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# CSE 291: Operating Systems in Datacenters

Amy Ousterhout

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# Agenda for Today

- Reminders
- Warm-Up assignment
- Snap overview
- ghOSt discussion

# Reminders

- Projects
  - Proposals due on 10/20
  - Talk to us if you want help brainstorming ideas
- Project check ins next week
  - We will give feedback on your proposal
  - Sign-ups will be posted on Thursday
  - Time slots:
    - Tuesday 10/25, 2-3 pm
    - Wednesday 10/26, 11-12 pm
    - Friday 10/28, 2-3 pm

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# Snap

# Research on CPU Scheduling


| Theory | Kernel Bypass Scheduling | Improve Linux's Scheduling | Linux's Scheduler (CFS) |
|---|---|---|---|
| • Prioritization<br>• First come first served (FCFS)<br>• Shortest remaining processing time (SRPT)<br>• Process sharing (PS)<br>• Etc. | • ZygOS (SOSP '17)<br>• Arachne (OSDI '18)<br>• Shenango (NSDI '19)<br>• Shinjuku (NSDI '19)<br>• Caladan (OSDI '20)<br>• Scheduling Policies (NSDI '22) | • **Snap (SOSP '19)**<br>• **ghOSt (SOSP '21)**<br>• Syrup (SOSP '21) | |
| **Limitations** | | | |
| Assumes known task service times, no overheads, centralized queues | Require app changes, don't support many policies or support multitenancy | Worse performance than kernel-bypass approaches | Lots of queueing, slow context switches, load imbalance, interference |

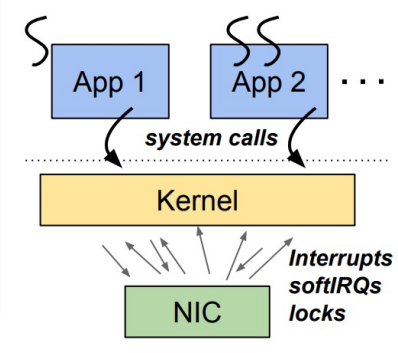
# Snap

- “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

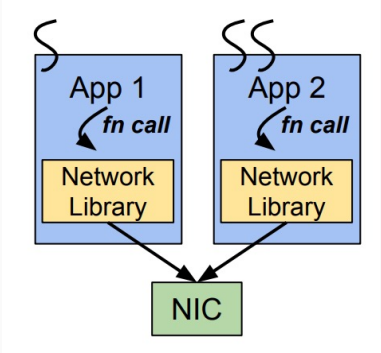
} different from existing kernel-bypass approaches

# Snap's Approach

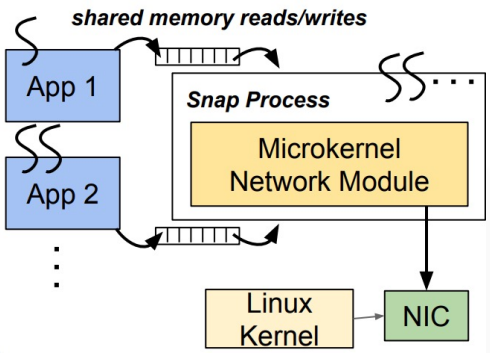
- Microkernel-like approach
  - Move network stack to userspace
  - Communicate with apps via shared memory




Kernel approach



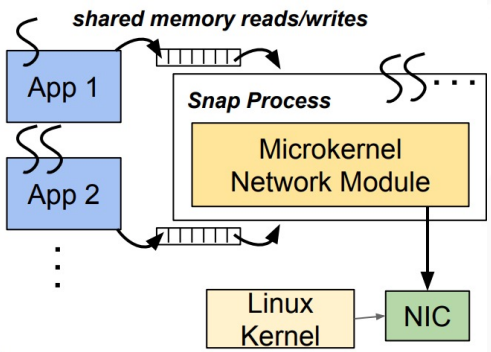

Library OS - Shenango, Shinjuku, etc.




Microkernel approach - Snap

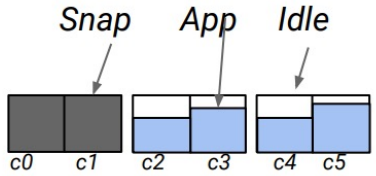
# Scheduling the Microkernel

- Which core(s) should Snap run on?



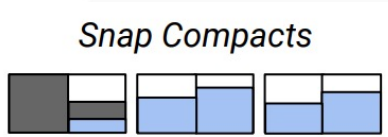

Microkernel approach - Snap

Dedicating cores:




Spreading engines:

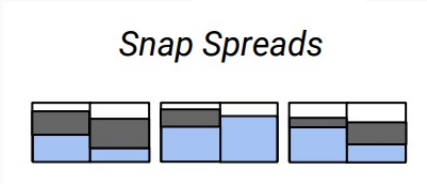

Compacting engines:



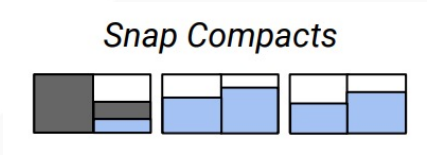
# MicroQuanta Kernel Scheduling Class

- How do you guarantee low-latency handling of network traffic?
- New MicroQuanta scheduling class
- Each MicroQuanta thread runs for *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:




Compacting engines:



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# ghOSt Discussion