Elasticizing the Linux Operating System for the Cloud

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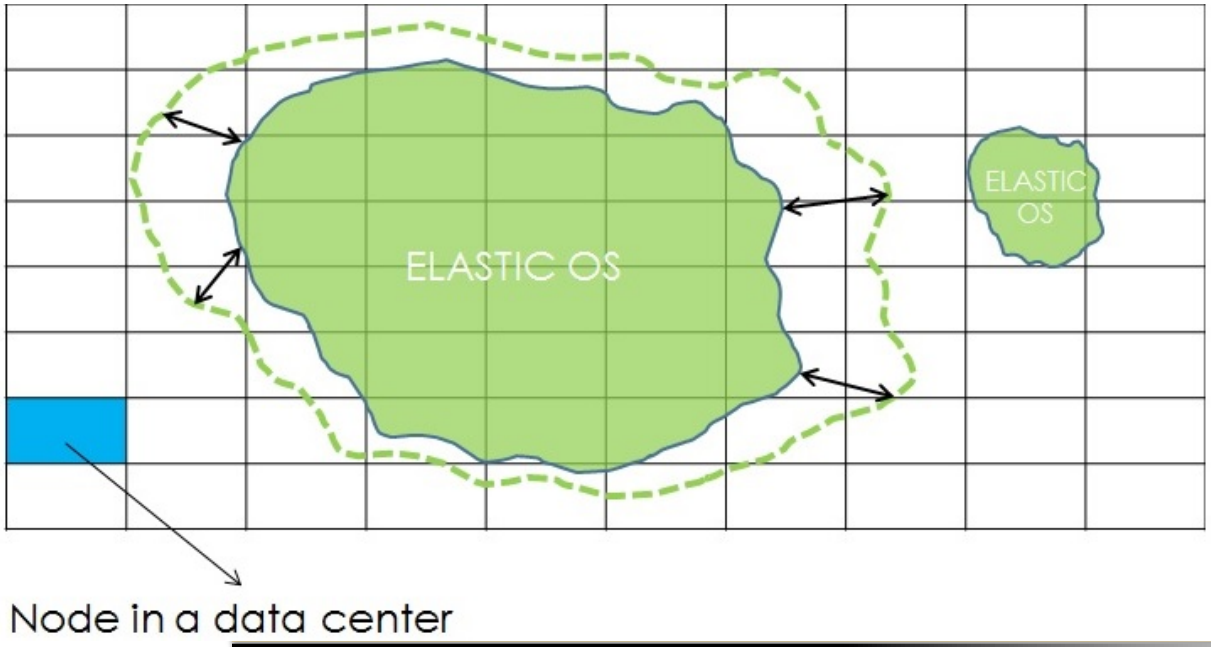
Why aren't Operating Systems more Elastic in a Cloud Era?

- *E* = *Elastic* in EC^2, i.e. *Elastic* Compute Cloud
- OSs typically compiled for static set of hardware
  - i.e. a single multi-core computer

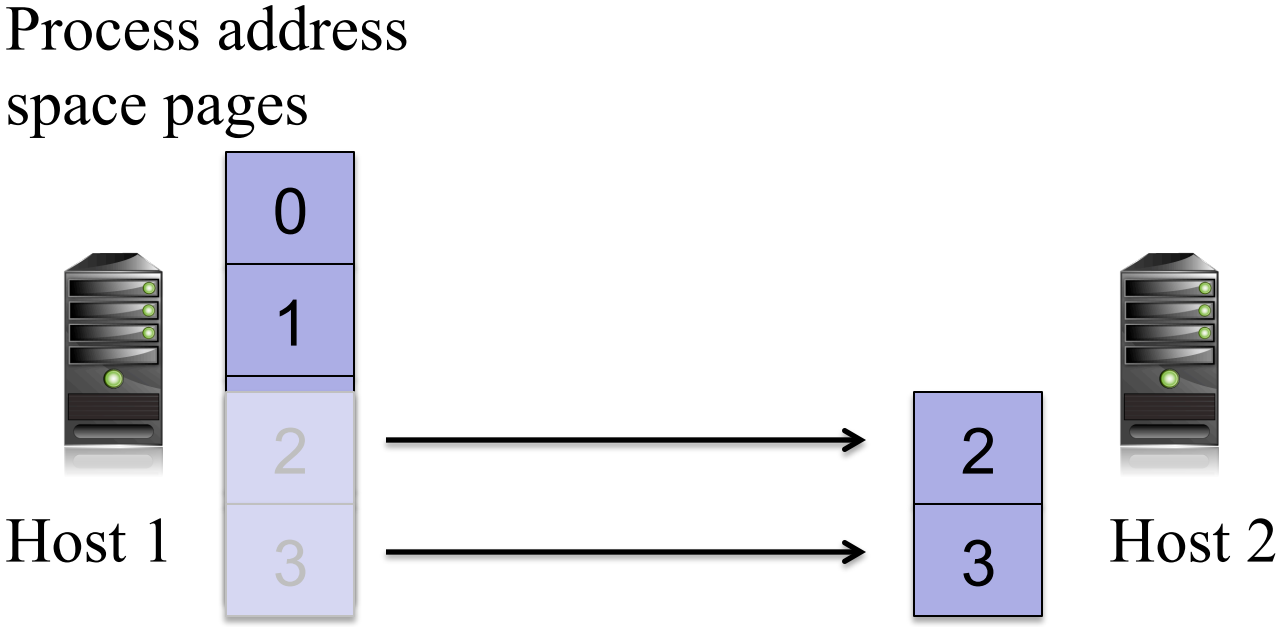
- How do applications scale today?
  - MPI, Map-reduce, … - need resources to do this
  - Fork/replicate multiple VMs/containers, …
    - refactor to synchronize
    - Build scripts to trigger scaling

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

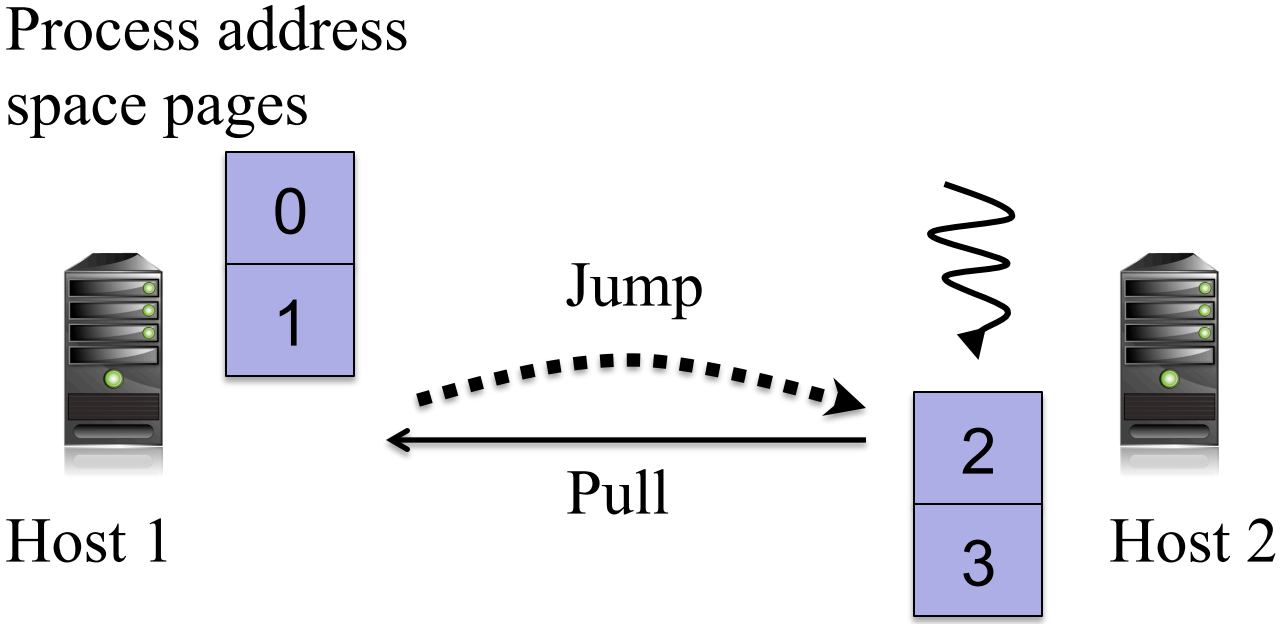


ElasticOS: Shard/Stretch Virtual Memory Across Many Machines



- *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

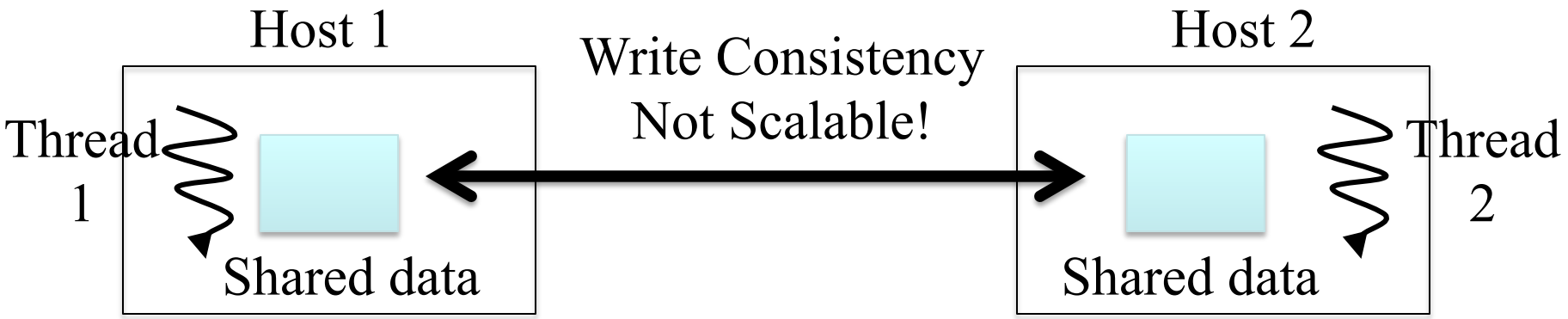
ElasticOS: Pulling, Pushing, Jumping



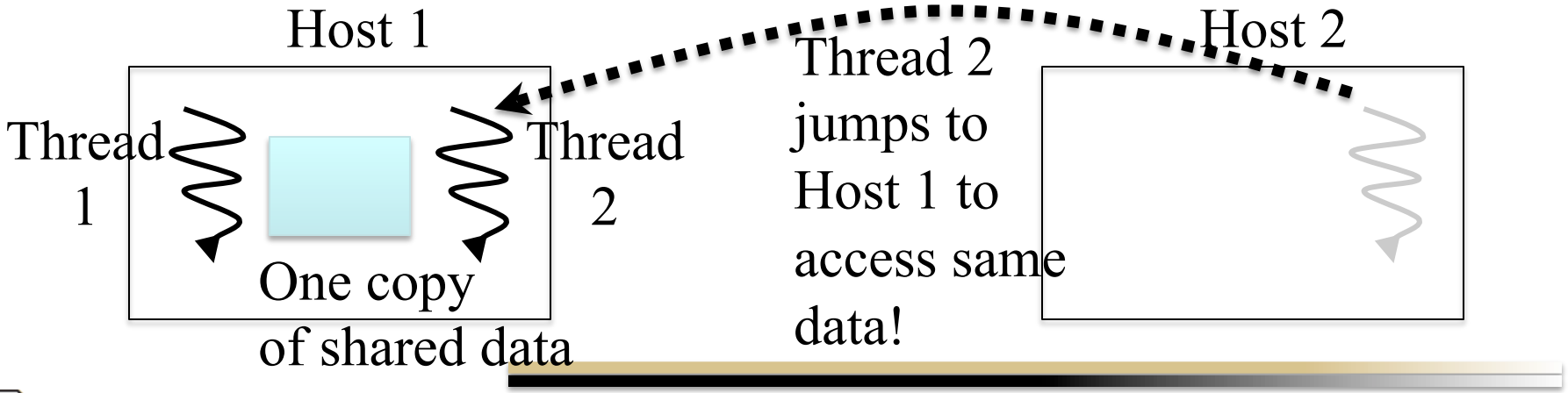
- Thread needing a page can
  - *Pull it*
  - *Jump to it if too many pulls (go towards locality)*
- If out of space, evict/push pages using LRU

How Elastic OS Differs from DSM

- DSM:



- ElasticOS sharding & jumping:



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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