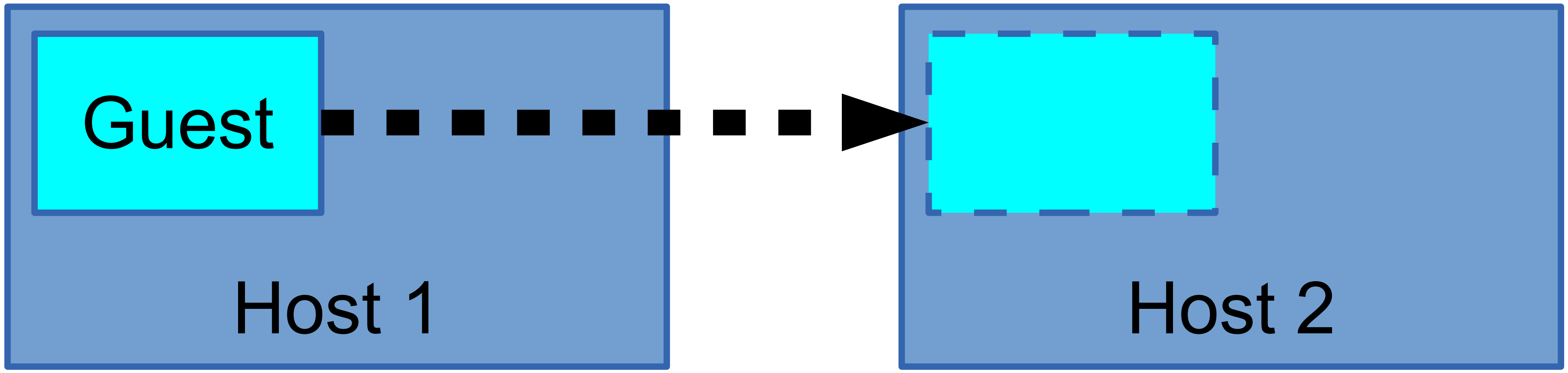
Virtual Machine Migration

NSRC

Migration

- Moving a VM from one host to another



Applications

- Load balancing
  - Move VMs to a less busy host
  - Make use of newly-added capacity
- Maintenance
  - Move VMs off a host before it is shut down
- Recovery from host failure
  - Restart VM on a different host

Types of migration

- Cold migration
  - Shutdown VM on host 1, restart on host 2
- Warm migration
  - Suspend VM on host 1, copy across RAM and CPU registers, continue on host 2 (some seconds later)
- Live migration
  - Copy across RAM *while VM continues to run*
  - Mark "dirty" (changed) RAM pages & re-copy
  - Brief suspension for final copy (<< 1 sec)

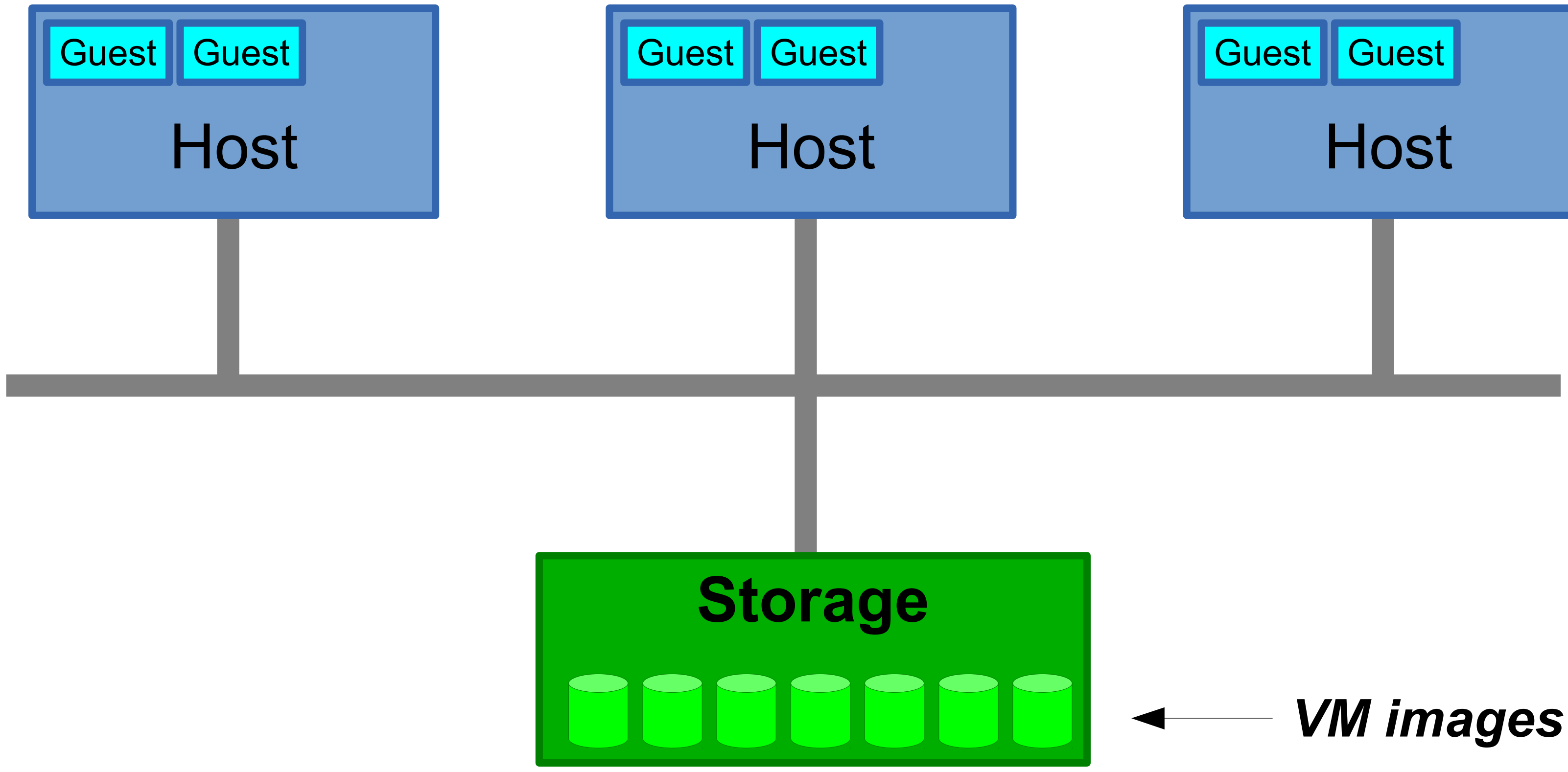
Migration and libvirt

- It does work, but not the ideal tool
- libvirt manages individual hosts, so it doesn't have a cluster-wide view
  - by default won't prevent the same VM starting up in two places at once (very bad!)
    - "sanlock" plugin available
  - can end up with multiple copies of the XML definition file on different hosts

Migration and Storage

- The VM disk image has to be accessible from the new host after the migration
- Just copy the image across?
  - Slow
  - Fine for a cold migration though
- Can we do a "live migration" of storage?
  - Yes (e.g. very recent versions of kvm can do this)
  - Risky
  - Doesn't help recover from node failure

Traditional solution: shared storage



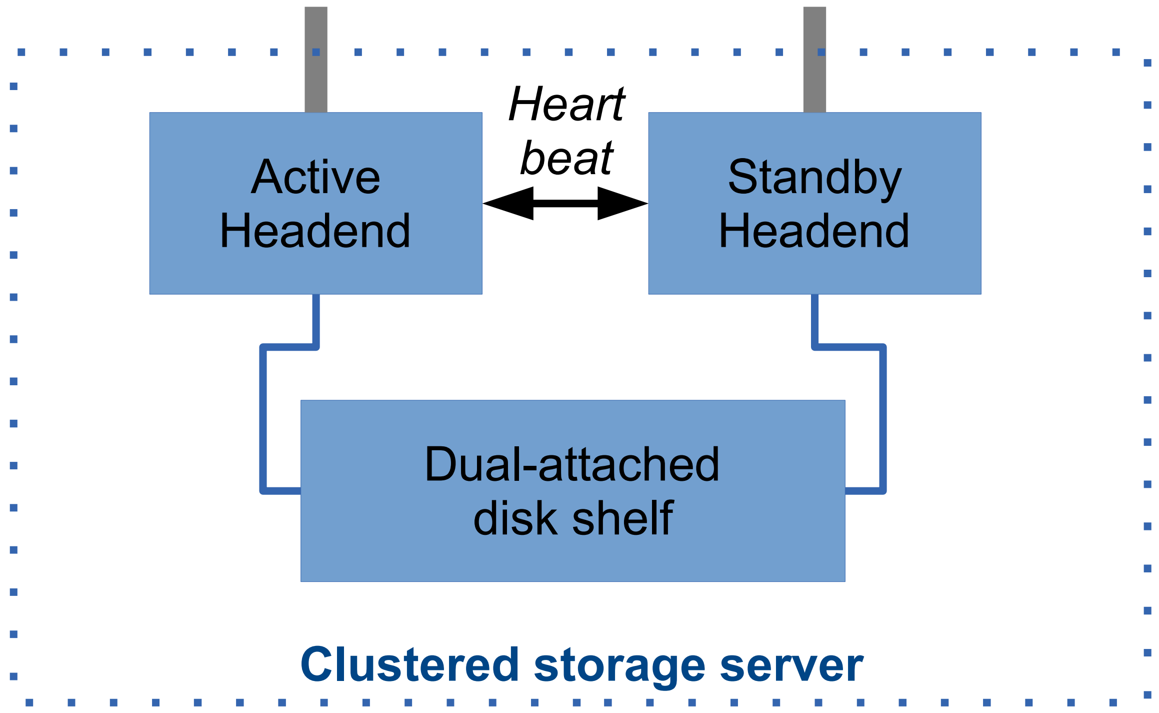
Advantages of shared storage

- Complete mobility of VMs with live migration
- Can scale the compute nodes and the storage nodes independently
- Simpler compute nodes
  - little or no local storage required
- Central point of volume management
- Central point of backup / DR

Disadvantages of shared storage

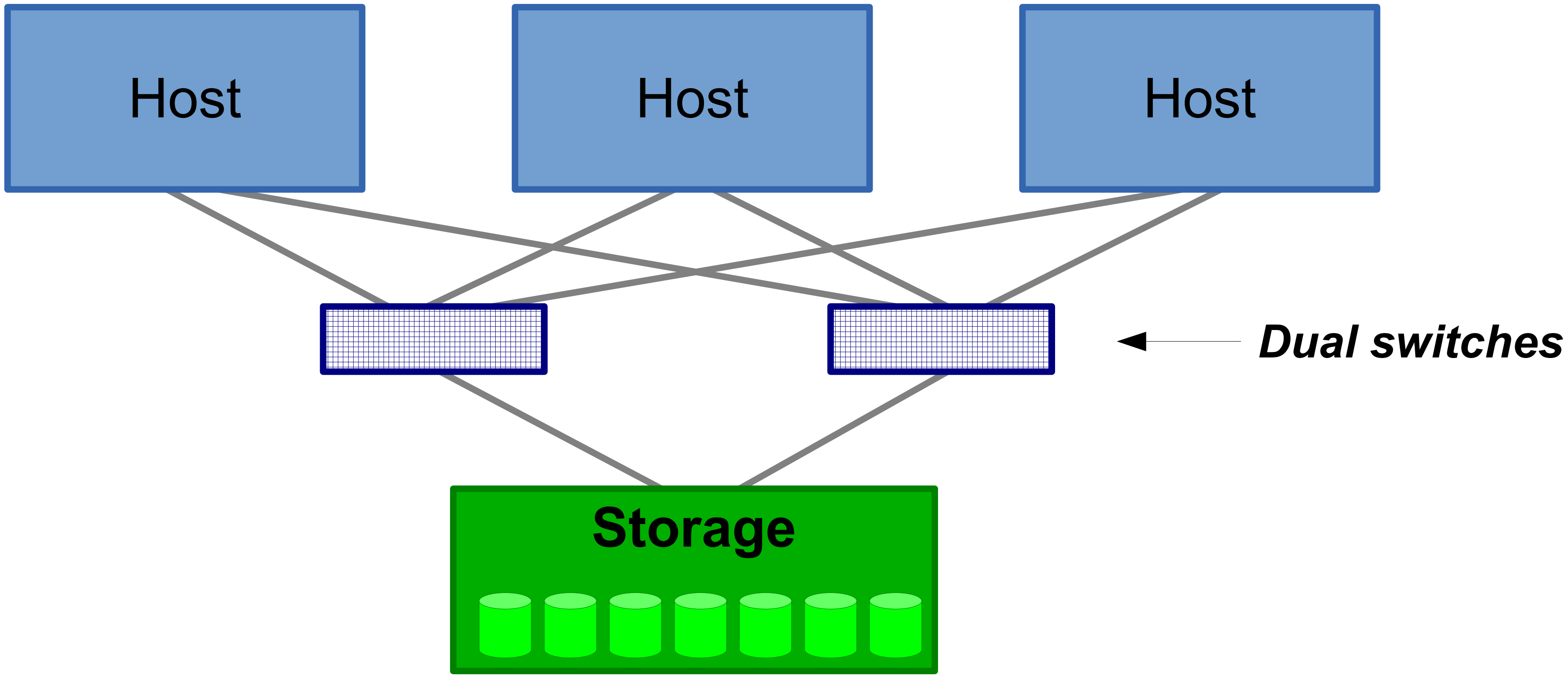
- Storage becomes single point of failure
- Network becomes single point of failure
- Network bandwidth can be a bottleneck
- Network latency can impact performance
- Network security
  - keep storage on a completely separate network
- Risk of accidentally starting two VMs using the same disk image!

Avoiding storage server SPOF



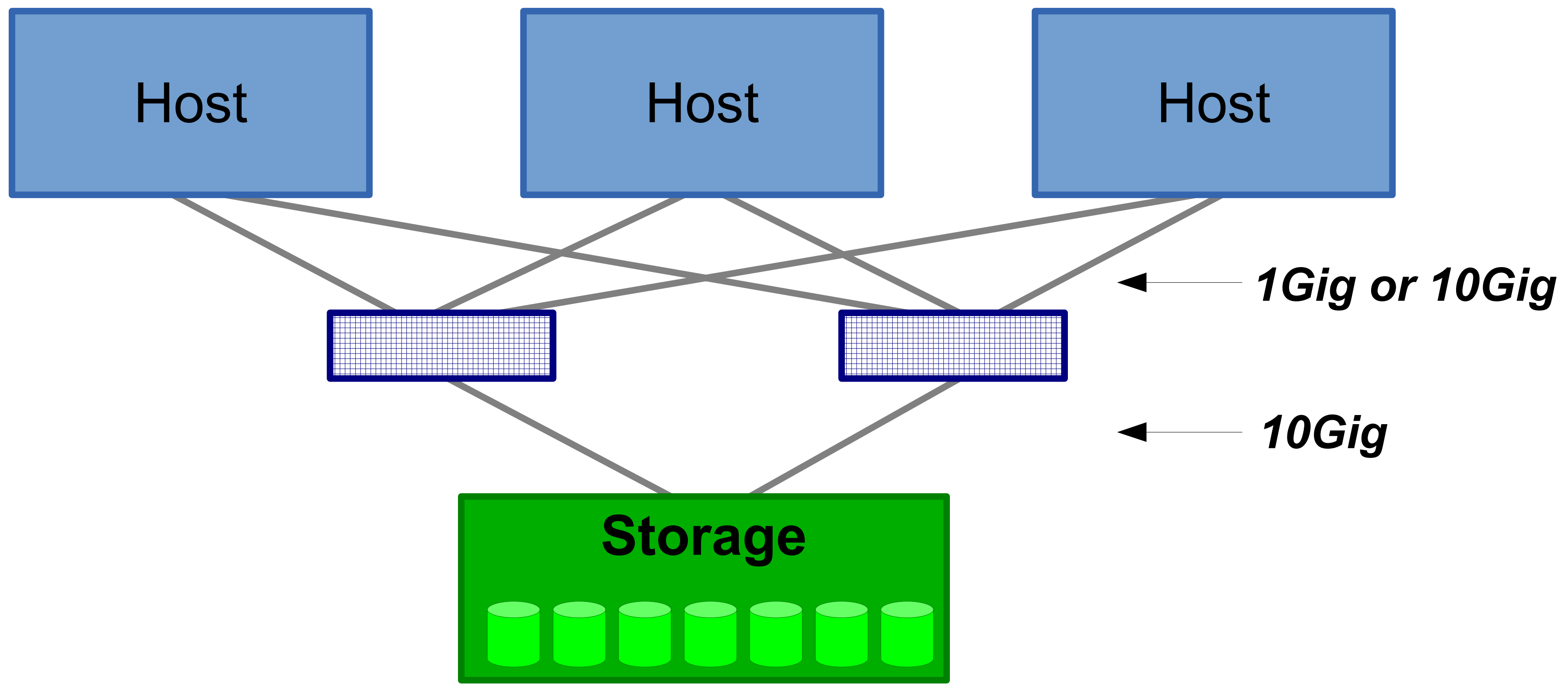
- This is **very hard** to build correctly
- Vendors will sell this to you for $$$

Avoiding network SPOF



Or you can buy a *really expensive* chassis switch with multiple power supplies, line cards, switching fabrics and management cards

Network bandwidth



Note: 1Gbps ≈ 100MB/sec ≈ throughput of a single hard drive

Latency

- Time between sending a request and receiving the reply
- Some applications are very latency sensitive
  - e.g. a database which writes to disk and waits for confirmation that data has been written
- Networking adds to the latency
  - 10G on CAT6/RJ45 has higher latency than fibre or SFP+ direct-attach cables
  - alternatives to ethernet: fibre channel, infiniband

Questions?

Shared storage protocols

- Fundamentally two types:
- Shared filesystem
  - a.k.a. "Network Attached Storage" or "NAS"
- Shared block device
  - a.k.a. "Storage Area Network" or "SAN"

Shared filesystem

- Client has remote access to server's filesystem
  - requests like "read directory", "open file named X"
- Examples:
  - NFS
  - CIFS (Windows/Samba shares)
- VM images are just files on the server
  - very easy to set up and understand
  - directory of image files, just happens to be remote
  - disk image files may support snapshots

Using shared filesystem

```
# mount s1:/var/lib/libvirt/images /mnt
# ls /mnt
debian1.img
debian2.img
debian3.img
debian4.img
...
```

Limitations of shared filesystem

- Overhead of traversing the kernel filesystem at both client side and server side
- Usual issues with disk images at the server side (e.g. fragmentation)

Shared block device

- Remote requests to read/write block N
  - this is closer to what the VM expects
- Server side can map these requests to a physical drive, a logical volume or an image file
- Examples:
  - iSCSI (standard, heavyweight)
  - **nbd (Linux only)**
  - ggated (FreeBSD only)
  - Fibre Channel ($$$)

nbd: server side

__/etc/nbd-server/config__

```
[generic]
        user = nbd
        group = nbd
        includedir = /etc/nbd-server/conf.d
        listenaddr = 10.10.0.241
        oldstyle = true

# Repeat for each volume to export
[disk1]
        exportname = /data/nbd/disk1.img
        port = 20001
        flush = true
        fua = true
```

"Old style" nbd protocol uses a different TCP port per volume. New servers use named volumes all accessible on the same port (10809)

nbd: client side

```
# nbd-client s1.ws.nsrc.org 20001 /dev/nbd0
# blockdev --getsize64 /dev/nbd0
2147483648


...


# nbd-client -d /dev/nbd0
```

- You can use /dev/nbd0 just as you would a local block device (mkfs, mount etc)

nbd: direct access from KVM

```
<disk type='network' device='disk'>
  <driver name='qemu' type='raw'/>
  <source protocol='nbd'>
    <host name='s1.ws.nsrc.org' port='20001'/>
  </source>
  <target dev='hda' bus='ide'/>
  <address type='drive' controller='0'... />
</disk>
```

- KVM knows how to speak the nbd protocol - so it can bypass the kernel's nbd client

nbd limitations

- Changing the config file requires a server restart, which can impact on active clients
  - Clients may see I/O errors
    - kvm's built-in nbd client fails to reconnect?
    - `apt-get install -t wheezy-backports qemu-kvm`
    - Still doesn't seem to work right
  - Pre-create logical volumes and export them before you need them?
- No security, apart from optional "IP allow"
  - Keep all nbd traffic on a separate network!

nbd tricks

- Alternative nbd server implementations
  - xnbd-server
    - nbd proxy for migrating disk images
  - flexnbd-c
    - separate IPv6 address per volume, migration support
- Test them before deployment!

Alternatives to shared storage

- Distributed storage
  - Examples:
    - Sheepdog - for KVM images only
    - Ceph (rbd) - general purpose
    - Glusterfs
  - Data is stored on multiple nodes
    - In principle resilient against loss of single node
    - Complexity, "split brain" problems
- Replicated storage
  - drbd - as used by Ganeti

Summary

- Migration of virtual machines allows load balancing and cluster maintenance
- Live migration makes this invisible to VM users
  - can achieve very high uptime
- Access to storage is the key
- Various options for shared, distributed or replicated storage
- Can be difficult and expensive to build for high availability