

OASIS

ENERGY PROPORTIONALITY WITH HYBRID SERVER CONSOLIDATION



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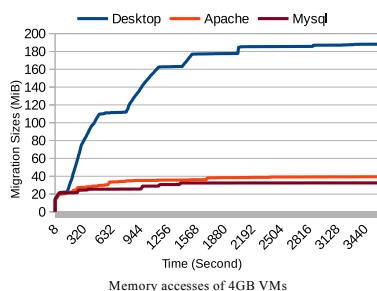
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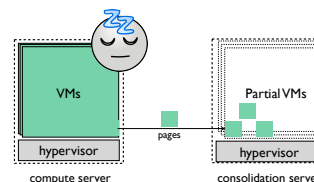
Data Center Utilization

- Cloud data centers operate with low utilization
- Idle servers running always-on applications
- Elasticsearch, ZooKeeper, Hadoop, HA cluster nodes send periodic heartbeat messages
- Cannot simply turn off servers
- Idle servers use fraction of their memory

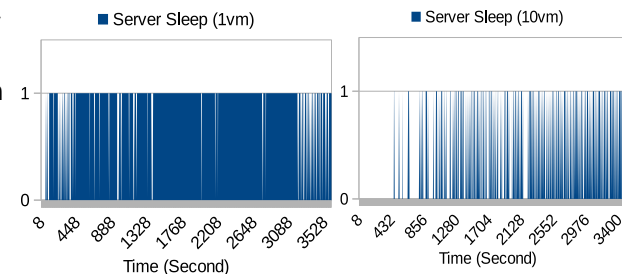


Partial VM Migration

- High density VM consolidation by migrating only the working sets of idle VMs
- On-demand migration of partial VM pages from compute to consolidation server
- Compute server sleeps when all of its VMs are consolidated and inactive
- Compute server wakes up to service page requests



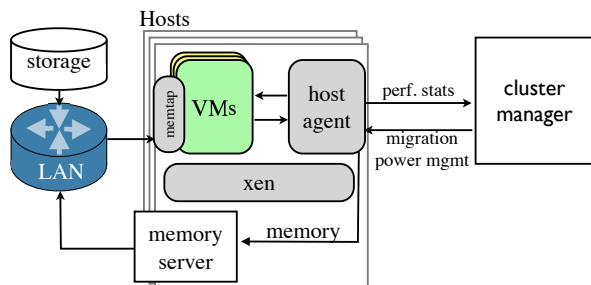
Server Sleep Opportunities



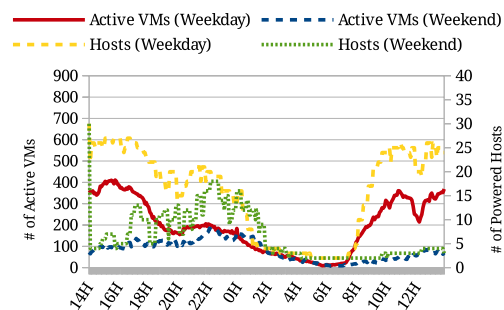
- Single VM hosts have long sleep periods
- Hosts of co-located VMs must respond to page requests more often
- Compute server cannot sleep if any of its VMs is active

Hybrid Server Consolidation

- Combines partial VM migration with full VM migration for dense VM consolidation
- Low-power memory server services page requests while compute server sleeps

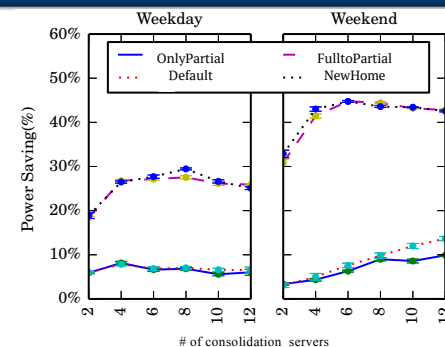


Energy Proportionality



- Powered hosts closely follow # of active VMs

Energy Savings



- 28-43% energy savings with 4 or more consolidation servers (needed for 900 VMs)