execution of threads and system events (e.g., interrupts)
- Sandbox kernels perform local scheduling on assigned cores
  - Avoid VM-Exits to Monitor – eliminate cache/TLB flushes

Efficiency

- Lightweight I/O virtualization for shared physical devices
  - e.g., VNICs implemented as separate interfaces to single NIC device
- Hardware performance monitoring for improved efficiency

Example Fault Recovery



Fault Recovery

- Inter-Processor Interrupts (IPIs) for inter-sandbox communication and remote recovery of faulty components

Quest Website

- http://www.cs.bu.edu/~richwest/quest.html