Nahanni

a shared memory interface for KVM

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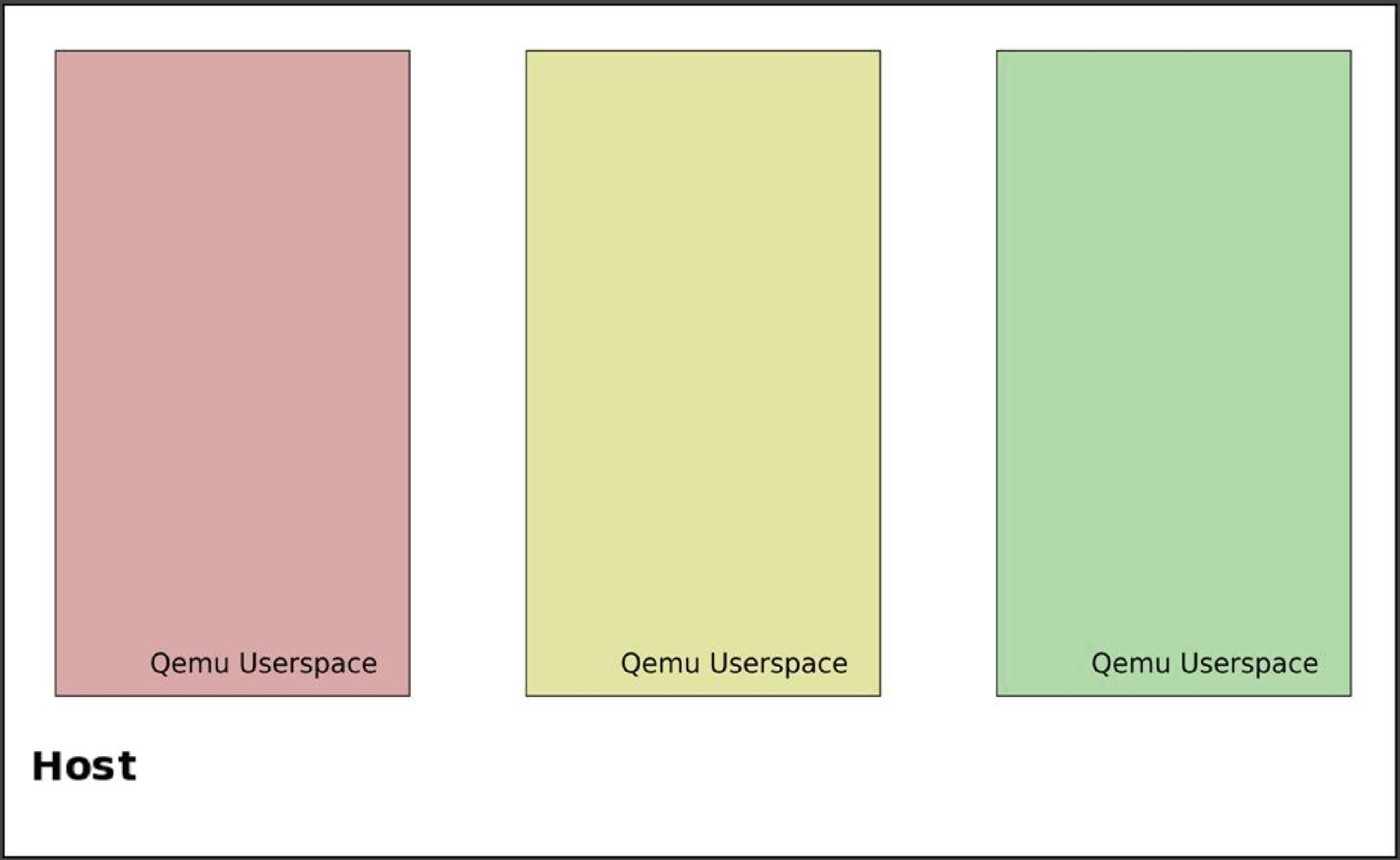
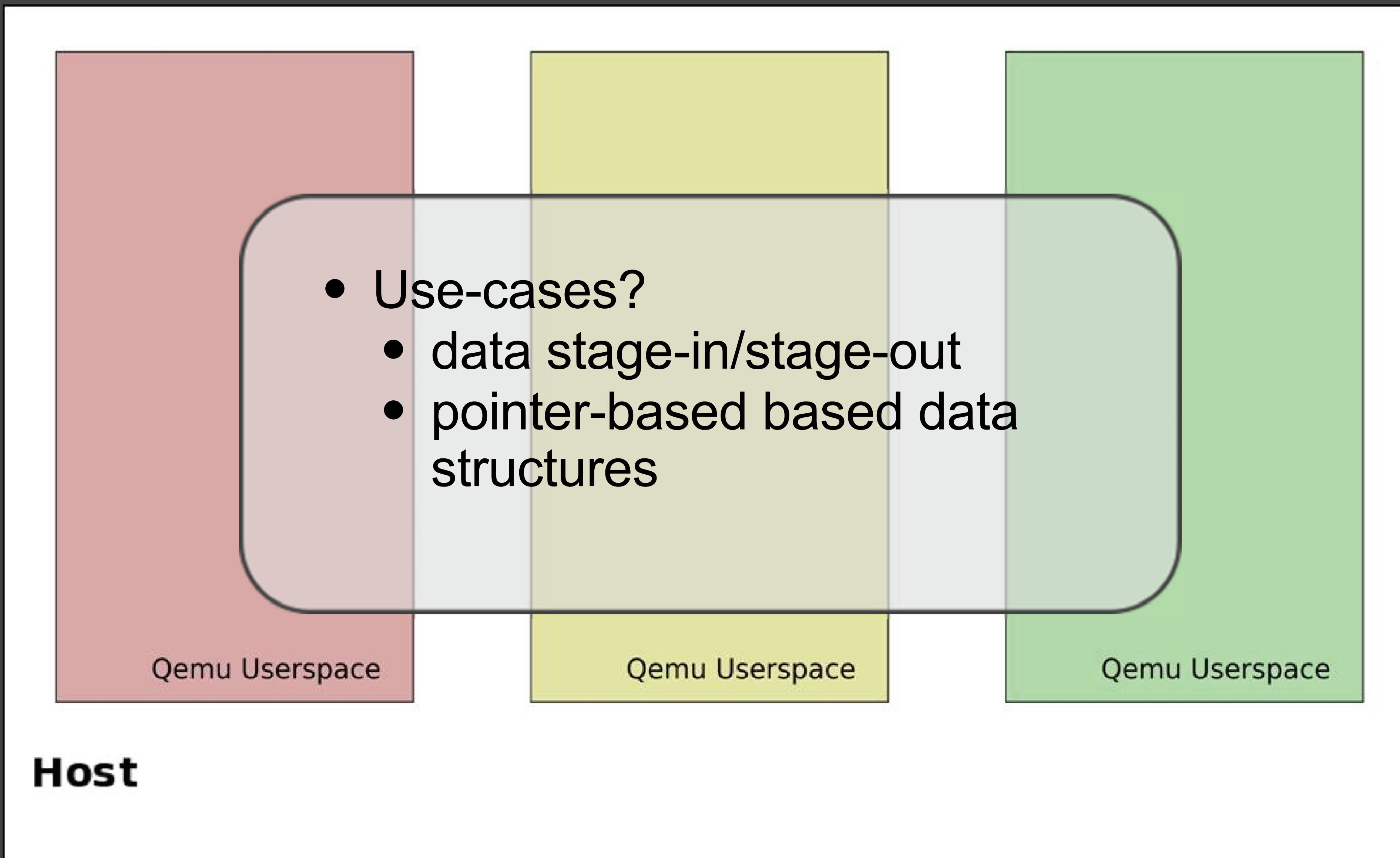
Sharing Memory

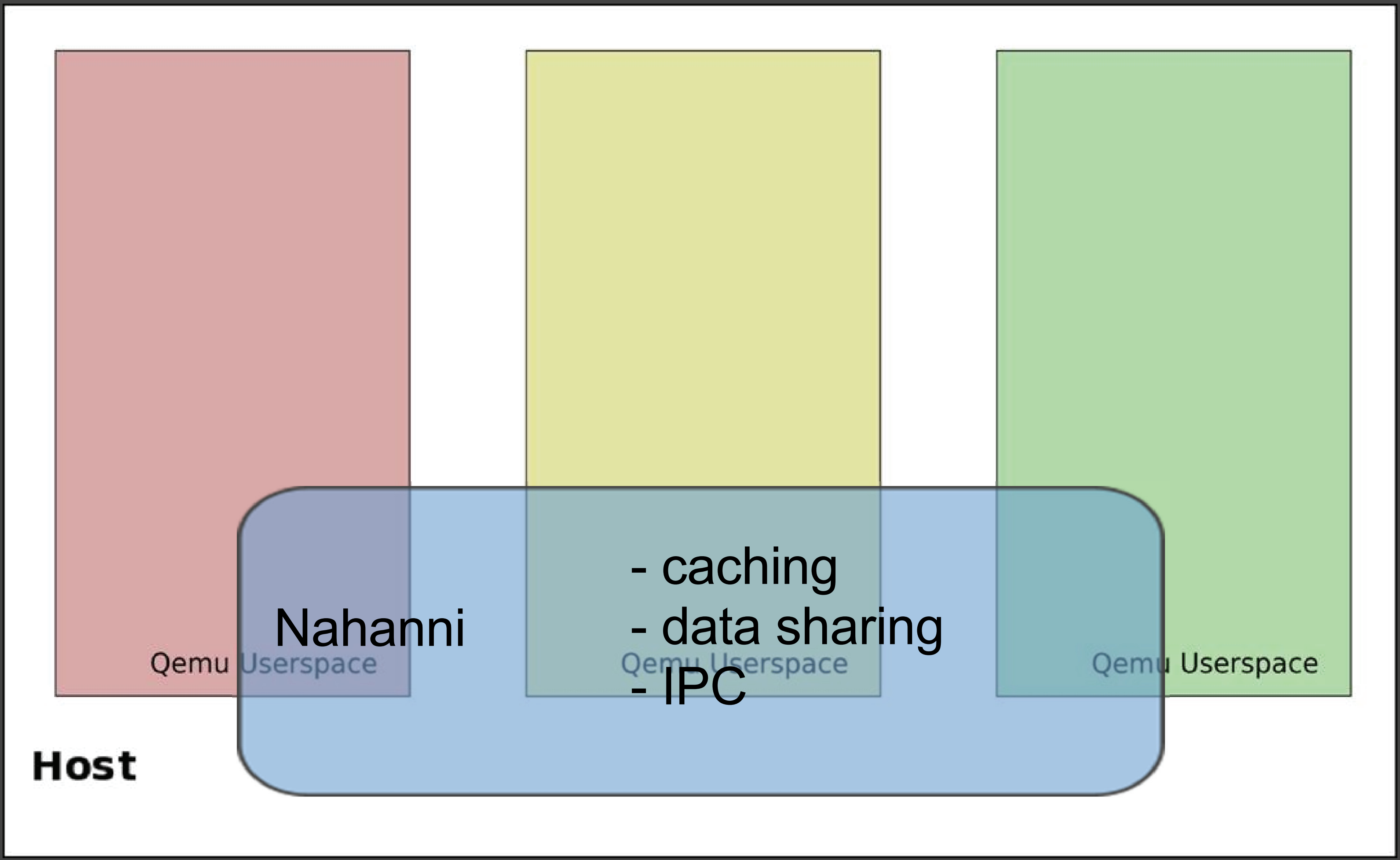


Sharing Memory

- Use-cases?
  - data stage-in/stage-out
  - pointer-based based data structures



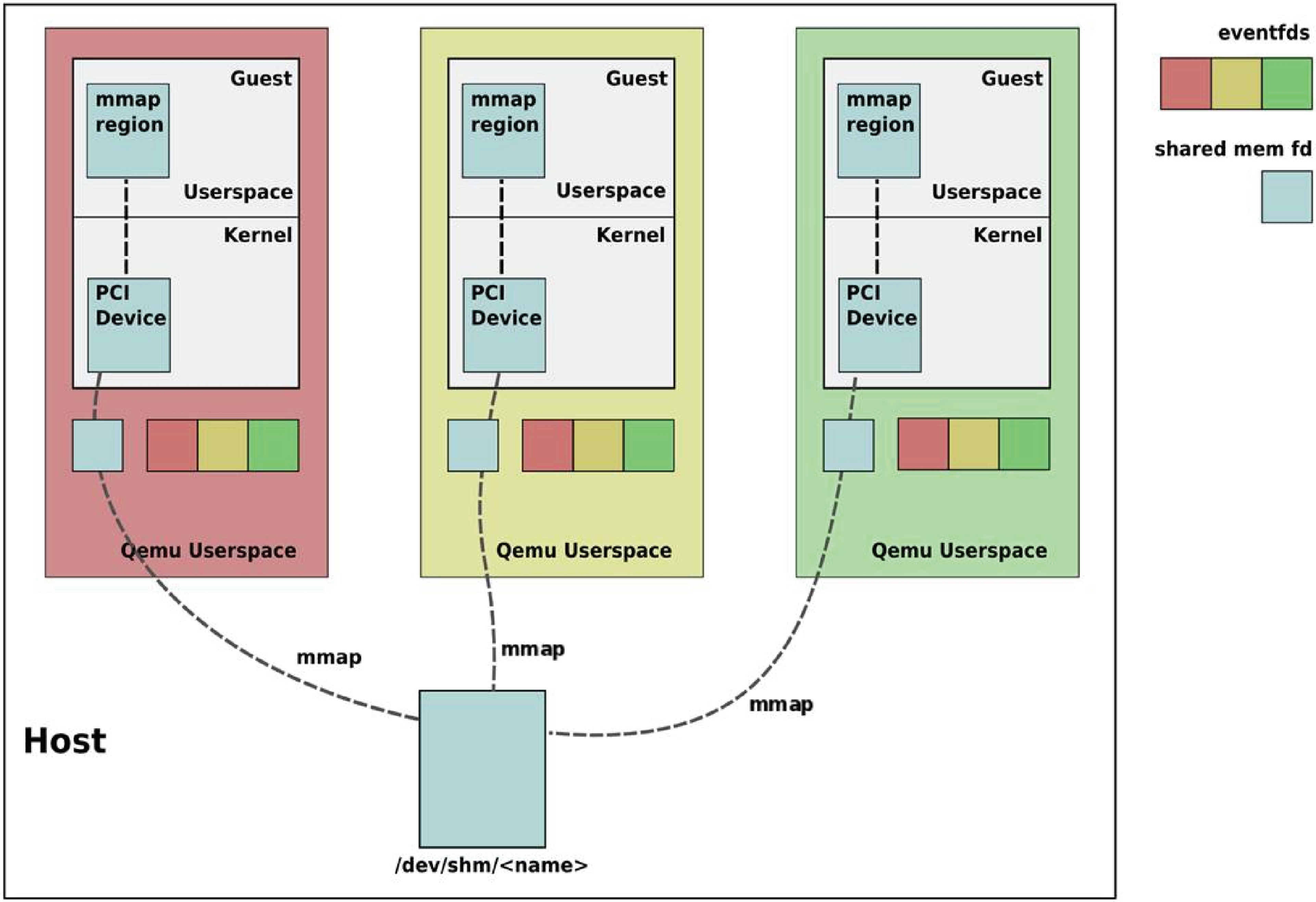
Sharing Memory

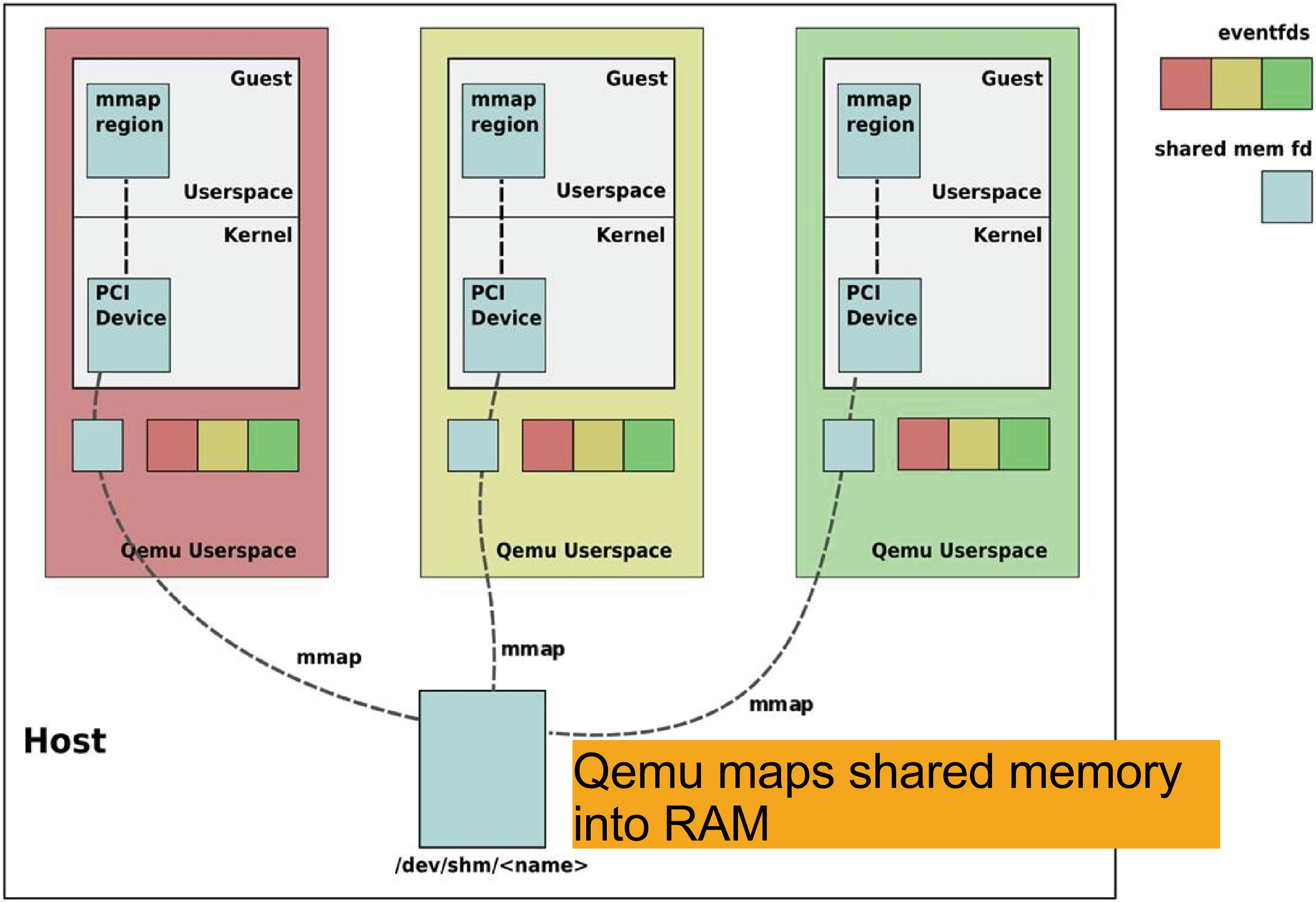


Nahanni* Overview

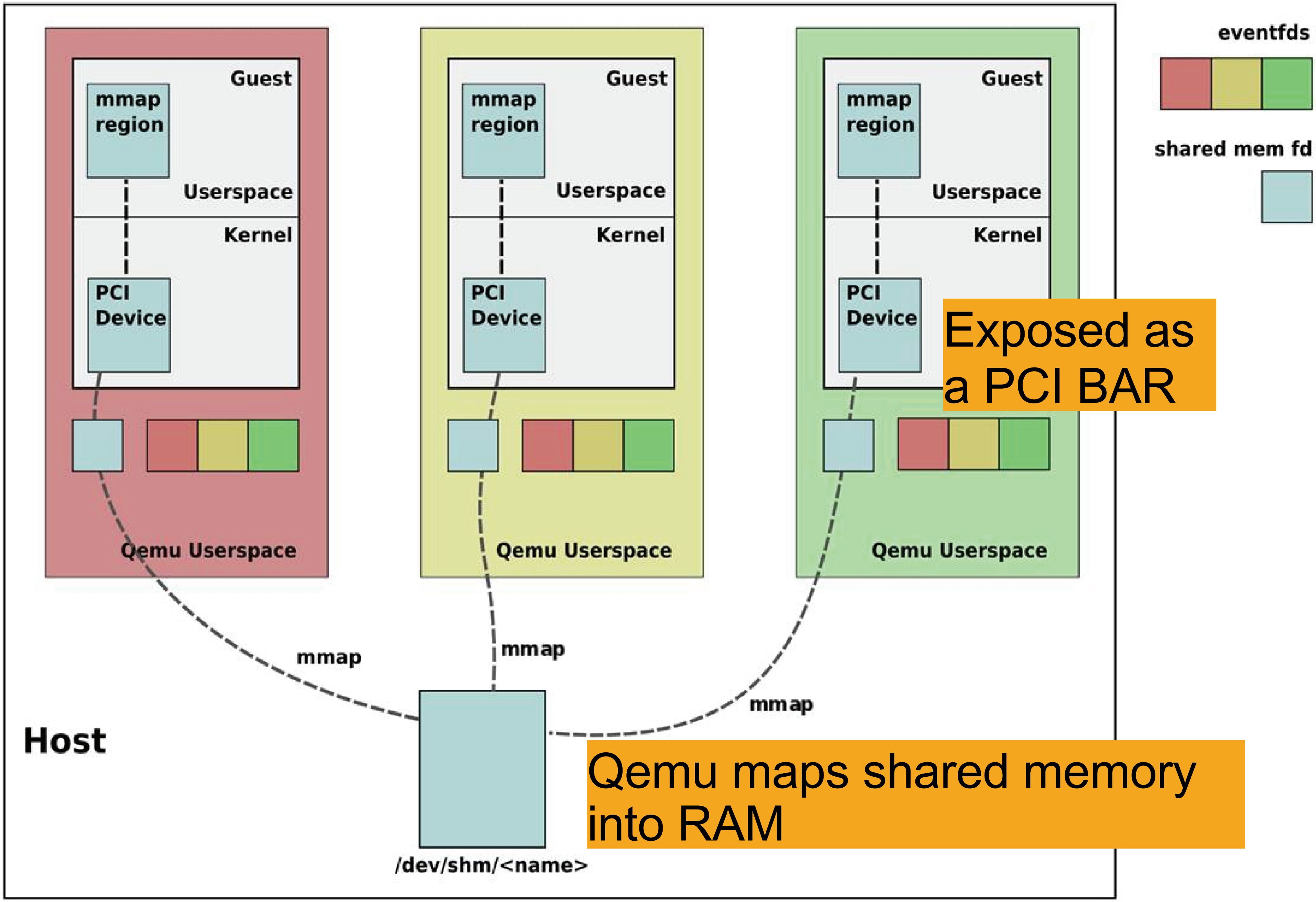
- Nahanni is a mechanism for sharing host memory with VMs running on that host
  - zero-copy access to data
  - interrupt/signalling mechanism
  - guest/guest and host/guest

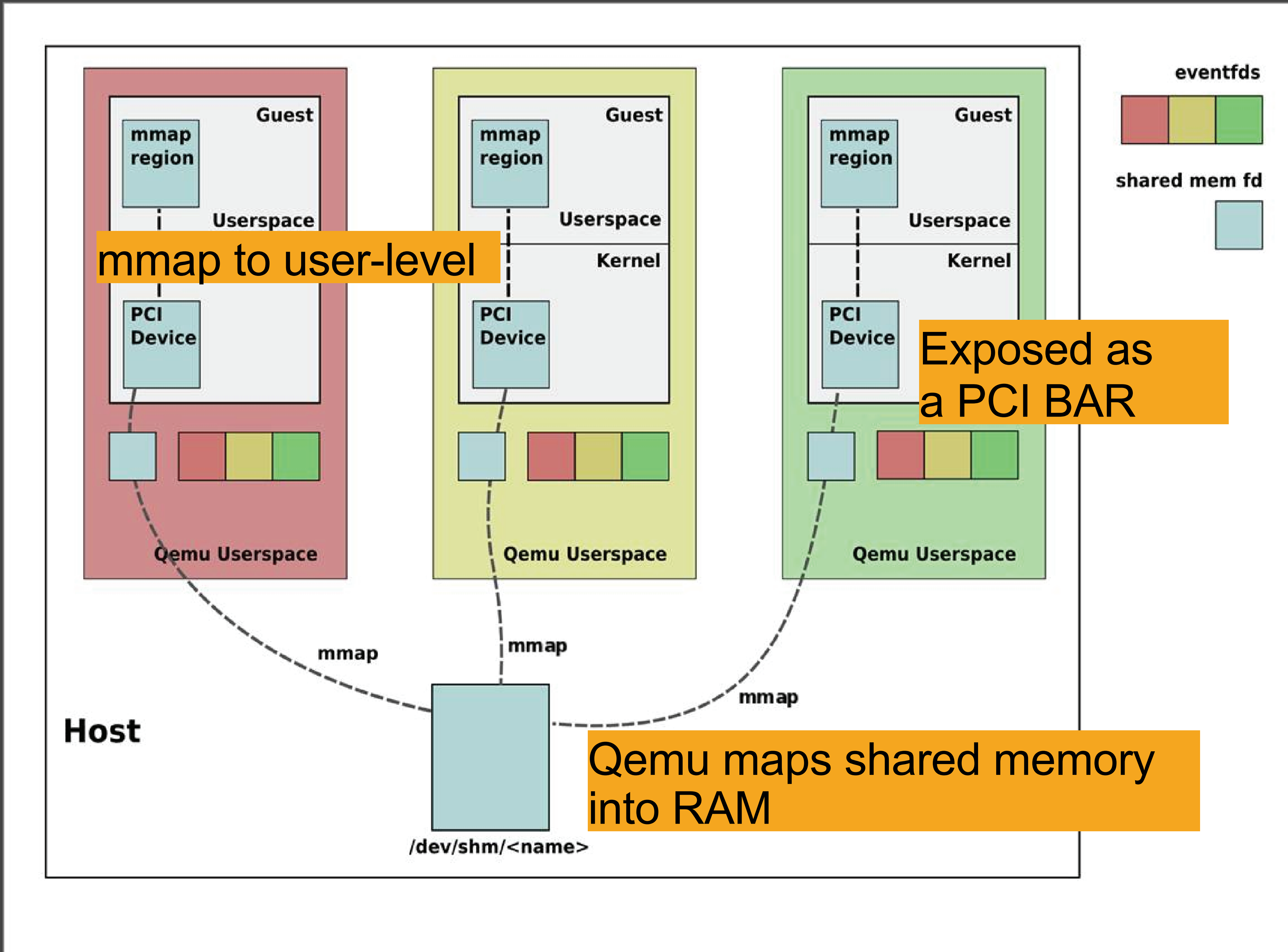
*also known as "ivshmem" on the KVM/qemu lists


Guest
mmap region
Userspace
Kernel
PCI Device
Qemu Userspace
Guest
mmap region
Userspace
Kernel
PCI Device
Qemu Userspace
Guest
mmap region
Userspace
Kernel
PCI Device
Qemu Userspace
eventfds
shared mem fd
mmap
mmap
mmap
Host
/dev/shm/<name>



Qemu maps shared memory into RAM


eventfds
shared mem fd
Guest
mmap region
Userspace
Kernel
PCI Device
Qemu Userspace
Guest
mmap region
Userspace
Kernel
PCI Device
Qemu Userspace
Guest
mmap region
Userspace
Kernel
PCI Device
Qemu Userspace
Exposed as a PCI BAR
mmap
mmap
mmap
Host
Qemu maps shared memory into RAM
/dev/shm/<name>



eventfds
shared mem fd
Guest
mmap region
Userspace
Kernel
PCI Device
Qemu Userspace
mmap
Host
/dev/shm/<name>
mmap to user-level
Exposed as a PCI BAR
Qemu maps shared memory into RAM

Using Nahanni

Start the server

```
% ivshmem_server -m 512 -p /tmp/nahanni
```

Add chardev and device to the Qemu command line

```
-chardev socket,path=/tmp/nahanni,id=nahanni
-device ivshmem,chardev=nahanni,size=512m
```

OR without interrupts

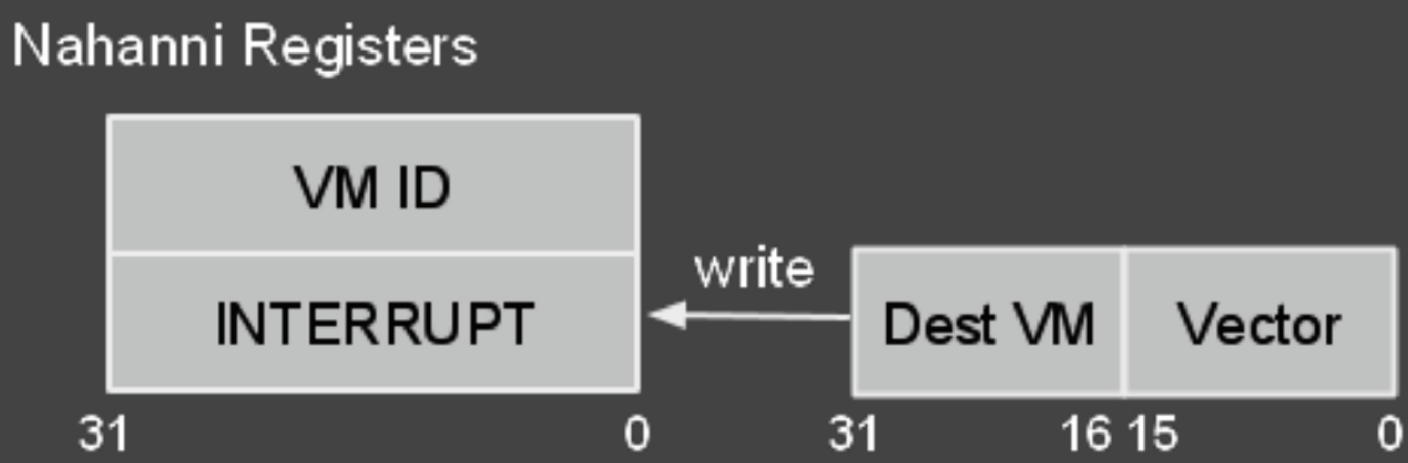
```
-device ivshmem,shm=nahanni,size=512m
```

Guest Interface

- Nahanni uses the UIO driver interface in the guest
- Initialization
  - mmap registers (map region #0)
  - mmap shared memory region (map region #1)
- Synchronization primitives
  - POSIX spinlocks work in shared memory
    - cond. variables/semaphores do not
  - GCC atomic operations work
    - MCS locks
  - Barriers
  - Interrupts

Implementation (interrupts)

- Interrupts are triggered via writes to the interrupt register




```
regs[INTERRUPT] = (dest << 16) | vector;
```

- Options
  - ioeventfd, irqfd, MSI-X

Implementation (interrupts)

- Interrupts trigger writes to the eventfds from Qemu

```
uint64_t one = 1;

write(peers[dest].eventfds[vector], &one, 8);
```

- With KVM's ioeventfd we can avoid the Qemu process

```
kvm_set_ioeventfd_mmio_long(peers[dest].eventfds[i],
        reg_addr + INTERRUPT, (dest  << 16) | vector, 1);
```

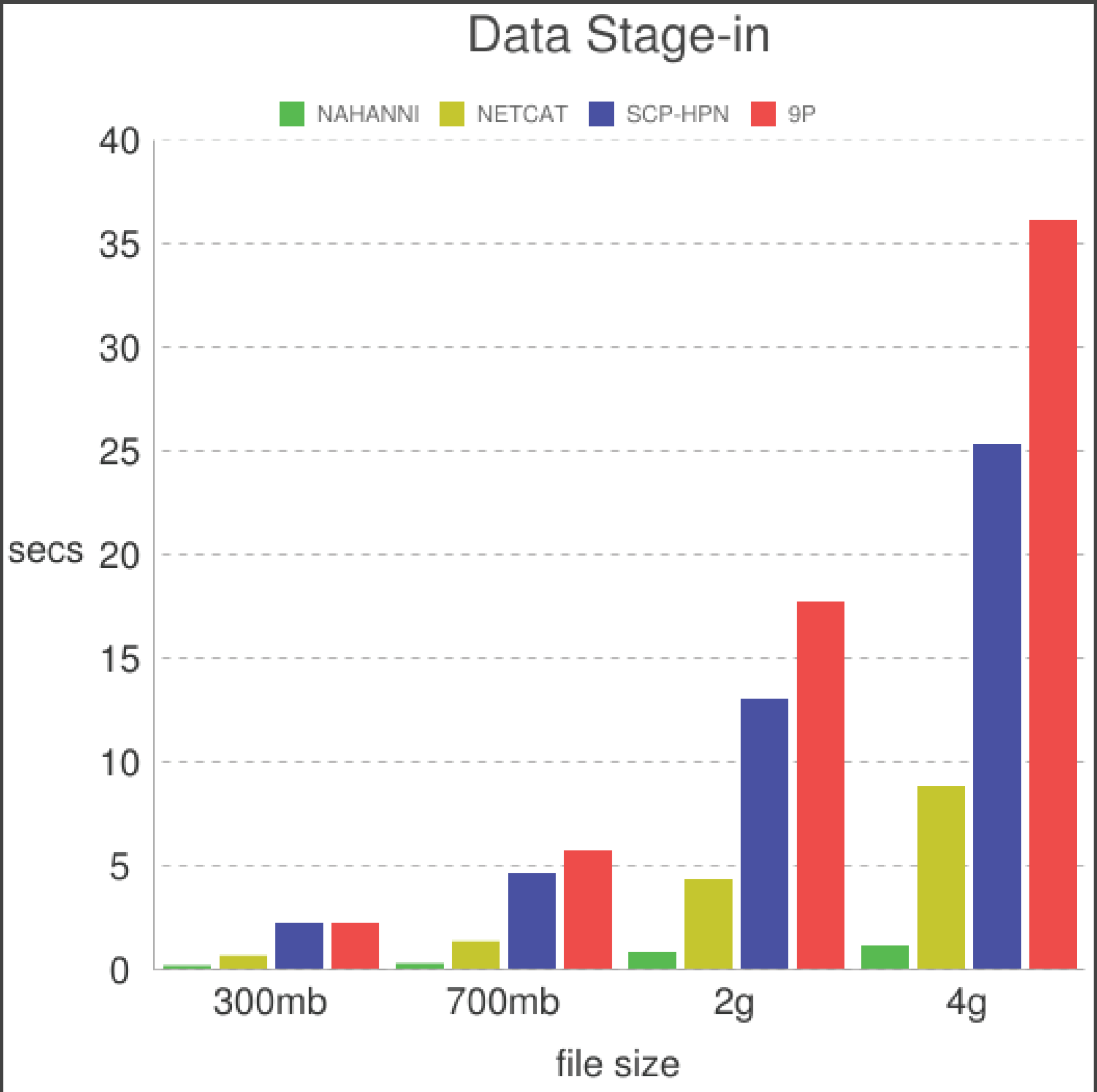
Possible Use Cases

- Simulations
  - NASA using shared memory for multiple-VM simulations that run on a custom OS
  - particle simulation (e.g. FLUID)
- Sharing application-level data
  - Moving data in Map/Reduce applications
    - Hadoop
  - Pointer-based data in Map/Reduce
    - Phoenix
- Host/guest applications

Performance

- Data staging benchmark (host-guest)
  - Nahanni
    - ring buffer using interrupts
  - Netcat & SCP-HPN
    - over virtio-net/vhost
  - 9p
- Transport mechanism is isolated
  - warm cache on host
    - no disk I/O on read
  - file is copied to /dev/null in guest
    - no disk I/O on write

Performance



Conclusions and Future Work

- Nahanni is a mechanism for sharing host memory with (possibly) multiple VMs
- Synchronization primitives
  - barrier implementation
  - reliable signalling (in progress)
- Memory Allocator for Nahanni Shared Memory
  - modifying talloc allocator that uses memory pools for allocation (in progress)
    - from Samba
- Applications (in progress)

Acknowledgements

Avi Kivity, Anthony Liguori, Alex Graf and the Qemu/KVM development communities for all the feedback

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Thank you

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www.gitorious.org/nahanni