Elasticizing the Linux Operating System for the Cloud

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Why aren’t Operating Systems more Elastic in a Cloud Era?

• $E = Elastic$ in EC², i.e. Elastic Compute Cloud

• OSs typically compiled for static set of hardware
  – i.e. a single multi-core computer

• How do applications scale today?
  – MPI, Map-reduce, … - need resources to do this
  – Fork/replicate multiple VMs/containers, …
    • refactor to synchronize
    • Build scripts to trigger scaling
ElasticOS: Let the OS Scale (underneath) the Application

• Improve programmability by letting (Linux) OS dynamically expand and contract across many rack machines as needed [HotOS 2013]
• Apps automatically scale without refactoring
ElasticOS: Shard/Stretch Virtual Memory Across Many Machines

• **Stretch/shard** a single process’ address space across many rack machines [HotOS 2013]
  – Need *elastic page table* to locate page

• Stretching triggered by local thrashing
ElasticOS: Pulling, Pushing, Jumping

- Thread needing a page can
  - Pull it
  - Jump to it if too many pulls (go towards locality)
- If out of space, evict/push pages using LRU
How Elastic OS Differs from DSM

- DSM:
  - Write Consistency
  - Not Scalable!
  - Shared data

- ElasticOS sharding & jumping:
  - One copy of shared data
  - Thread 2 jumps to Host 1 to access same data!
How ElasticOS Differs from SSI

- Traditional Single System Image (SSI) OSs
  - Kerrighed, MOSIX, LinuxPMI, etc.
- Common characteristics of SSI implementations:
  - Process migration
  - Distributed Shared Memory
- In process migration, a process can move but doesn’t expand beyond a single machine
  - Couldn’t *stretch* a process over many machines, e.g. large in-memory DB
ElasticOS: Status

• High risk high reward research
• Modifying Linux 2.6.38 kernel to implement stretching, jumping, pulling and pushing
  – Stretching is implemented
  – Jumping in one direction is implemented
  – Pulling and pushing is still under construction
• Examining locality of applications in a simpler model
  – Knowing when to jump, pull and push depends on locality of application
  – A single NUMA cache-coherent multi-core domain with different delays to different memory banks
Thanks

Feedback welcome!

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