VMs, Unikernels and Containers: Experiences on the Performance of Virtualization Technologies

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NEC Europe Ltd. (Heidelberg)

In the Beginning…

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“Tinyfied VMs”

In the Beginning…

“Tinyfied VMs”

unikernels

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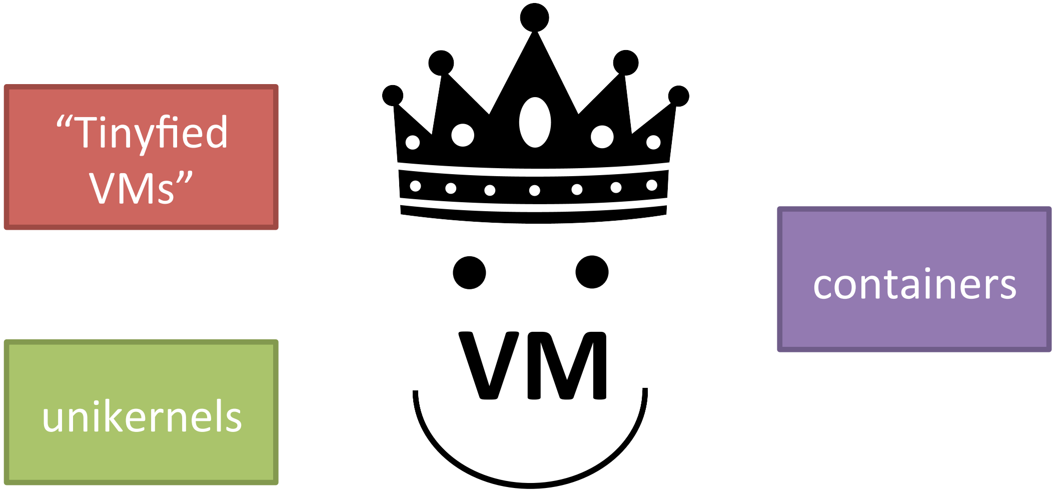

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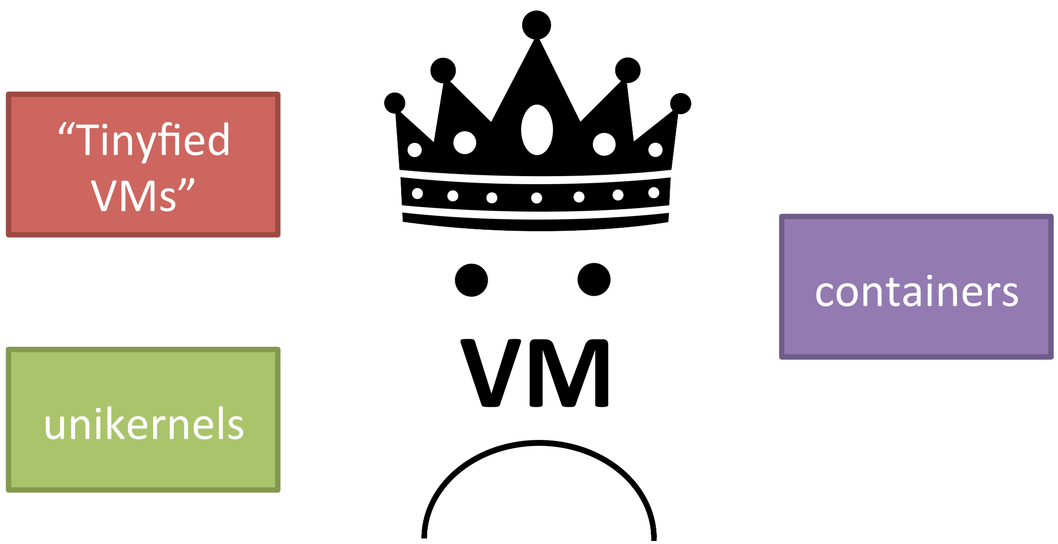

Virt. Technology Benchmarking

- Metrics:
  - VM Image and memory consumption
  - VM creation time
  - Delay
  - Throughput

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higher overhead

lower overhead

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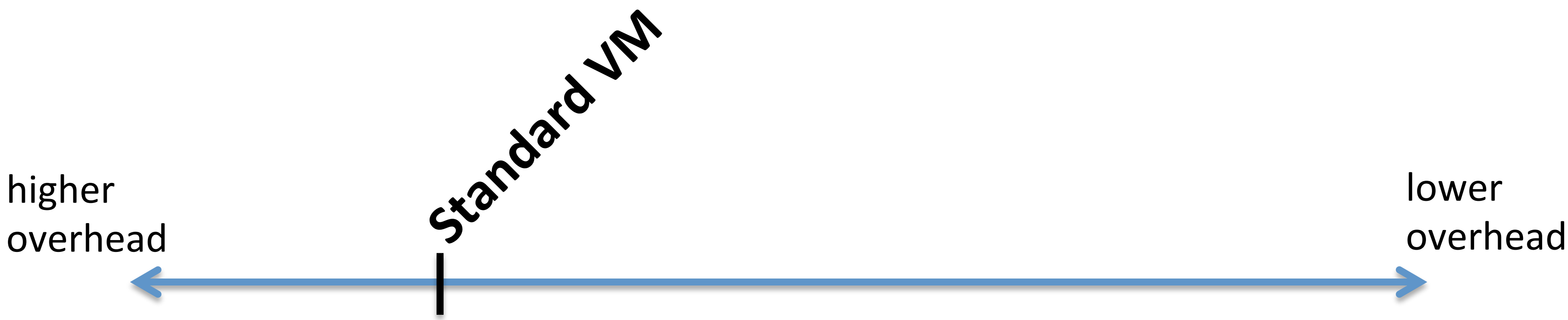

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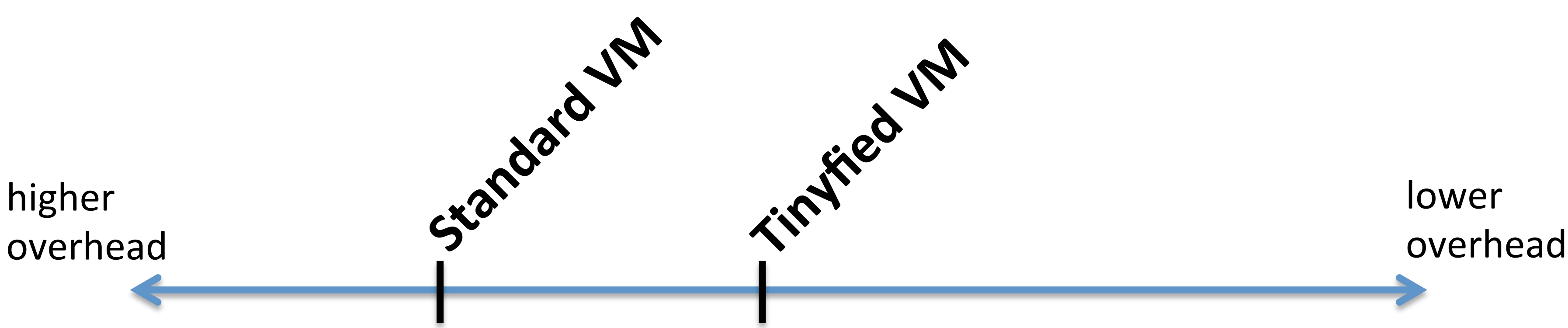

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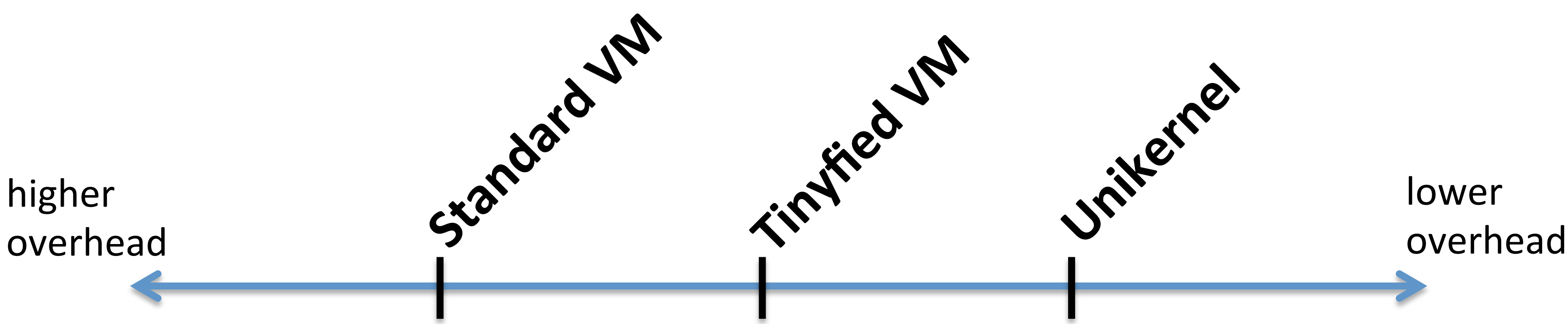

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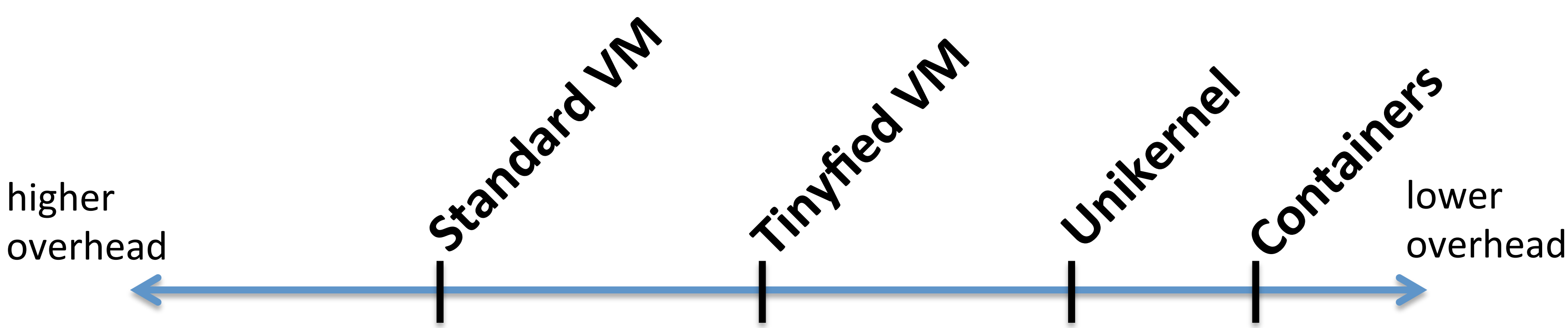

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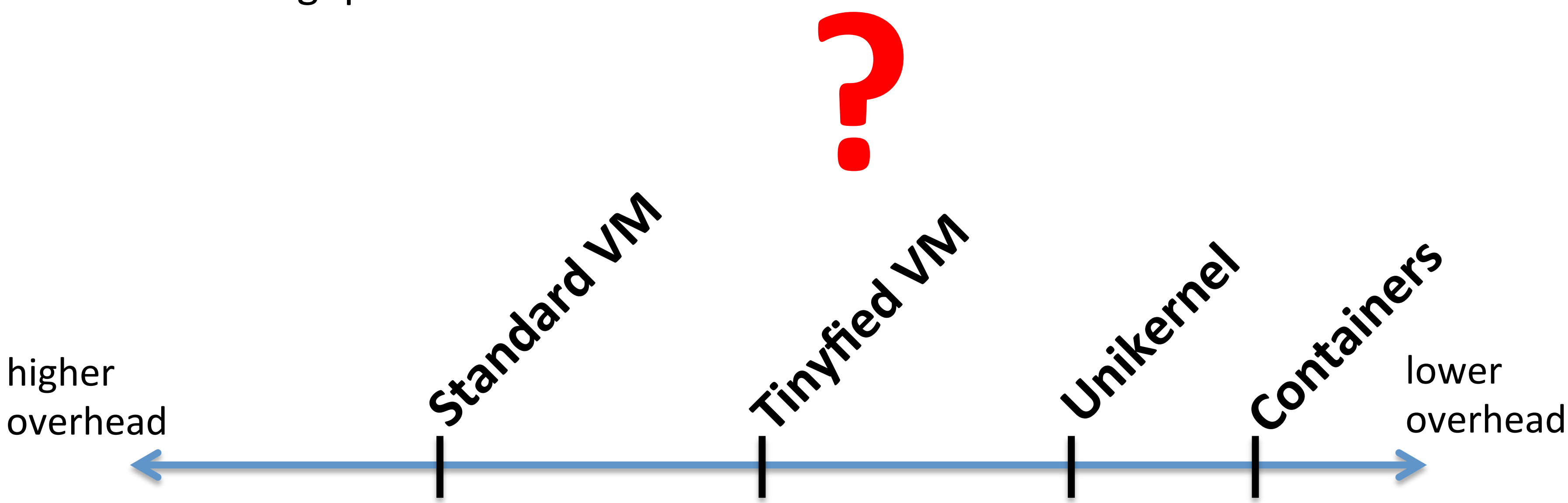

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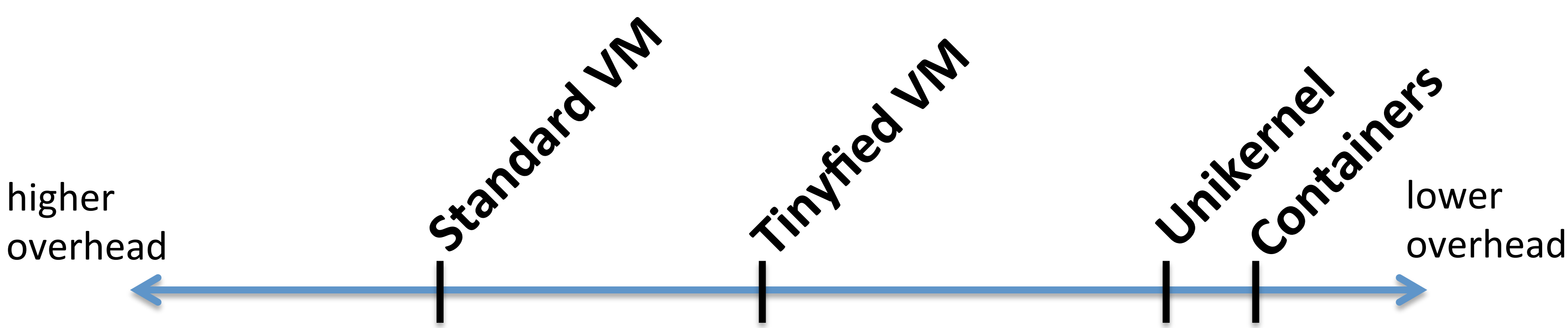

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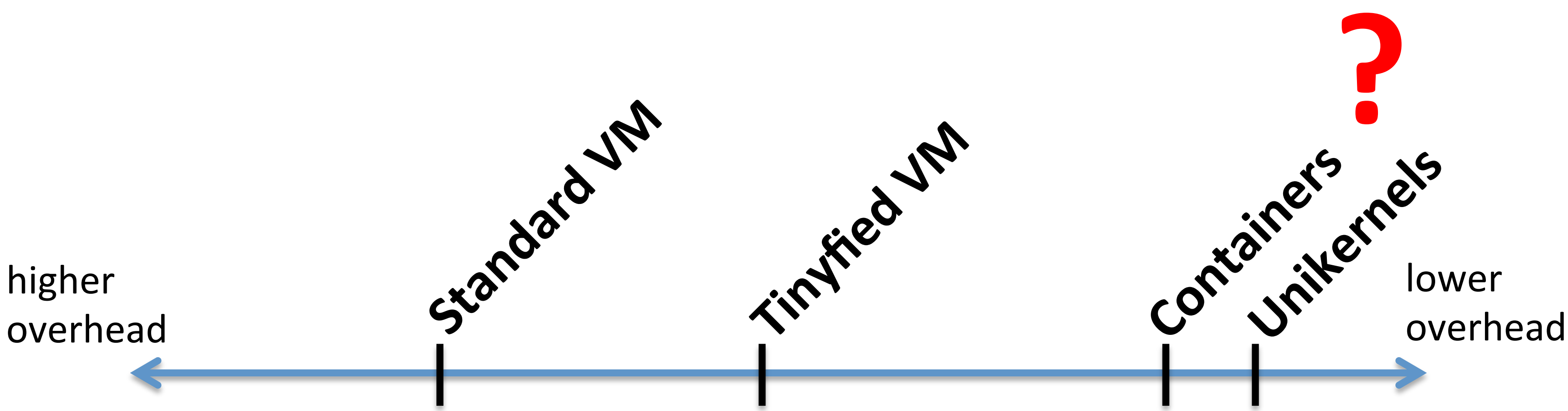

Virtualization Technology Benchmarking

- Metrics:
  - VM image and memory consumption: ls, top, xl
  - VM creation time: SYN flood + RST detection
  - Throughput: iperf, guest to host (TCP traffic)
  - RTT: ping flood
- VM-based tests run on both Xen and KVM
- Hardware: x86_64 server with an Intel Xeon E5-1630 v3 3.7GHz CPU (4 cores), 32GB RAM.

Virtualization Technologies

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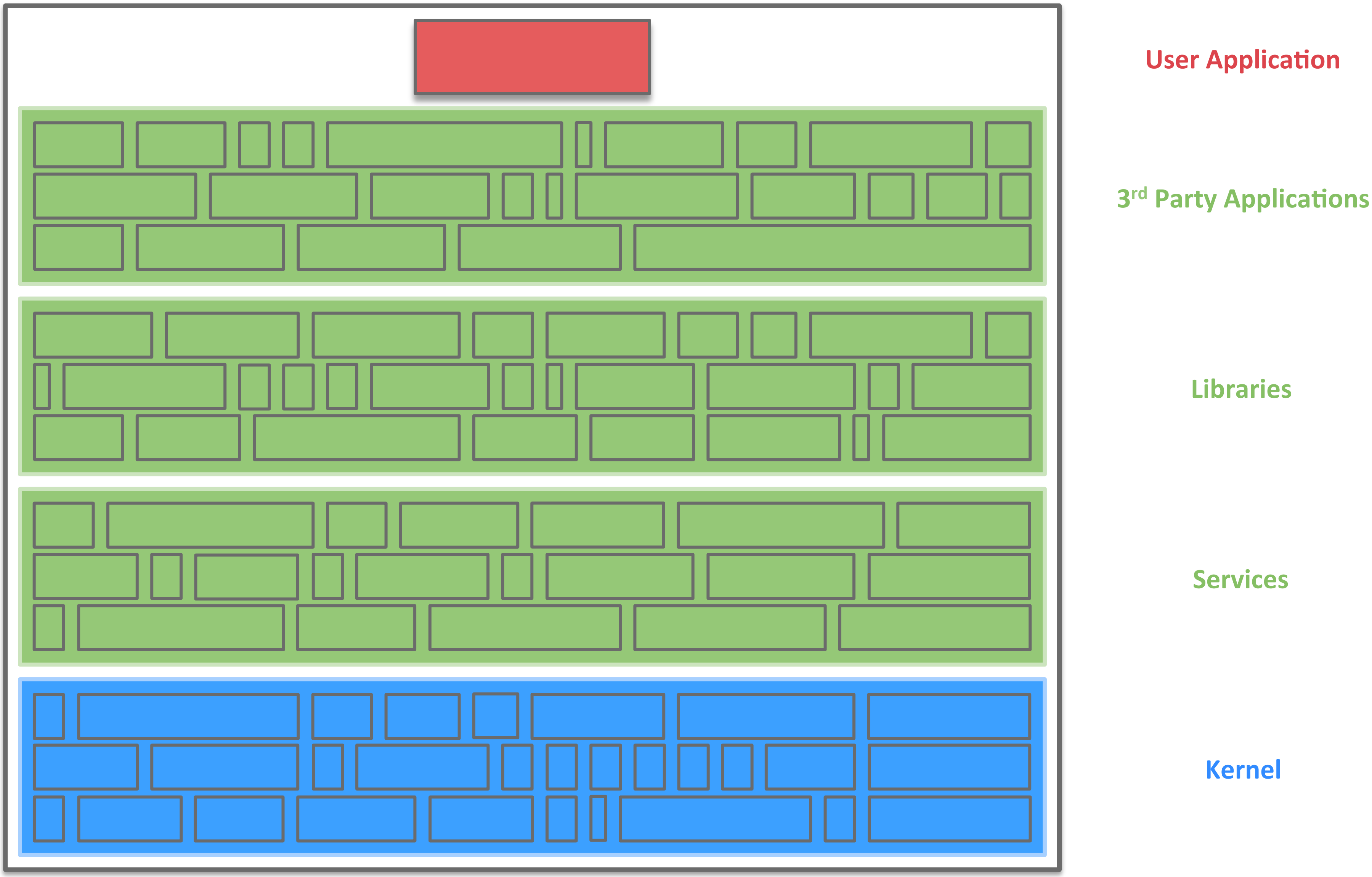
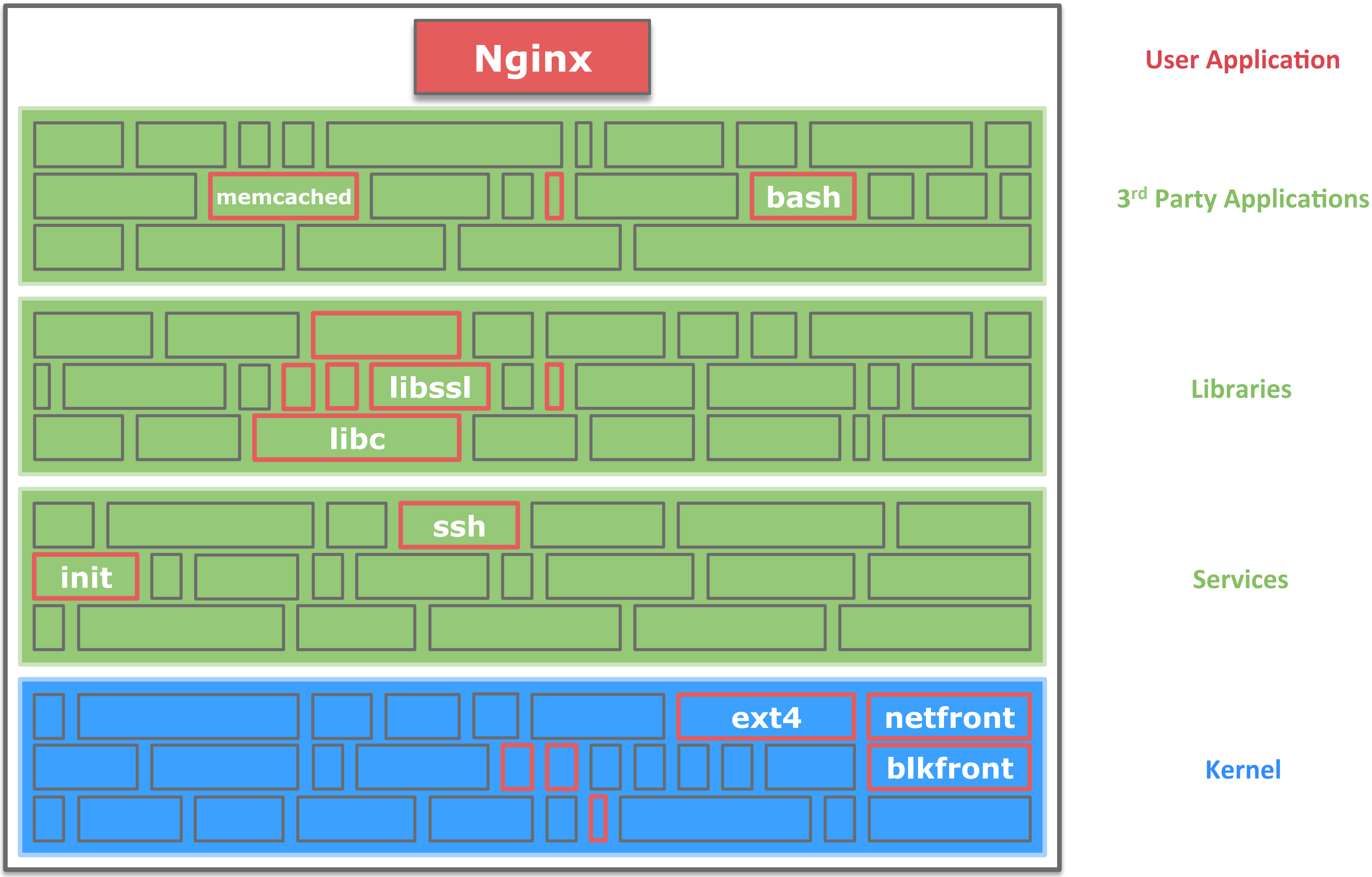
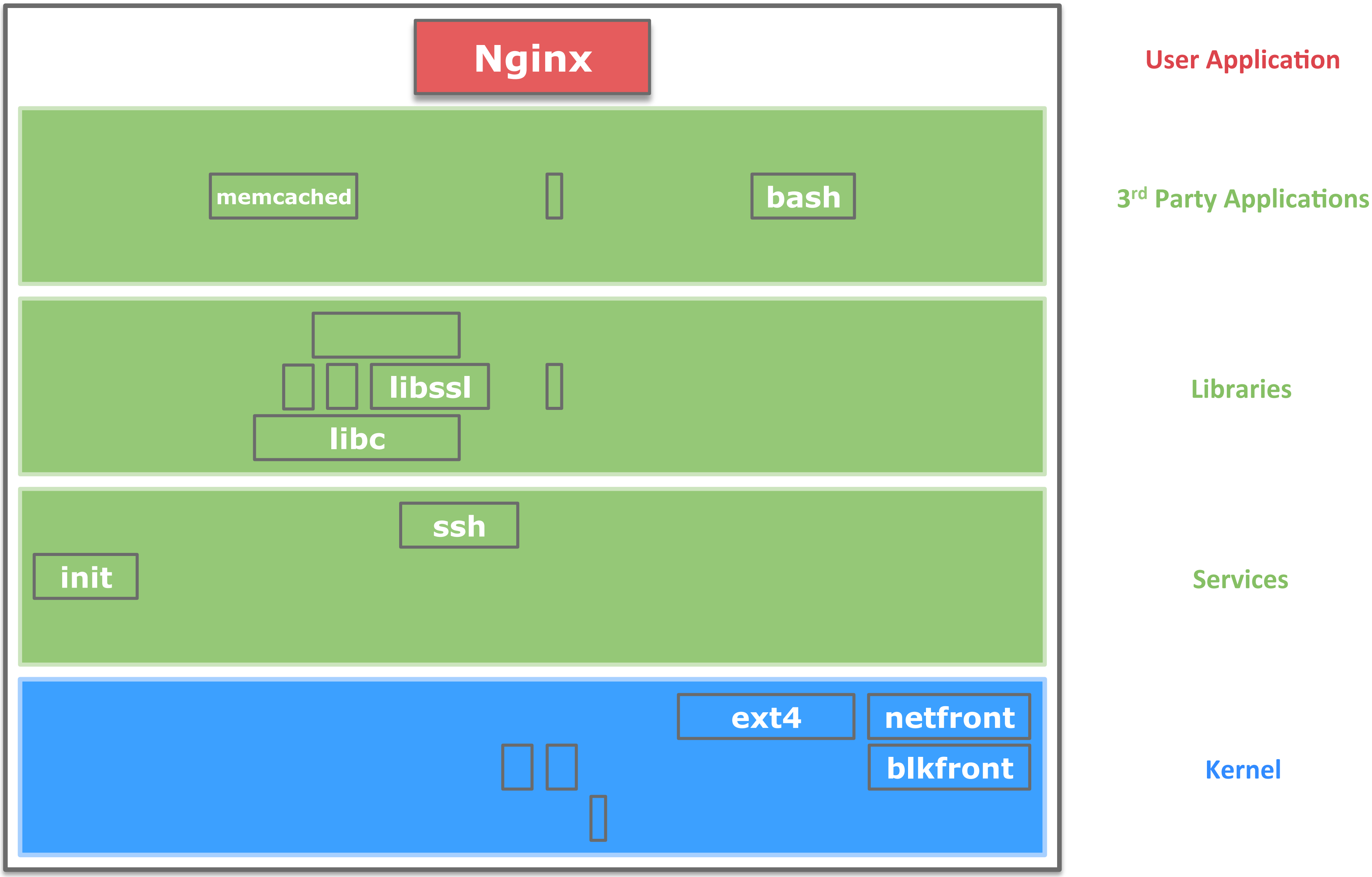
Standard VM: Application on Top of Distro



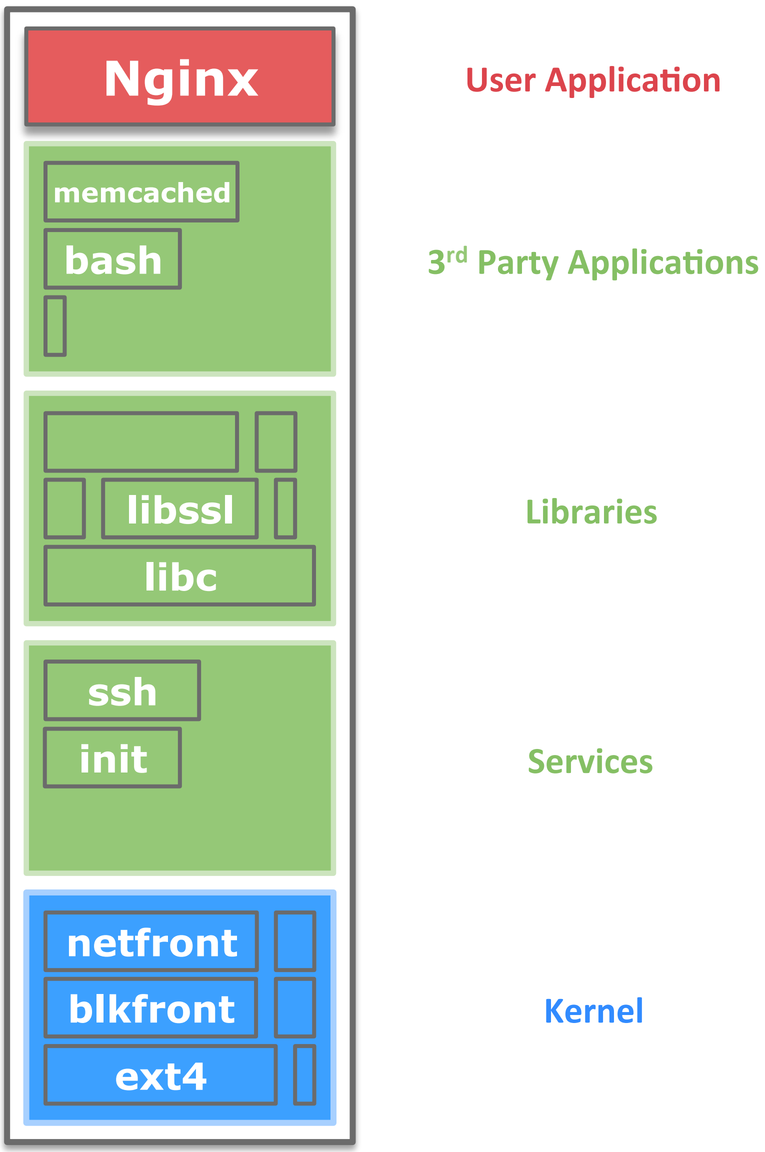
Most of the VM not Used…



Tinyx: Keep Only What's Needed



Tinyx: Taylor-made Distro



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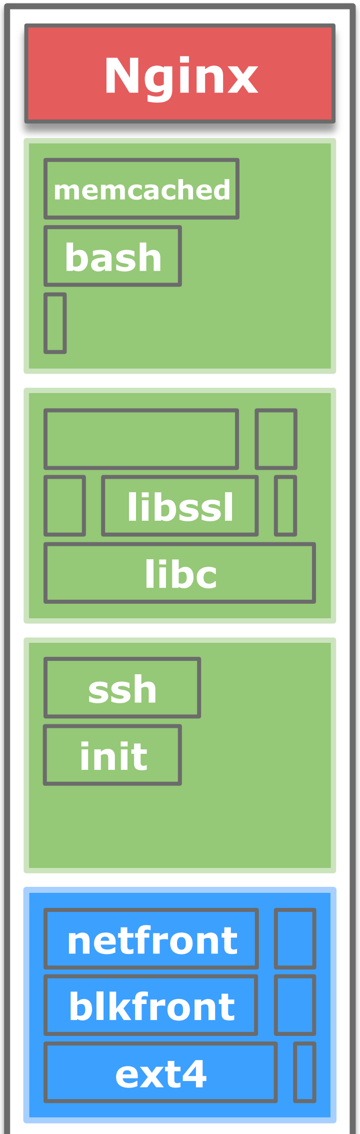

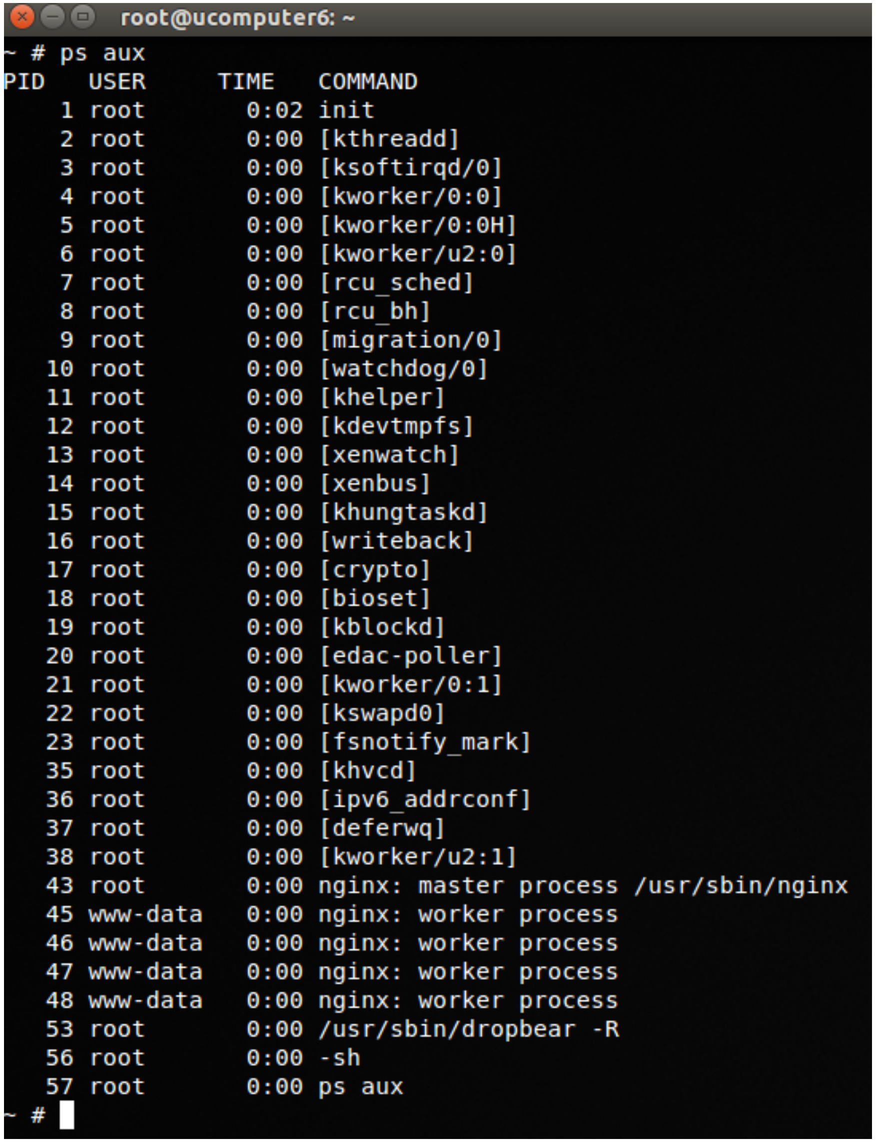


```
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    2 root       0:00 [kthreadd]
    3 root       0:00 [ksoftirqd/0]
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    5 root       0:00 [kworker/0:0H]
    6 root       0:00 [kworker/u2:0]
    7 root       0:00 [rcu_sched]
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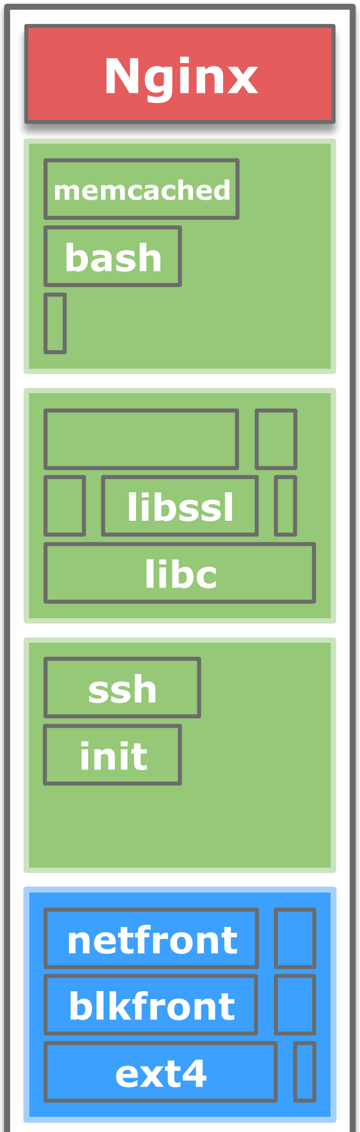

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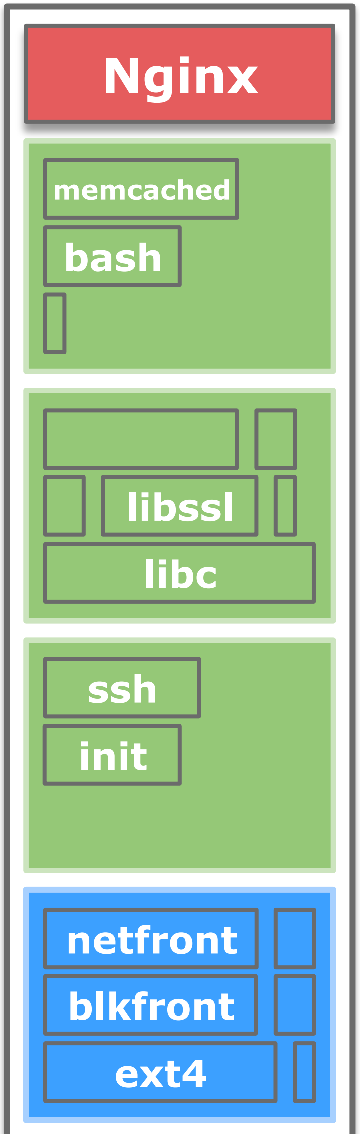


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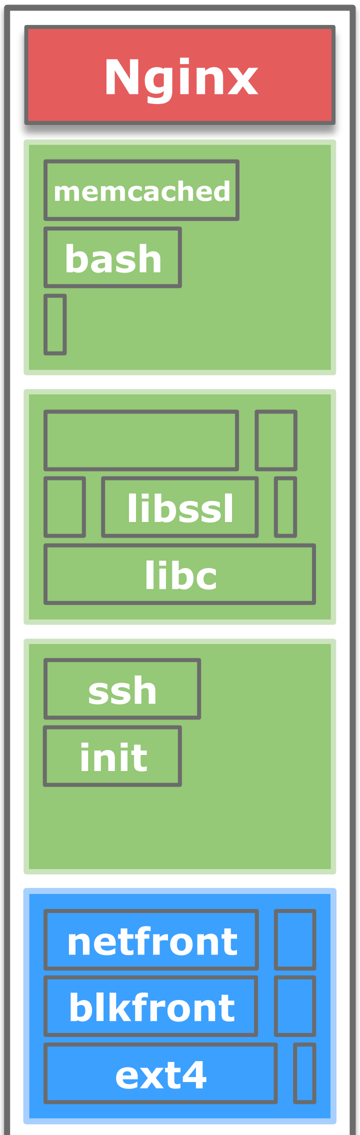

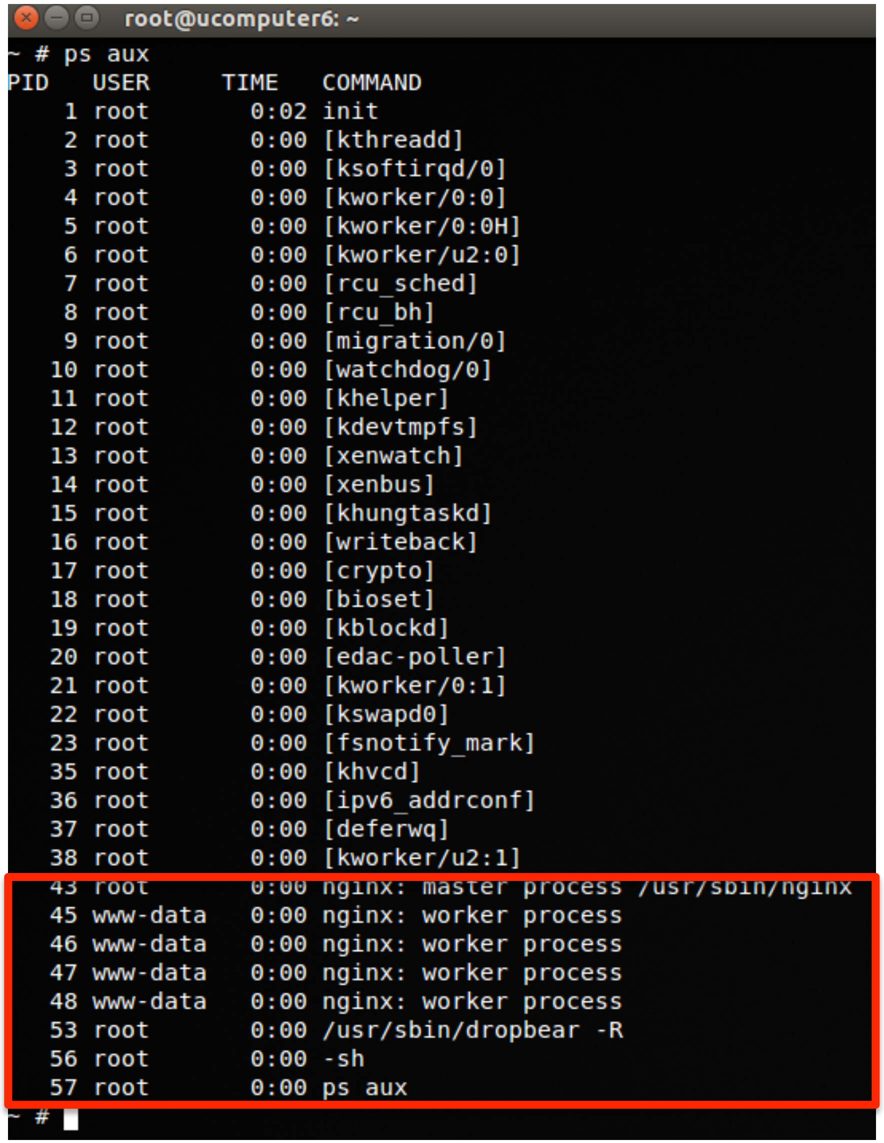


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- Keep only the necessary bits and pieces
  - Specialized kernel build containing only the necessary modules
  - Root filesystem populated with only necessary services, libraries and 3rd party applications

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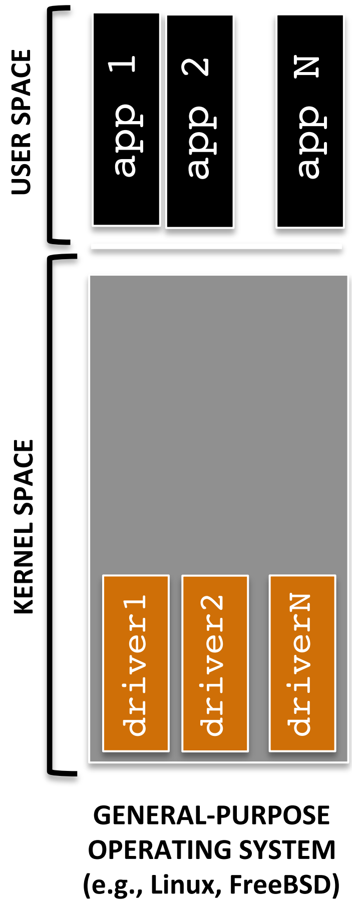

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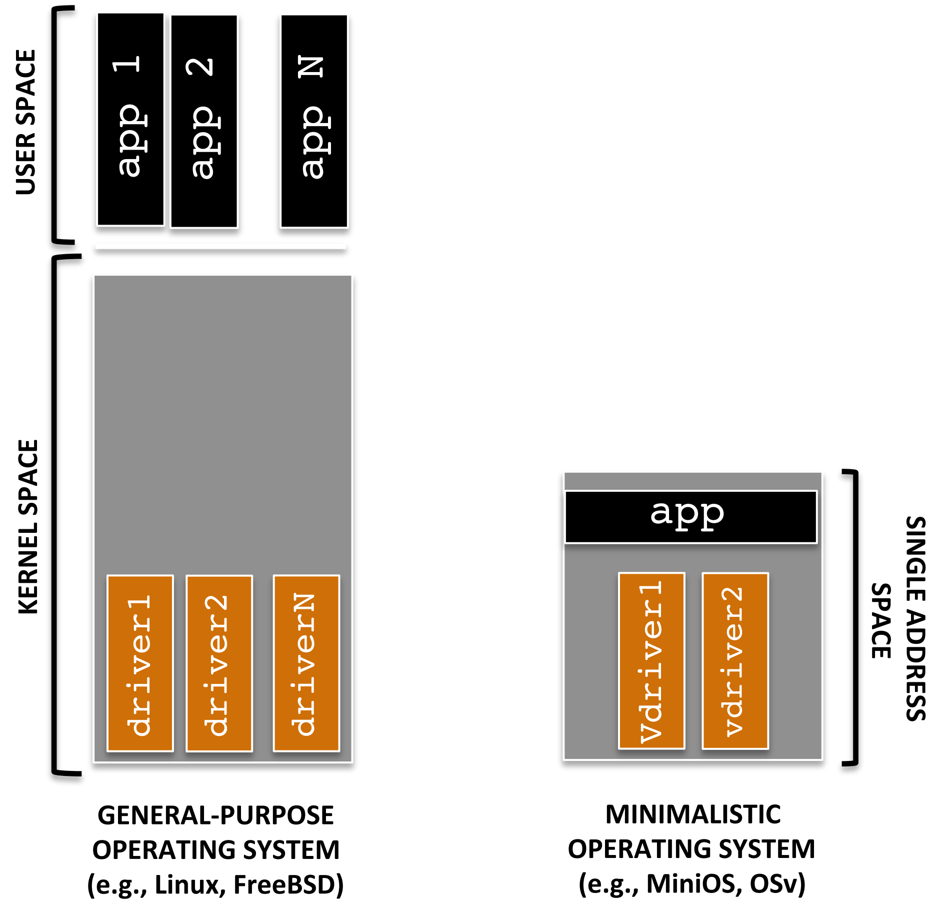
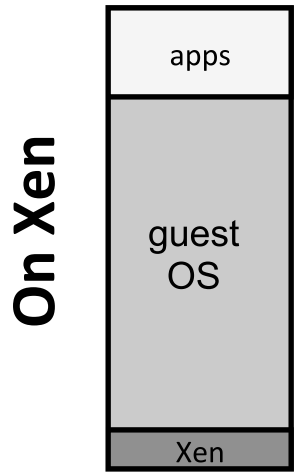


Unikernels for Benchmarking



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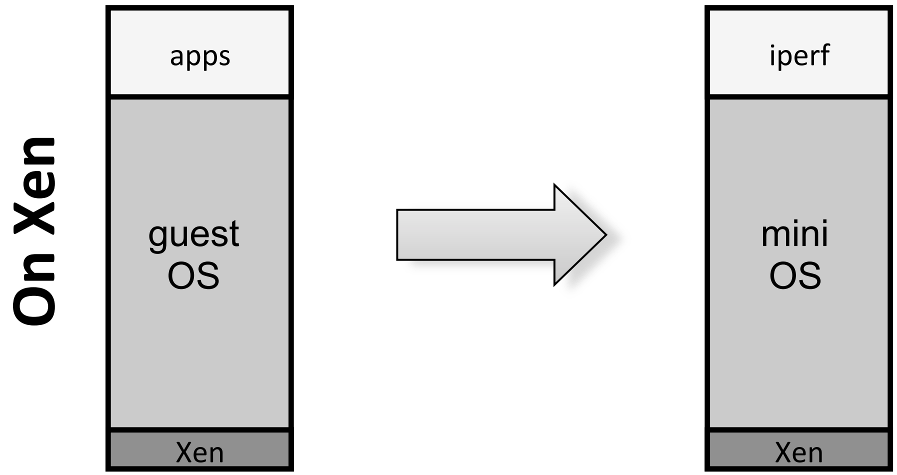

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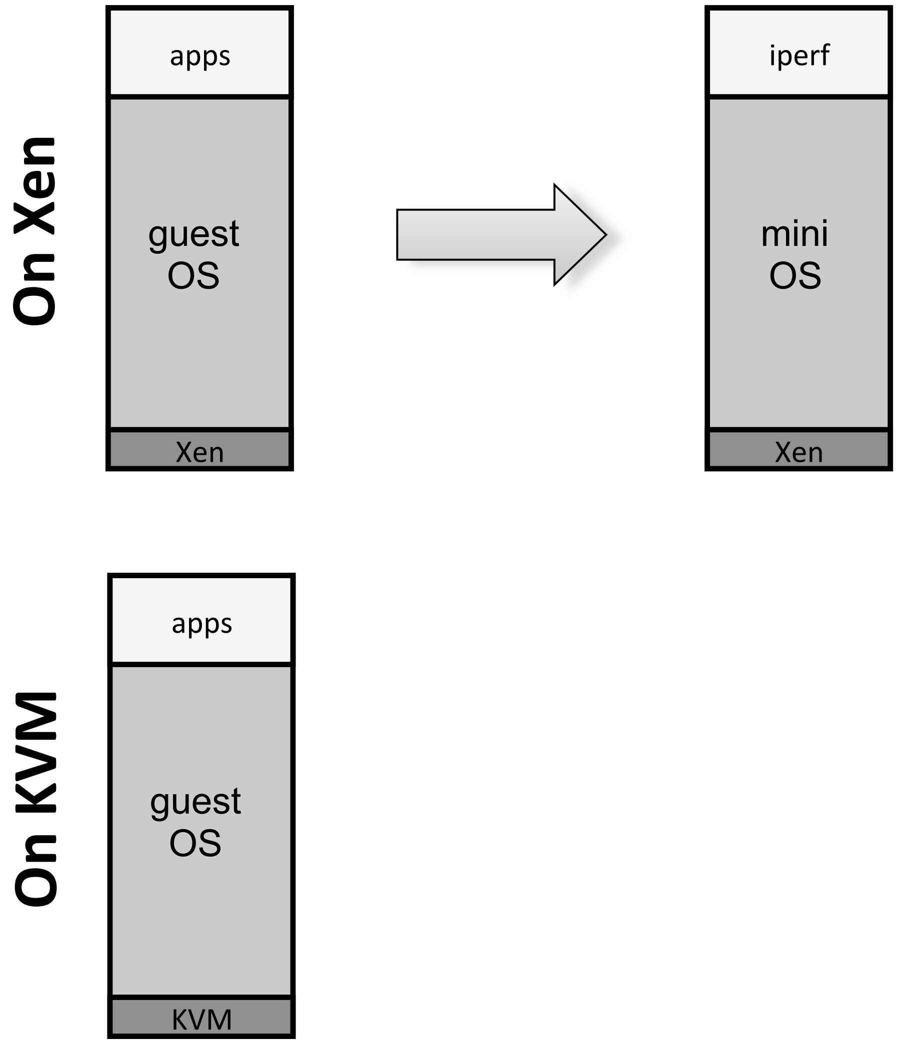

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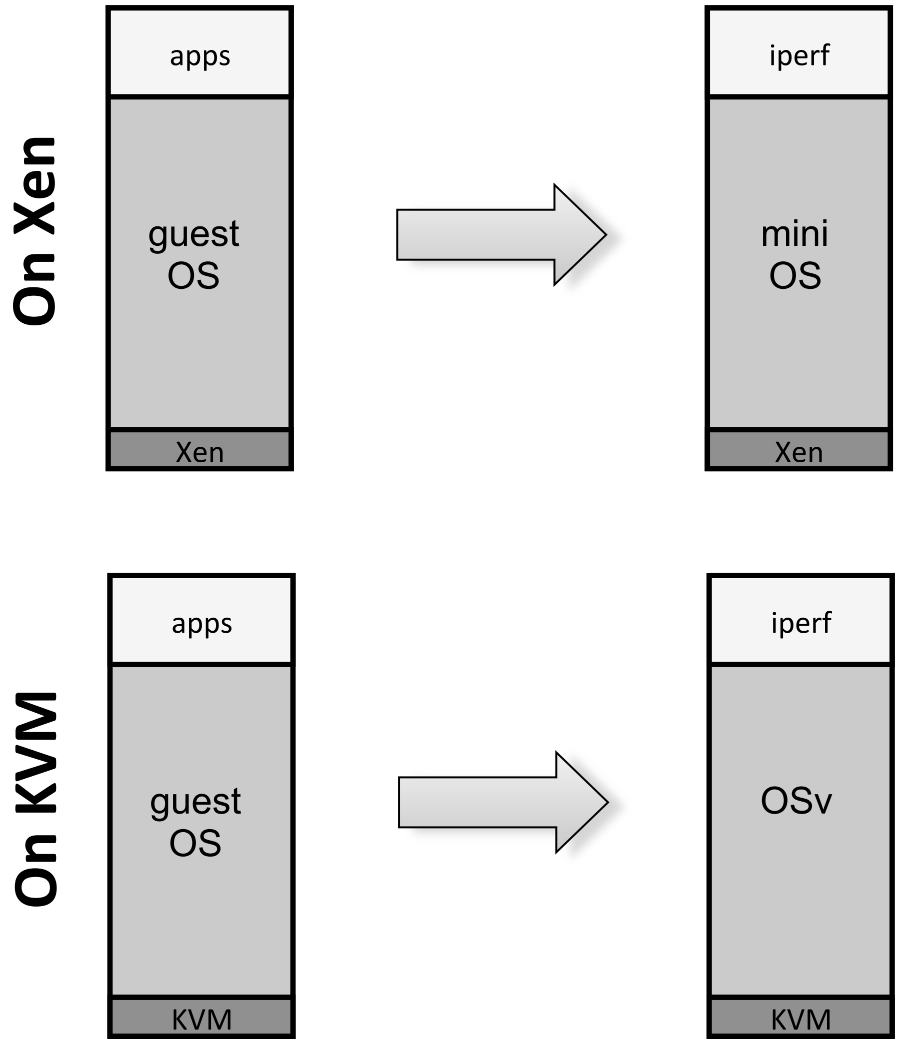
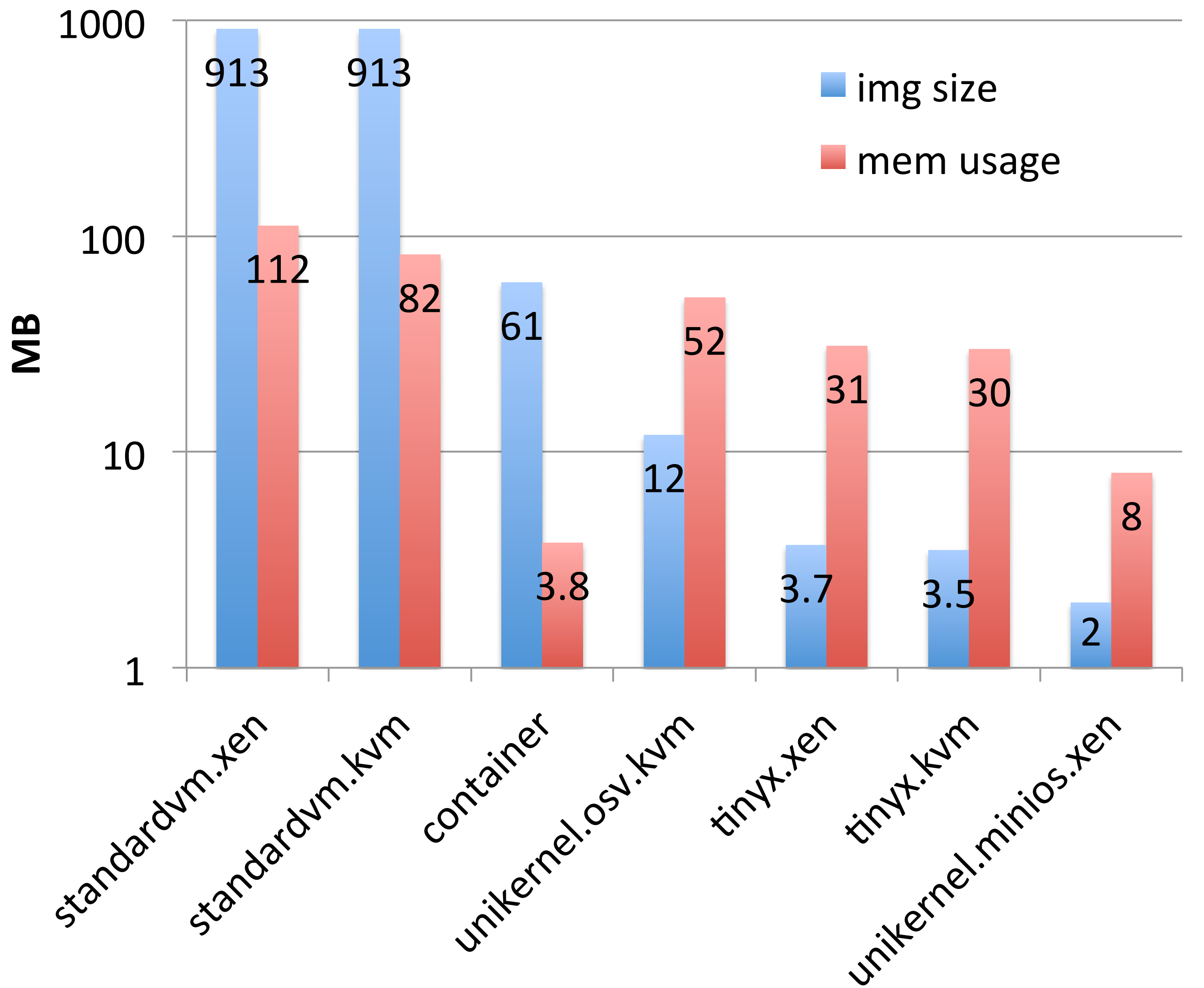


Nota Bene…

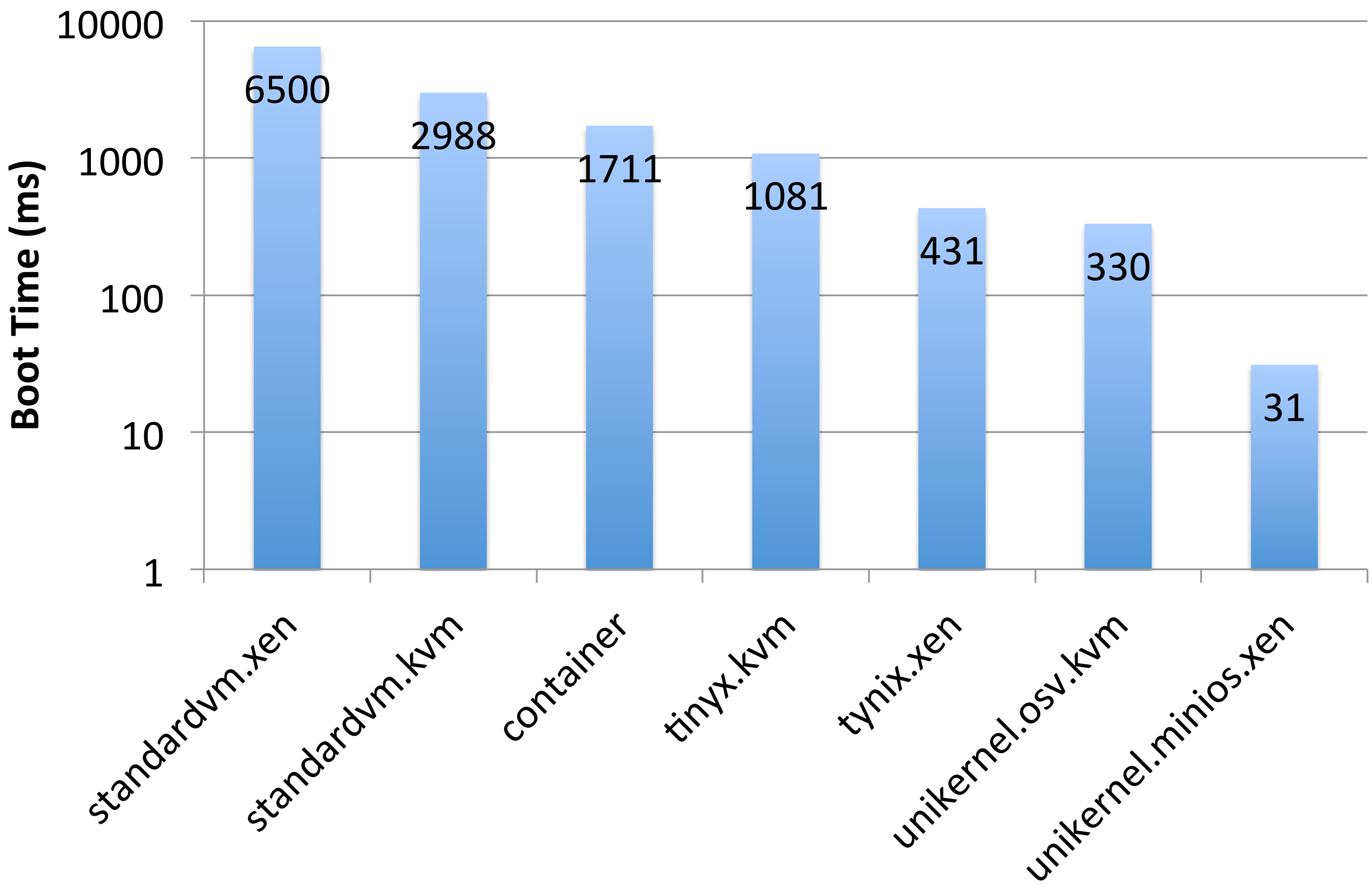
- Our unikernel numbers include optimizations to the underlying virtualization platforms (Xen, KVM)
  - Toolstacks
  - Back-end stores
  - Hotplug scripts
  - Network drivers (on Xen Tx)
- No time to go over these…

RESULTS

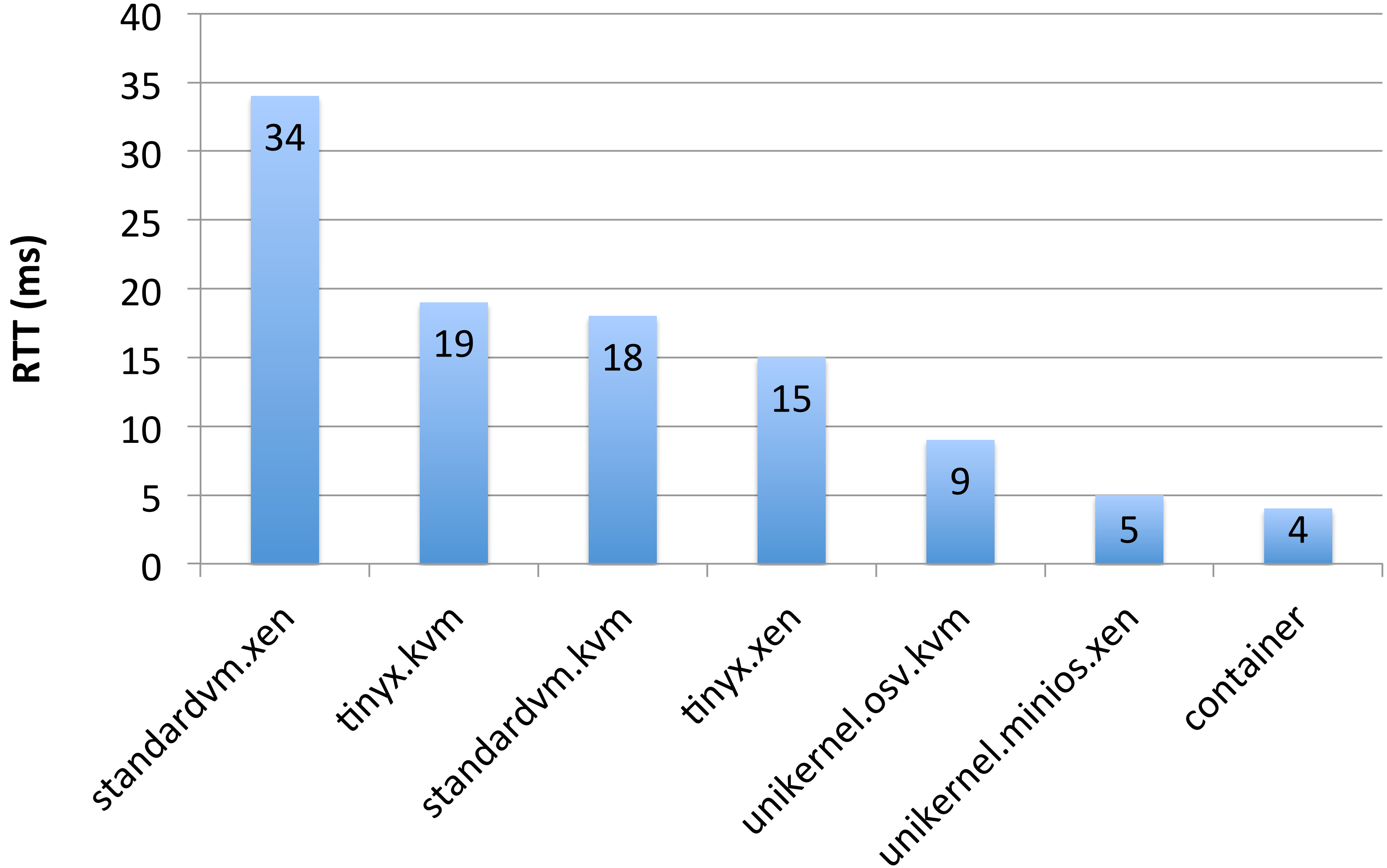
Image Size, Memory Usage (log scale)



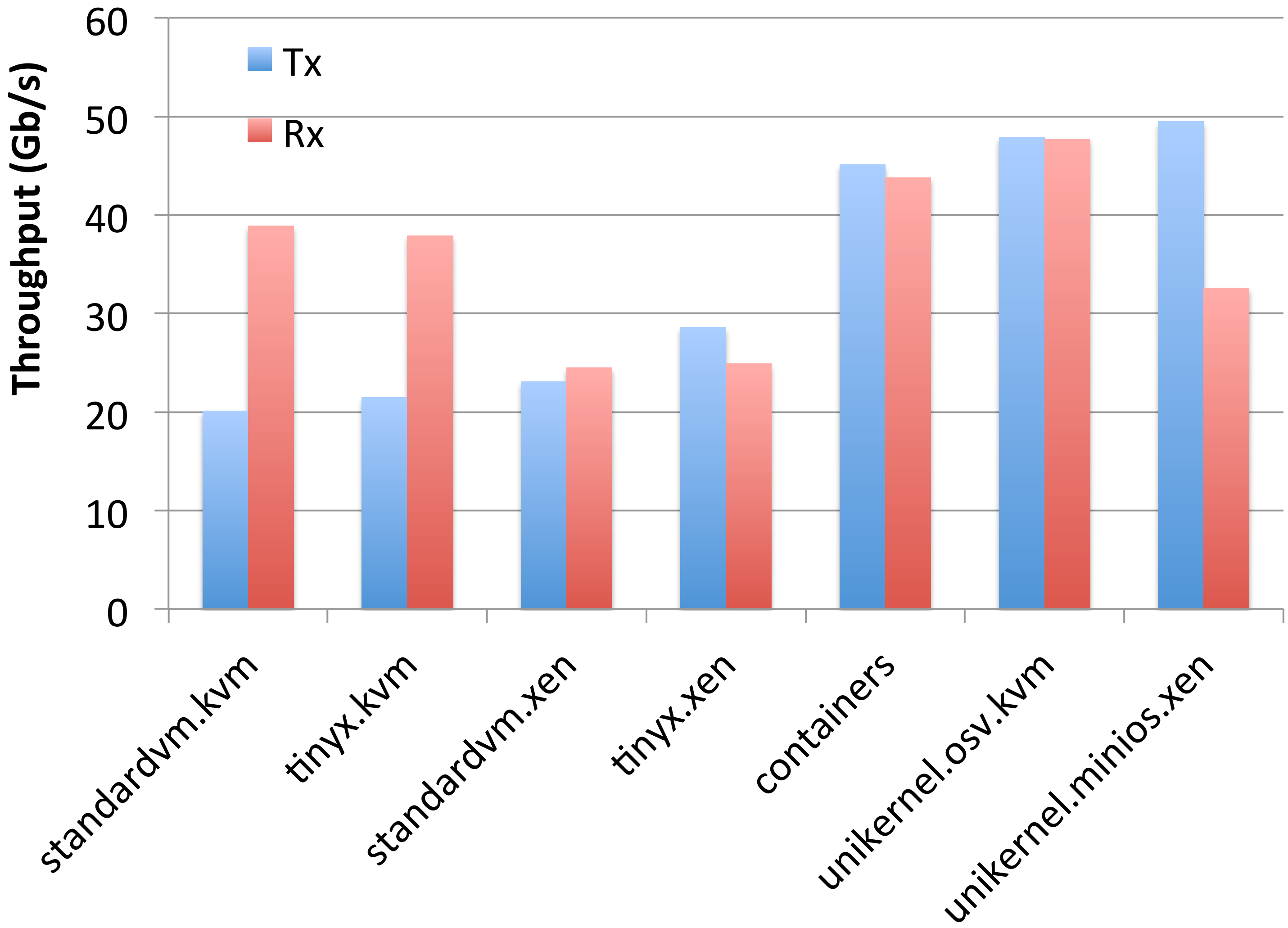
Boot Times (log scale)



RTT


RTT (ms)
40
35
30
25
20
15
10
5
0
34
19
18
15
9
5
4
standardvm.xen
tinyx.kvm
standardvm.kvm
tinyx.xen
unikernel.osv.kvm
unikernel.minios.xen
container

Throughput



Throughput (Gb/s)
60
50
40
30
20
10
0
Tx
Rx
standardvm.kvm
tinyx.kvm
standardvm.xen
tinyx.xen
containers
unikernel.osv.kvm
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Conclusions

- Common lore: VMs provide good isolation but are heavyweight
  - Results with standard VMs confirm this
- Containers provide lighter-weight virtualization
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Potential Contributions to draft-natarajan-nfvrg-containers-for-nfv-01

2.1.1 Challenges

- VNF provisioning time
- Runtime performance (throughput, scaling up/down)

3. Benefits of Containers

- Service agility vs VMs
- Containers have better runtime performance
- Auto-scaling of VNFs
- Cross-VNF compatibility: container unikernel/minimalistic distro
- Overall performance: VMs -25% throughput vs containers

5. Conclusion

- Containers have significant advantages vs hypervisor-based solutions