An Operating System for Multicore and Clouds

Mechanisms and Implementataion

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SOCC 2010

Problem Statement

- Traditional OS doesn't scale well
- Current IaaS push complexity to the user (Management of VMs)
- Need for a redesigned OS to scale - effectively harness unprecedented computational power potentially provided by clouds and multi-core processors

Challenges

- Heterogeneity: Current OS requires same ISA for all cores
- Scalability: Locks, locality aliasing reliance on shared memory
- Variability of Demand: Active number of live cores instead (Space partitioning instead of time partitioning)
- Faults: Hardware (Including Performance Impact from other entities) & Software (due to programming complexity).
- Programming challenges: Lock-based code, Resource management to be done by the cloud

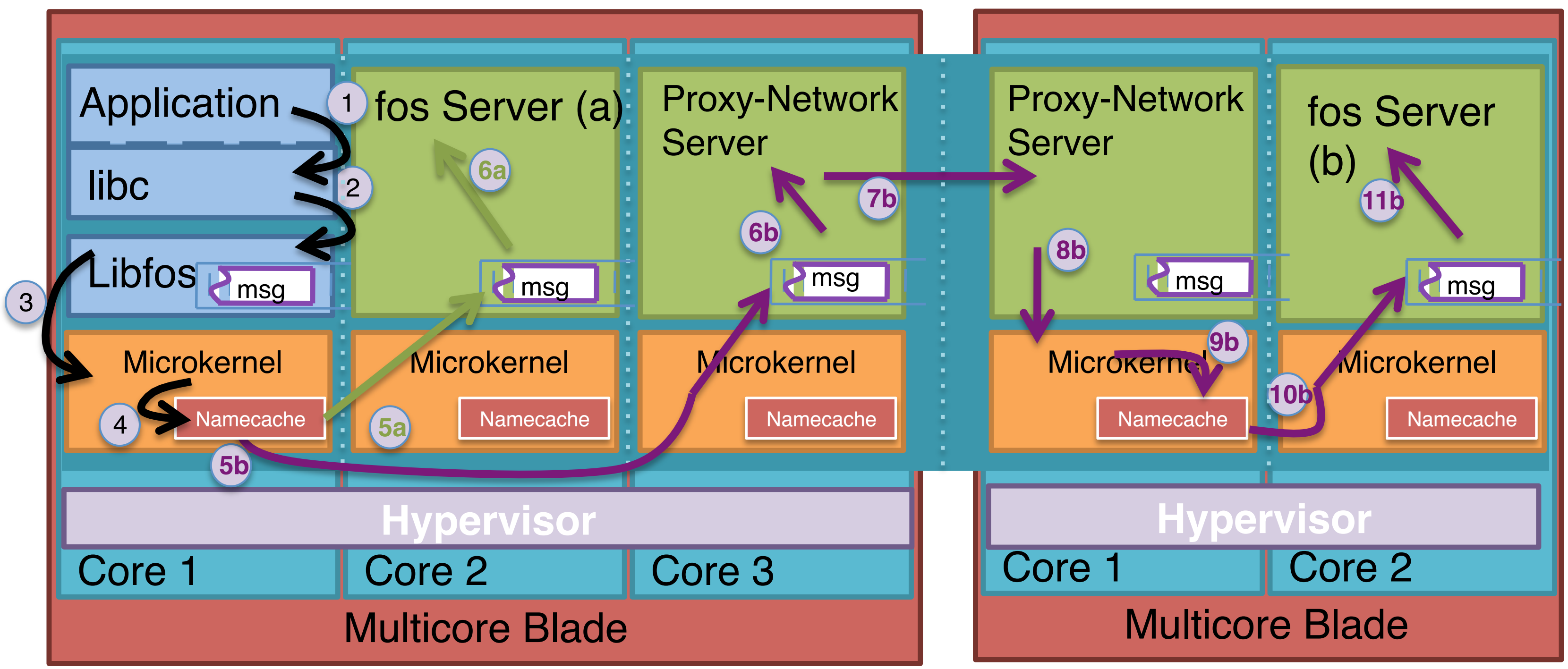
fos – Factored Operating System

- Single System Image across the cores
- MircroKernel, most of OS services provided in user space
- Function-specific services – Each one is distributed, e.g. File System services, paging service.
- Message passing – common communication primitive, across cores within the same machine and across machines

Advantages

- Ease of administration – OS Updates etc
- Transparent sharing – paging across the cloud? How efficient?
- Informed optimizations, OS has low-level knowledge, One system image
- Consistent view – load balancing, process migration
- Fault tolerance – global view

Architecture



Architecture

- Small microkernel on each core, to provide basic messaging between applications and servers, *capabilities* to restrict access into the microkernel
- Space partitioning - Belief that there will soon be a time where the number of cores in the system exceeds the number of active processes
- Name mapping kept by distributed set of proxy-network servers (Cached by each microkernel) – Leveraging P2P solutions, WIP
- Applications communicate through libfos to interact with OS services

Messaging

- Basic communication primitive
- Operating system services also implemented using messaging, need to communicate with the servers
- Messaging medium can be network or shared memory
- Intra – machine communication uses shared memory
- Across the cloud, shared memory is first used to send messages to the local proxy server which then uses the network

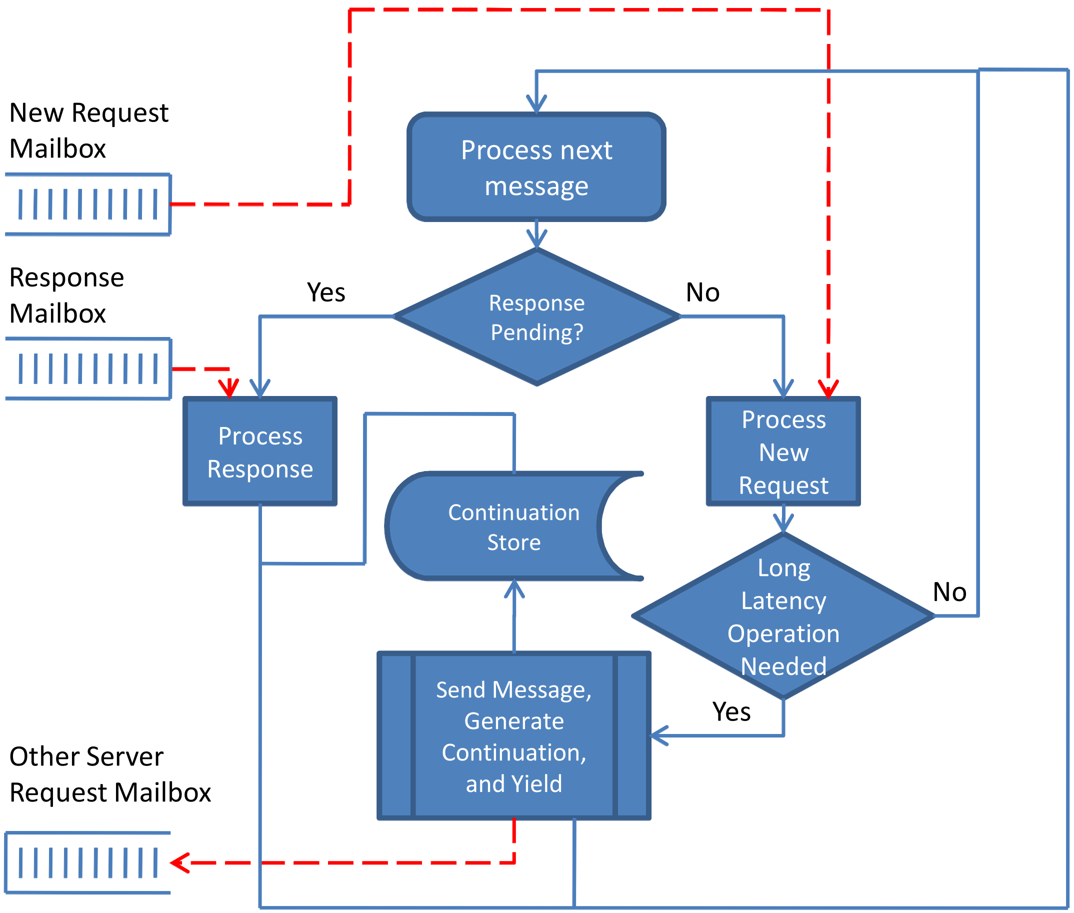
Naming

- Processes register a particular name for a mailbox
- OS service provided by several independent processes, these form a fleet, Nameserver picks a member of the fleet on receiving a request
- How this is cached, consistency etc. still in works – needs to be extremely low latency but still maintain consistent and global view of namespace

OS Services

- Fleet of servers – each service implemented as a set of processes
- File System Fleet, naming fleet, scheduling fleet, paging fleet etc.
- Uses a server model – RPC semantics (Requires serialization / deserialization primitives)
- Parallel data structures – managing the state of the service among members

Main Loop of a server



File System as a Service

- Application client, fos file system server and block device driver server – (may) execute on separate cores
- fos intercepts file system call, and sends it to the file system server (requires name server lookup)
- File system server communicates with the block device driver server to provide Disk I/O Operations and access to the physical link.

Discussion

- Is this the OS that the Datacenter needs?
  - Resource Sharing, Data Sharing
  - Programming abstraction?

- Provisioning at the granularity of VMs – not at the level of cores. Is the Hypervisor necessary? (NO). Can the single system image OS itself provide required isolation?

Discussion

- Tessellation also exploits the idea of Space-Time partitioning but designed for many-cores only. Can this scale? Seems to target multi-core systems with more emphasis on performance prediction. Hardware support?

- Microkernel vs. Multikernel (Barrelfish)
  - Make inter-core communication explicit (No single abstraction)
  - State is replicated instead of shared

Multikernel

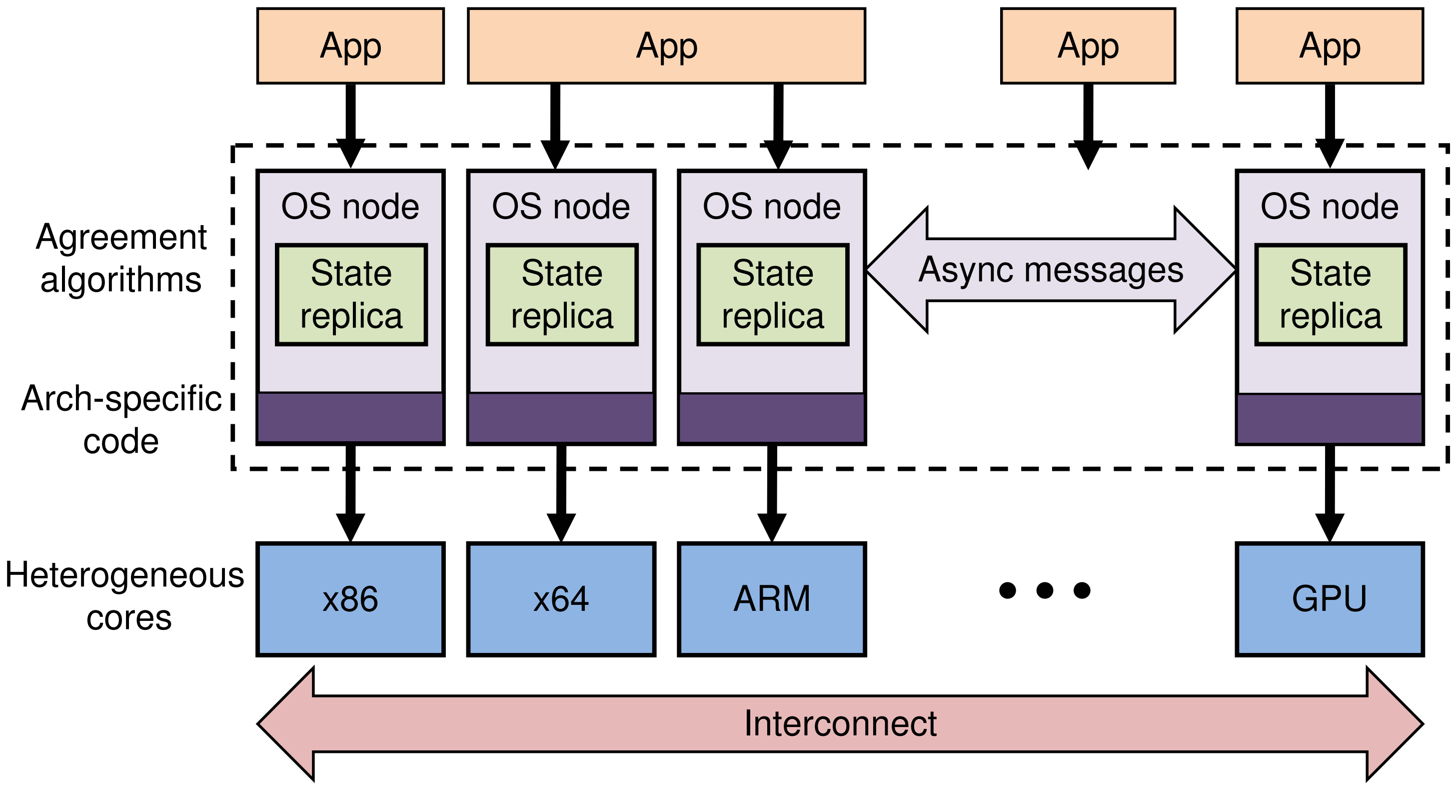


Figure 1: The multikernel model.

Discussion

- Per – Node efficiency?
  - Is efficiency really not a concern? Paging across the cloud?
  - Akaros – Many core processes (MCP) – gang scheduled
  - Present applications with finer details of the resources they are allocated (or provisioned)
  - Incremental – Data-intensive / processing intensive nodes to run Akaros while others can run general purpose OS

Thanks!

- Gautam