Lego: A Distributed, Decomposed OS for Resource Disaggregation

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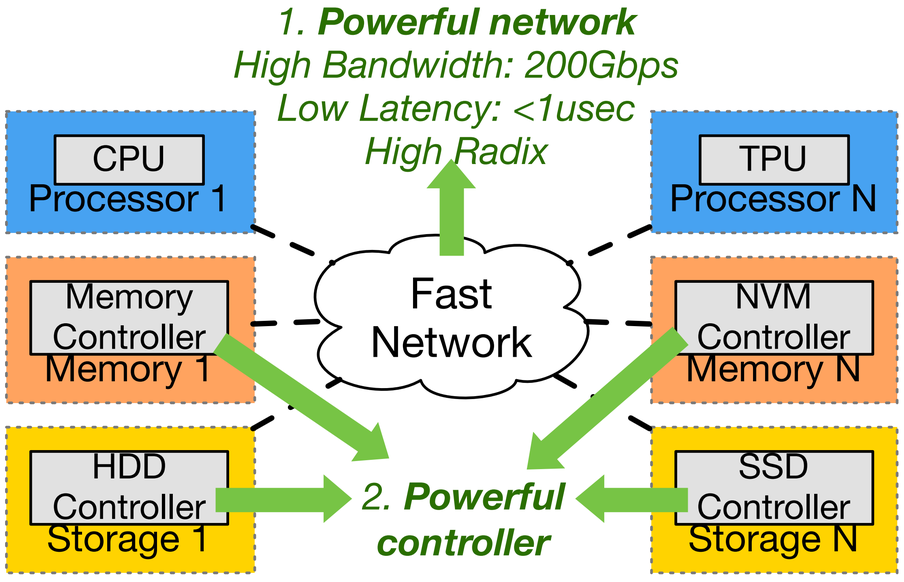
When hardware is disaggregated, the OS should be also!

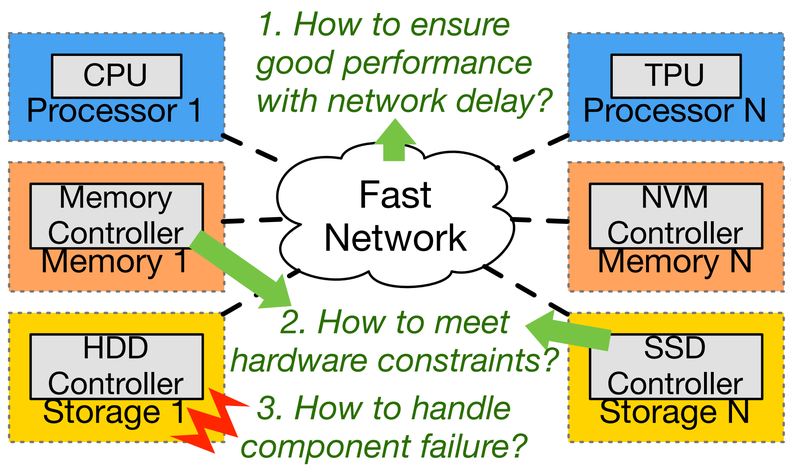
Resource Disaggregation

Breaking *monolithic* servers into network-attached, independent hardware components



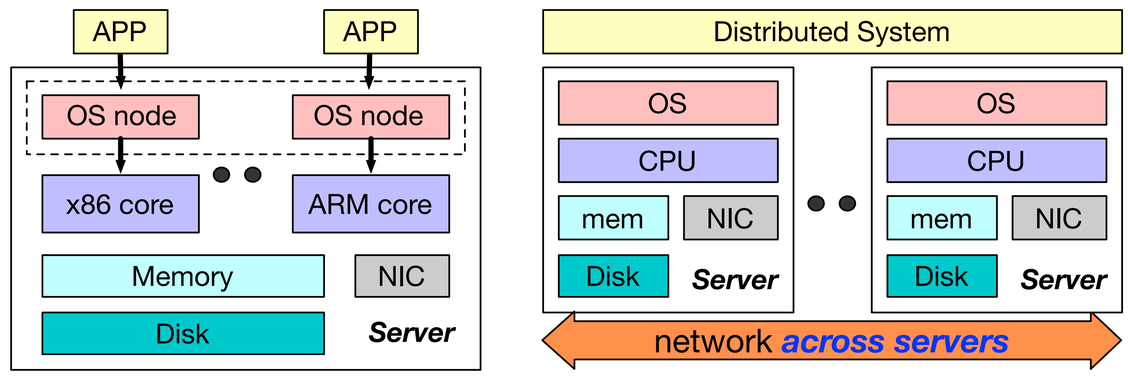
- Efficient resource utilization
- Finer-grained failure domain
- Easy to add/remove/change hardware

Unique Challenges



No existing OS solves the unique challenges of resource disaggregation!

Problems with Existing OSes



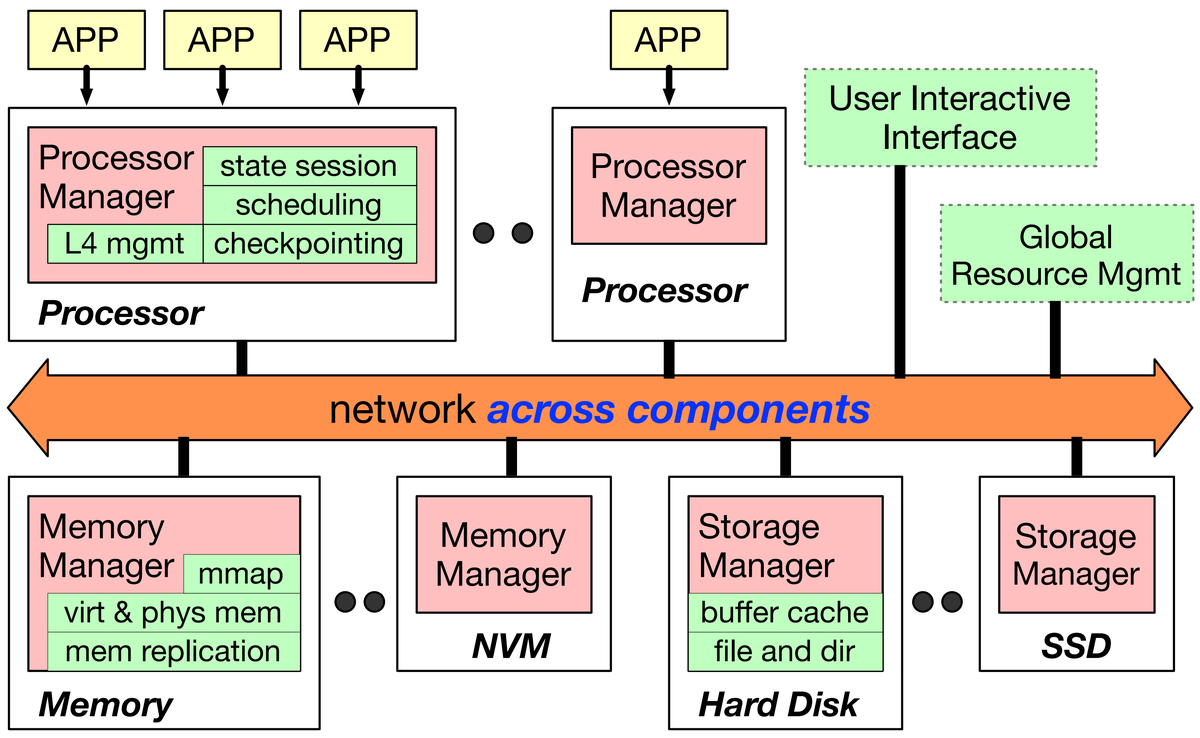
Multikernel: manages cores separately, not other components

Monolithic/micro- kernel: built for monolithic server

Distributed OS: manages distributed monolithic servers, but not distributed hardware components

Lego: a Disaggregated OS

How to build an OS for resource disaggregation?



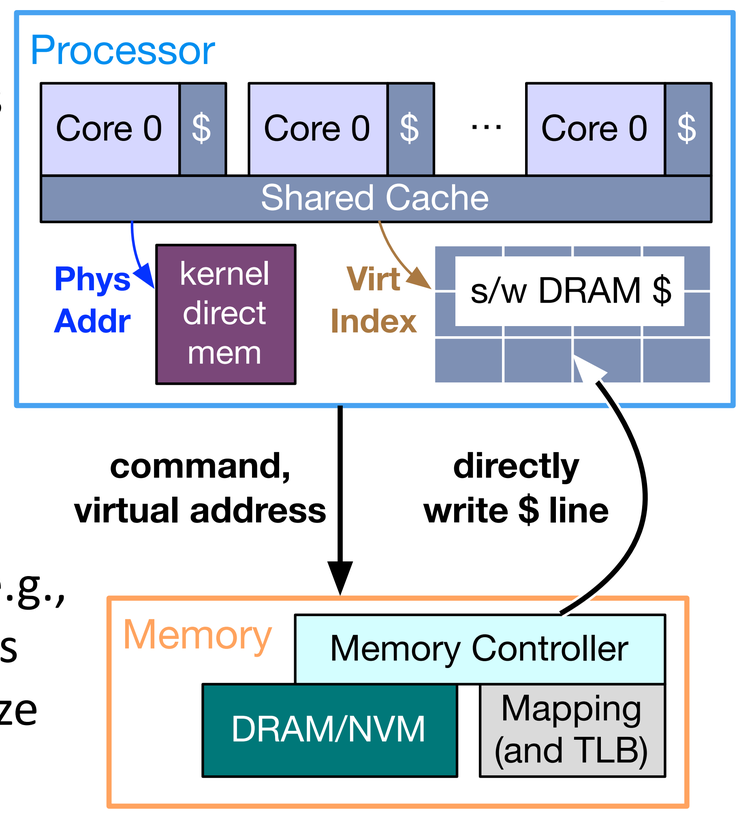
- Split kernel into stateless managers
- Handle failures transparently
- No memory sharing across processors
- Built from scratch; ongoing, open-source project
- Supports x86-64 and unmodified Linux binaries

Hardware Design

How to cleanly separate hardware components while ensuring good performance?

Processor

- Only knows virtual addresses, all caches are virtually indexed and tagged
- Small local DRAM as software-managed last-level cache
- Small physically-addressed memory for kernel usages



Memory/Storage

- Device controllers (e.g., ***ASIC***) run OS services
- Manage and virtualize DRAM/NVM/HDD

Failure Handling

Handle Processor Failure

- Per-process coordinated checkpointing
- Stateless managers → efficient checkpointing
- Minimal dependencies across processes

Handle Memory Failure

- Replicate memory at checkpointing time
- *Selective* dirty memory replication → ***< 2X space***
- Use replicated memory for better parallelism
- *Lazily* compact replicas and checkpoint to storage