ROS

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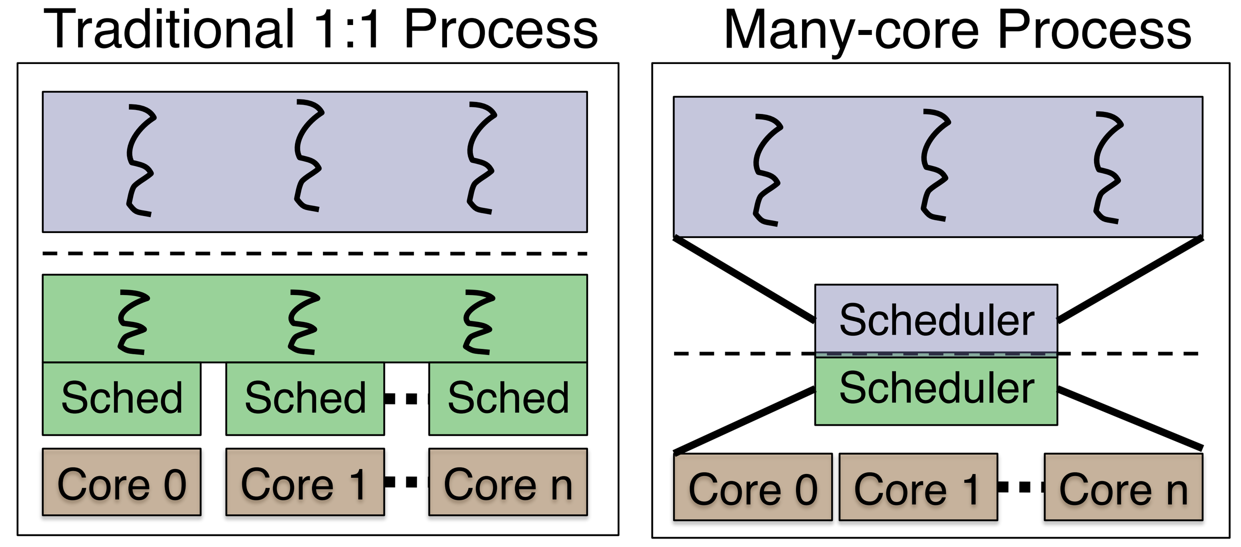
A Scalable Operating System For Parallel Applications On Many-core Architectures

Design

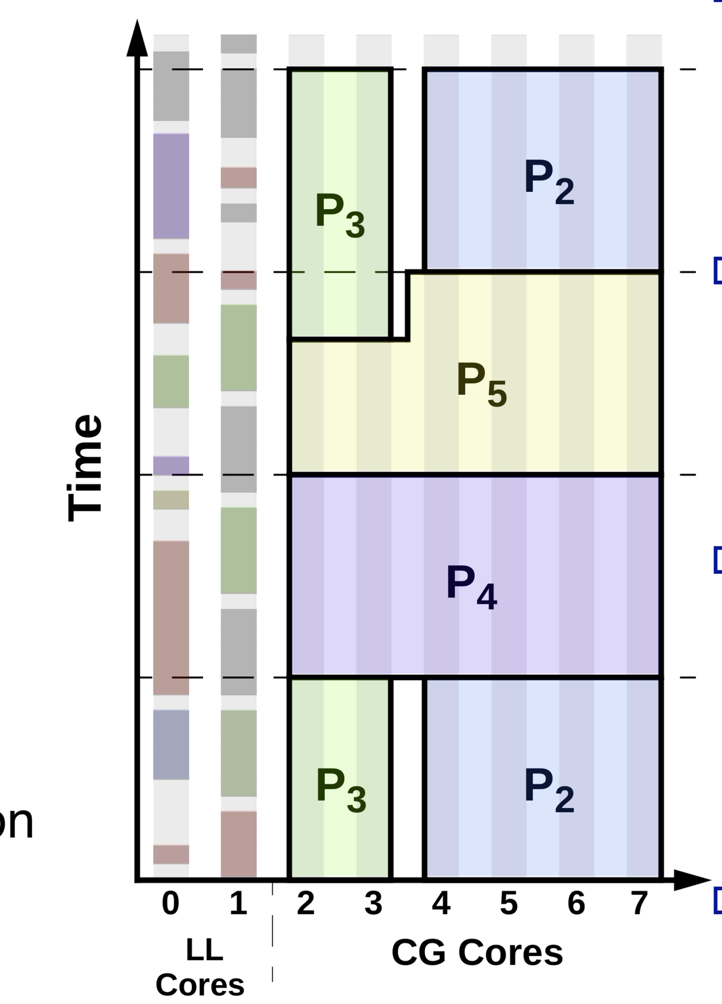
- GOAL: Explicitly support parallel applications while improving kernel scalability
- Many-core Process (MCP)
  - No longer a single thread in a virtual processor
  - Multiple cores 'owned' by a single process
  - All cores gang scheduled
  - Information exposed up, requests sent down
- Asymmetric Use of Cores
  - Low-Latency vs. Coarse-Grained Cores
  - Asynchronous Remote Calls (ARCs)
  - Kernel control path on a limited number of cores
- Resource Provisioning
  - Provisions setup before allocation takes place
  - Increases isolation between processes
  - Enables predictable application performance
  - Allows the system to utilize unused resources

Many-Core Process



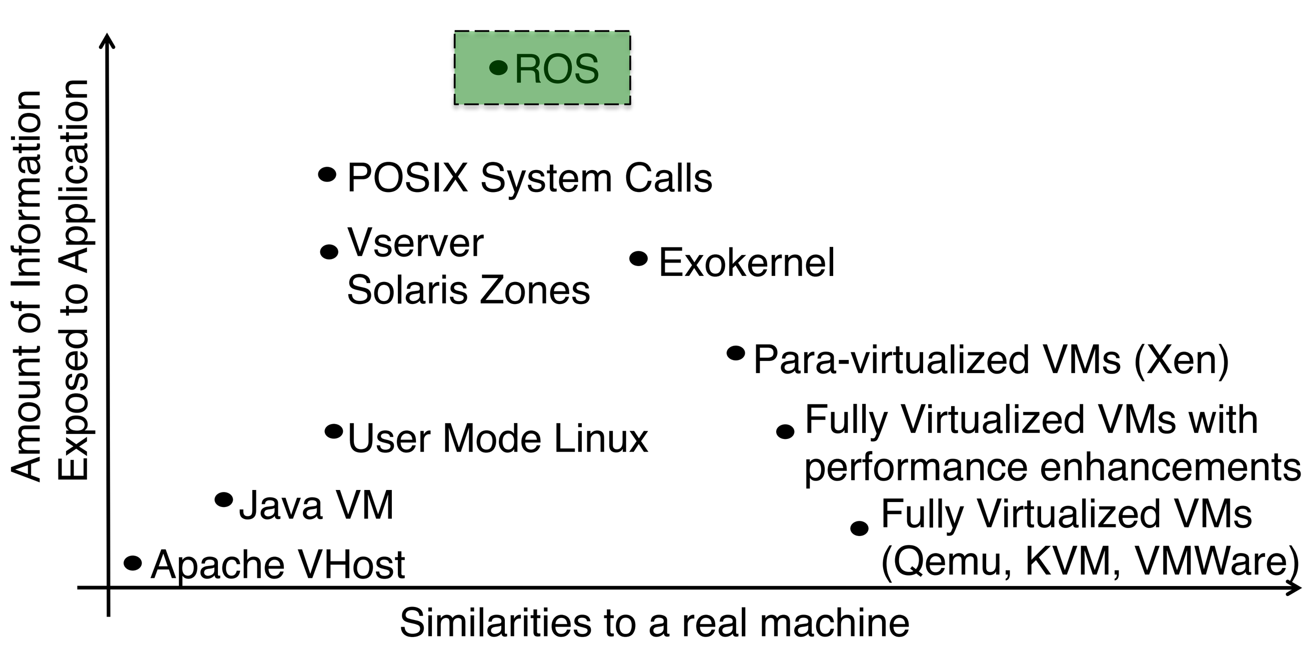
- More scalable than traditional process models
  - No mapping of user-level threads to kernel threads (the kernel is completely event-based)
  - No per-core run queues
- Provides richer set of resource guarantees to processes
  - Expose more information about system resource utilization
  - MCPs make explicit requests for those resources
- All cores granted to an MCP are gang scheduled
- No unexpected interrupts or blocking system calls (ARCs)

Asymmetric Use of Cores

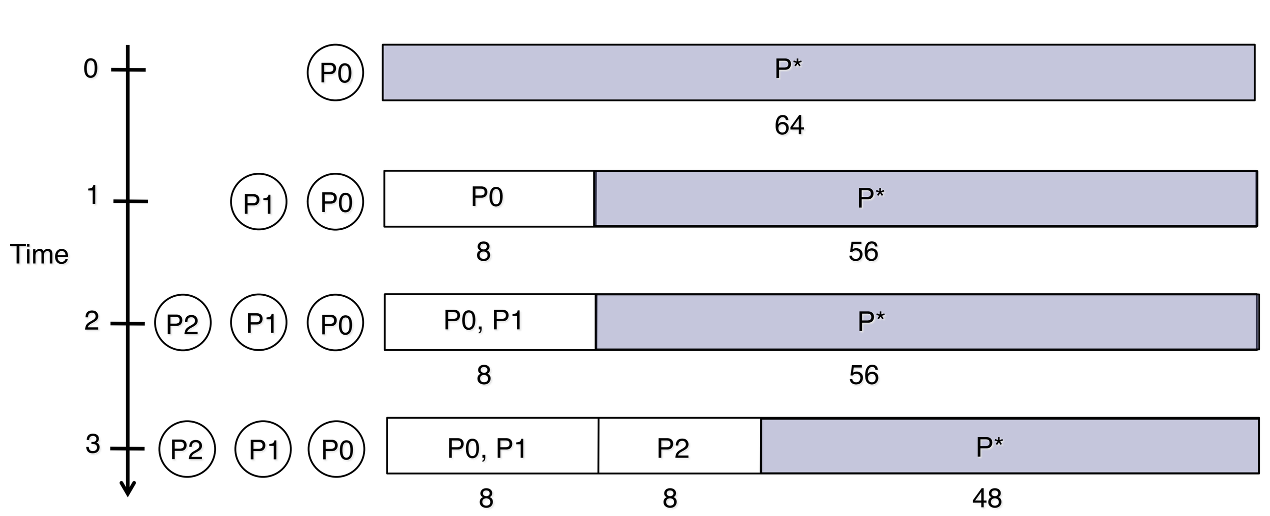


- Coarse-Grained Cores
  - Used for parallel computations requiring predictable performance
  - Time-sliced at coarse-granularity
  - Granted to apps running as MCPs
- Low-Latency Cores
  - Handle time-critical events out of band
  - Always runnable, not gang-scheduled
  - Time-sliced at fine-granularity
  - Examples: UI events, TCP ACKs, etc.
- Asynchronous Remote Calls (ARCs)
  - System calls serviced asynchronously on Low Latency Cores
  - Increase per core cache locality
  - Decrease cross core lock contention
  - Limit kernel interference with apps
- Small set of cores control the system
  - Manages what processes run where
  - No need for per core run queues

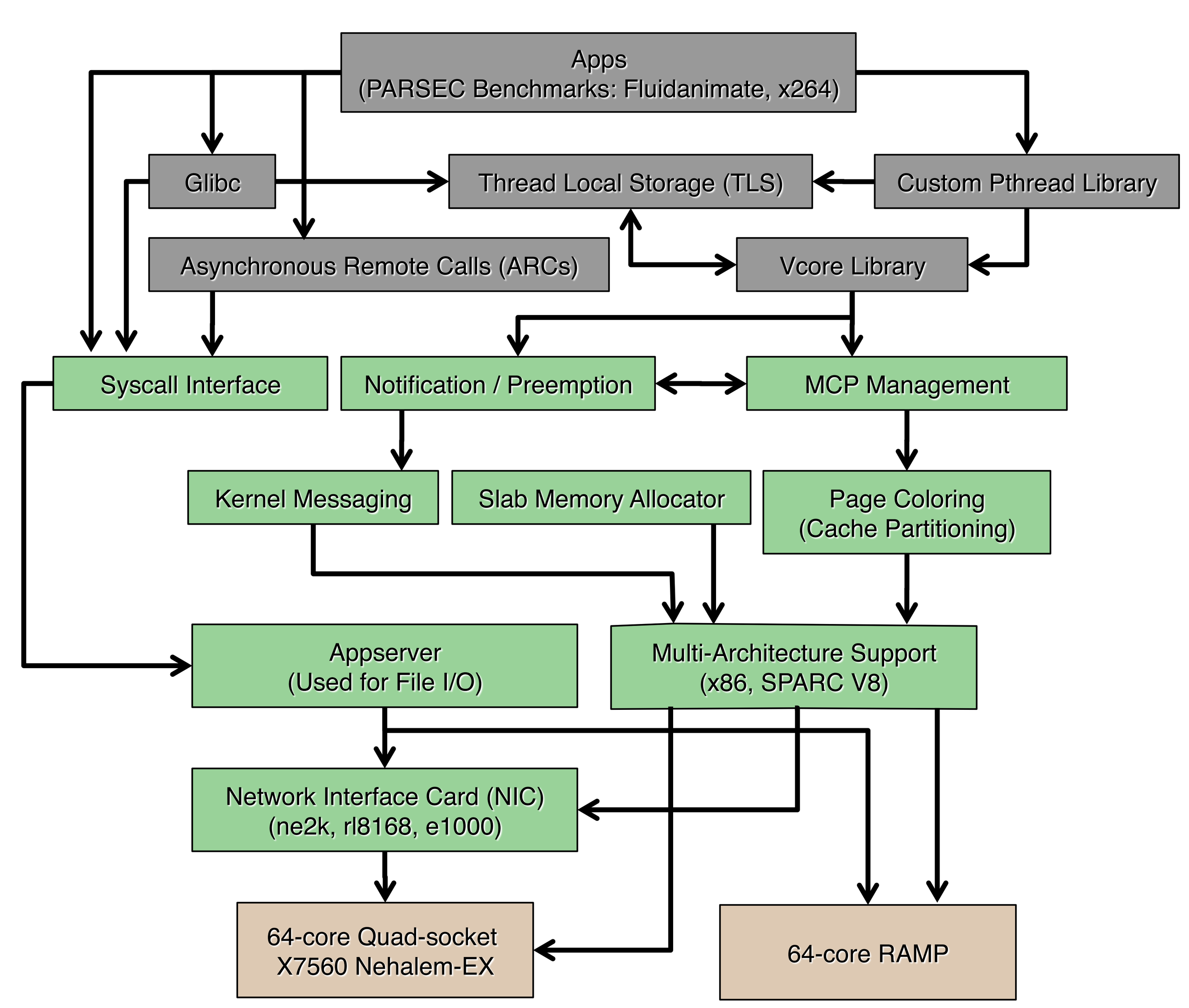
Resource Provisioning



- Resources **provisioned** to MCPs based on future needs
- Resources **allocated** to MCPs based on immediate needs
- Processes scheduled based on meeting resource guarantees (QoS)
- Resource guarantees enforced either in hardware or in software



Current Implementation



Preliminary Results