UC San Diego

CSE 291: Operating Systems in Datacenters

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Agenda for Today

- Snap overview
- ghOSt discussion

UC San Diego

Snap

Research on CPU Scheduling

theoretical ⟷ practical

Theory

- Prioritization
- First come first served (FCFS)
- Shortest remaining processing time (SRPT)
- Process sharing (PS)
- Etc.

Kernel Bypass Scheduling

- ZygOS (SOSP ‘17)
- Arachne (OSDI ‘18)
- Shenango (NSDI ‘19)
- Shinjuku (NSDI ‘19)
- Caladan (OSDI ‘20)
- Scheduling Policies (NSDI ‘22)

Improve Linux’s Scheduling

- **Snap (SOSP ‘19)**
- **ghOSt (SOSP ‘21)**
- Syrup (SOSP ‘21)

Linux’s Scheduler (CFS)

Limitations

Theory: Assumes known task service times, no overheads, centralized queues

Kernel Bypass Scheduling: Require app changes, don’t support many policies or support multitenancy

Improve Linux’s Scheduling: Worse performance than kernel-bypass approaches

Linux’s Scheduler (CFS): Lots of queueing, slow context switches, load imbalance, interference

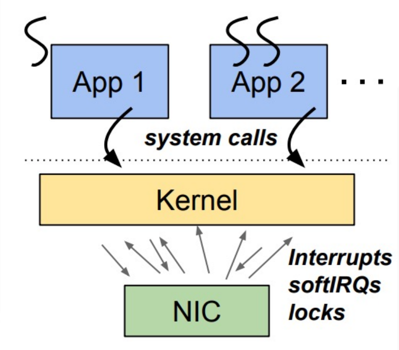
Snap

- "Snap: a Microkernel Approach to Host Networking" [SOSP '19]
  - Authors from Google
- Goals:
  - High-performance networking (latency and throughput)
  - Ease of deployment
  - Reuse Linux's threads

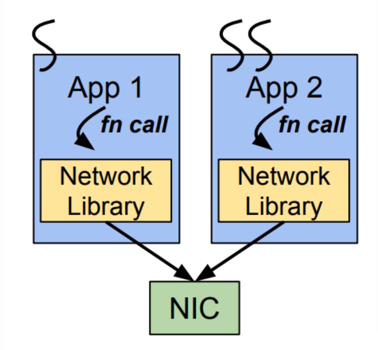
  } different from existing kernel-bypass approaches
- Widely deployed within Google (as of 2019)
  - "Snap is deployed to over half of our fleet of machines and supports the needs of numerous teams"

Snap's Approach

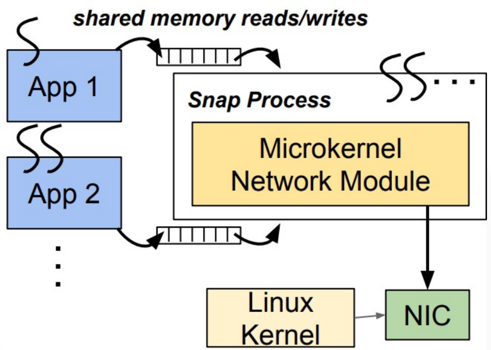
- Microkernel-like approach
  - Move network stack to userspace
  - Communicate with apps via shared memory



Kernel approach



Library OS - Shenango, Shinjuku, etc.

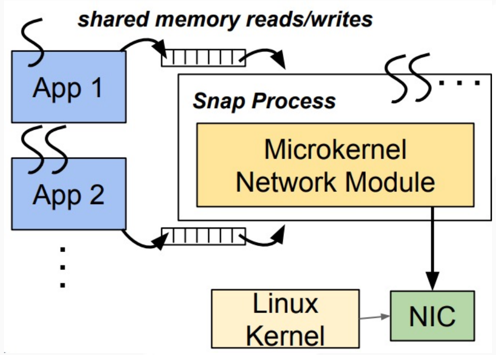


Microkernel approach - Snap

https://sosp19.rcs.uwaterloo.ca/slides/marty.pdf

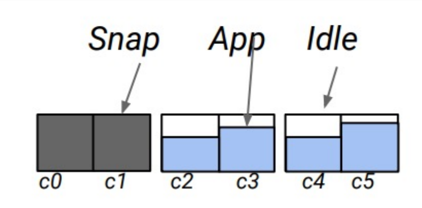
Scheduling the Microkernel

- Which core(s) should Snap run on?

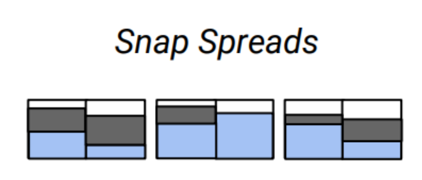


Microkernel approach - Snap

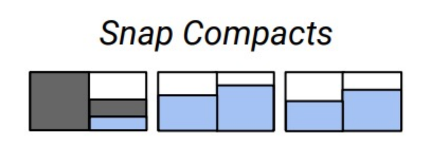
Dedicating cores:



Spreading engines:



Compacting engines:

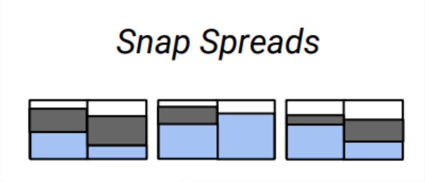


https://sosp19.rcs.uwaterloo.ca/slides/marty.pdf

MicroQuanta Kernel Scheduling Class

- How do you guarantee low-latency handling of network traffic?
- New MicroQuanta kernel scheduling class
- Each MicroQuanta thread can run for up to *runtime* out of every *period* time units
  - E.g., Snap threads can run for 0.9 ms out of every 1 ms
- Demonstrates the kinds of scheduling challenges that Google faces

Spreading engines:



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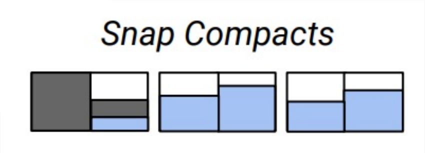

ghOSt Discussion