What a Lustre Cluster

(Improving and Tracing Lustre Metadata)

yaaaasss

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Overview

- Motivation
- Configuration
- Tracing Metadata
- Improving Metadata Hardware
- Multiple Lustre Clients via Virtualization
- Conclusions & Future Work

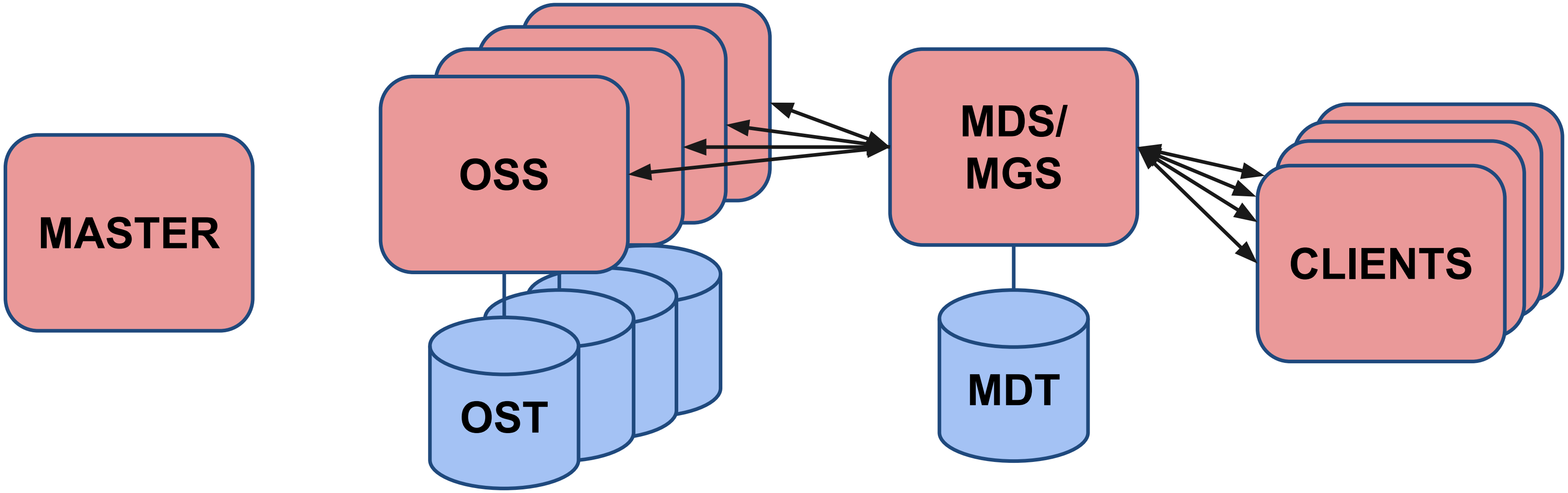
Motivation

- **Tracing Metadata Motivation**
  - Can we get enough information without too much overhead?
- **Improving Metadata Hardware Motivation**
  - MDS can be a performance bottleneck
  - Faster MDT ☞ better performance?
- **Lustre Client Virtualization Motivation**
  - Single Lustre Client/Node underutilized IB device
  - Higher throughput ☞ Less transfer agents needed
  - Multi-VM nodes ☞ better throughput?

Lustre Configuration

- **TAMIRS**
  - MASTER (sa-master)
  - 4 X OSS (sa02-sa05)
    - Single disk RAID0
  - 1 X MGS/MDS (sa01)
    - hdd, nvme, KOVE
  - 5 X CLIENTS (sa06-sa10)

- **PROBE**
  - MASTER (n01)
  - 5 X OSS (n02-n05,n11)
    - 8 disk RAID0
  - 1 X MGS/MDS (n06)
  - 2 X CLIENTS (n07-n08)
  - 2 X VM CLIENTS (n09-n10)

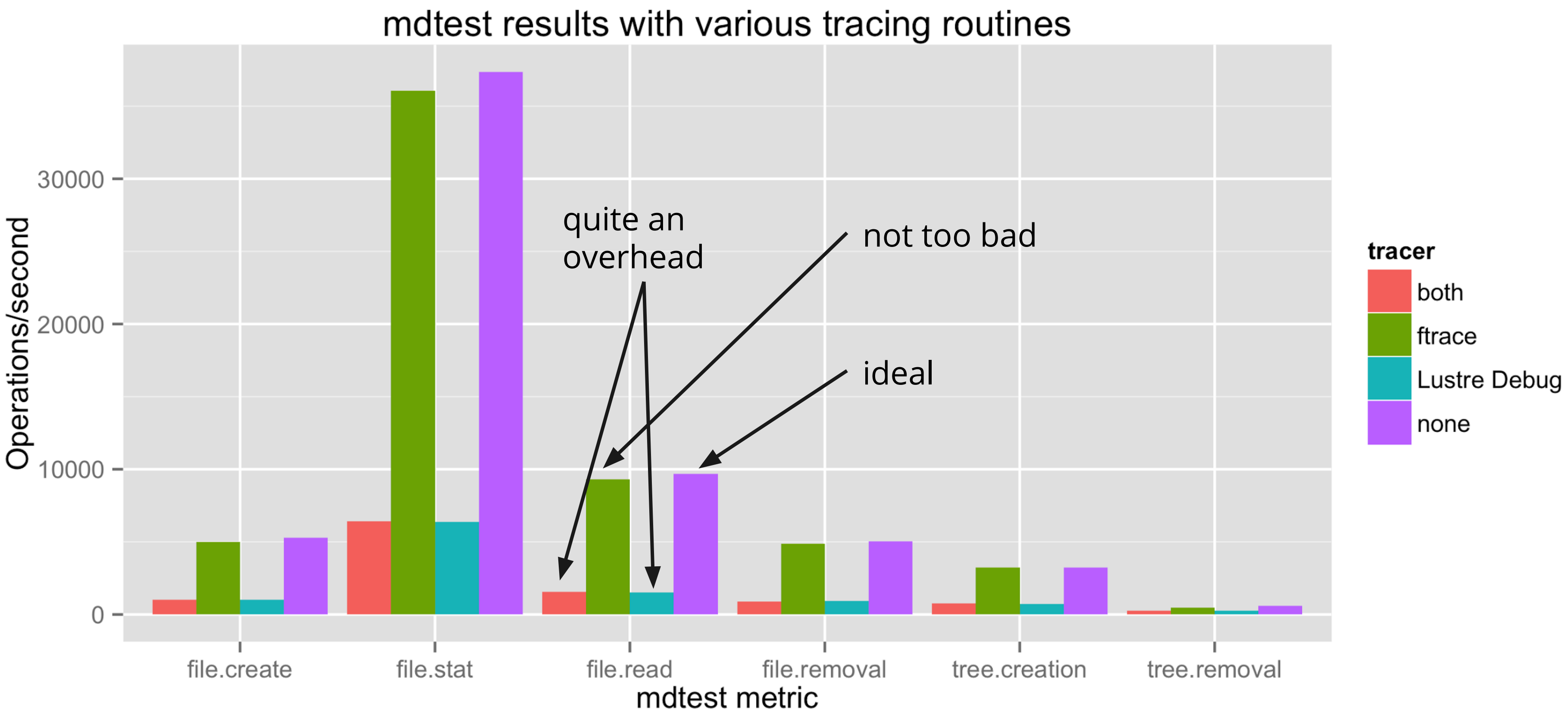


MDS Tracing

Tracing Metadata

- Test tool: mdtest
- Tracers
  - Lustre Debug
  - debugfs (ftrace)
- Mask
  - ftrace - create, open, link, unlink, readdir, getattr, setattr
  - Lustre Debug - no mask

Tracing Metadata - Results



quite an overhead

not too bad

ideal

MDS Hardware

Improving Metadata Hardware

- **HDD**
  - meh. (96.7 MB/s write & 206 MB/s read)
- **NVMe**
  - Fast! (686MB/s write & 1.3GB/s read)
- **KOVE Express Disk (XPD)**
  - RAM Storage Appliance
  - FAAAST! (2.8GB/s write & 3.5GB/s read)

Improving Metadata Hardware - Testing

- **mdtest**
  - Concerned with node caching (dropped caches!)
  - Performance still “low”

- **MDS-Survey**
  - Runs on MGS/MDS
  - Independent of CLIENT and OSS nodes.

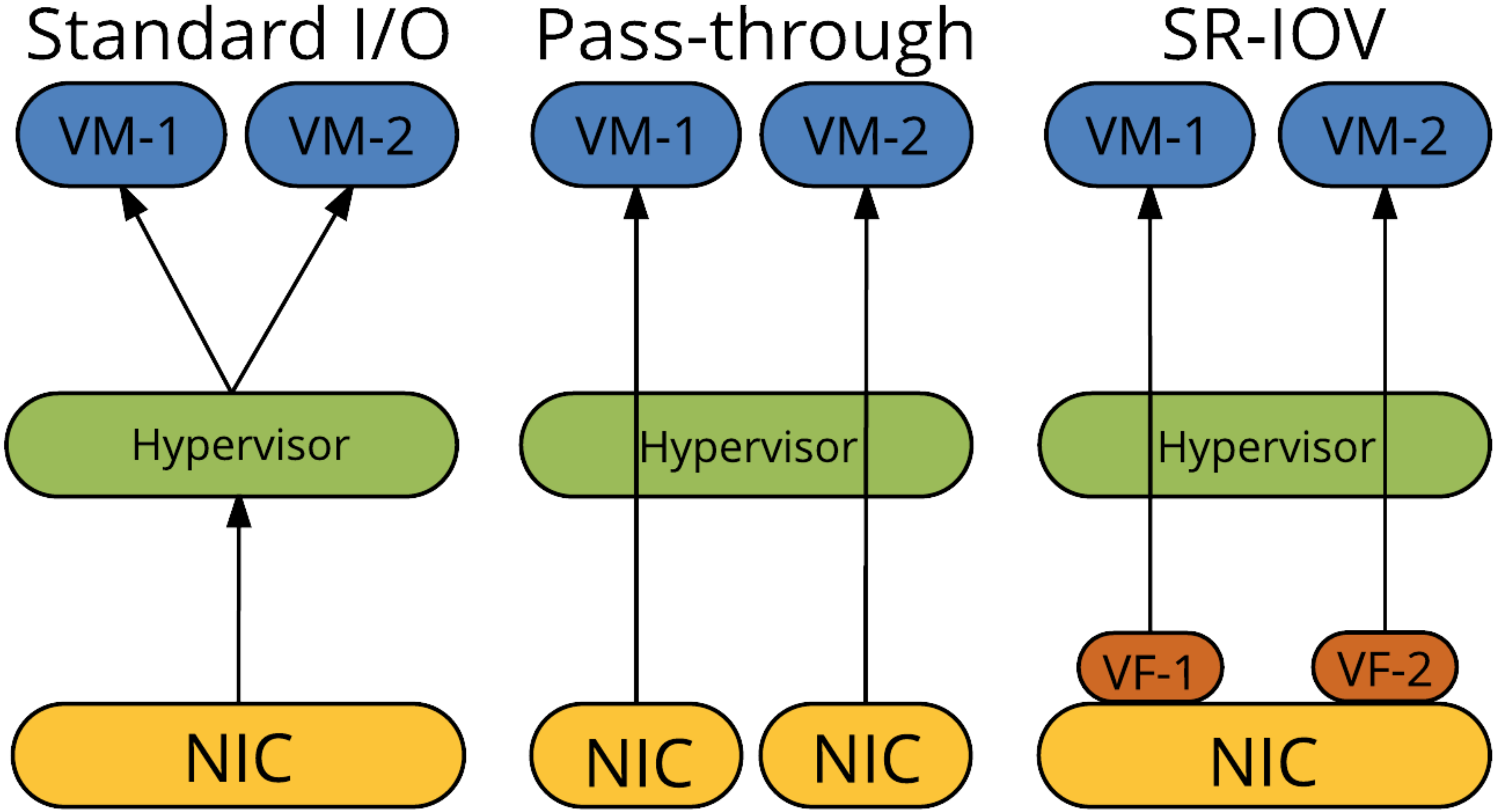
Improving Metadata Hardware - Results

	hdd to nvme (%)	hdd to kove (%)	nvme to kove (%)
create	**19.57**	**20.12**	0.46
lookup	-1.67	0.99	2.70
md_getattr	-0.12	4.72	4.85
setxattr	**287.45**	**244.46**	-11.09
destroy	**43.45**	**46.83**	2.36

PERCENT INCREASE FROM NVME TO HDD, KOVE TO HDD, & KOVE TO NVME

Lustre Client Virtualization

SR-IOV


Standard I/O
Pass-through
SR-IOV
VM-1
VM-2
VM-1
VM-2
VM-1
VM-2
Hypervisor
Hypervisor
Hypervisor
VF-1
VF-2
NIC
NIC
NIC
NIC

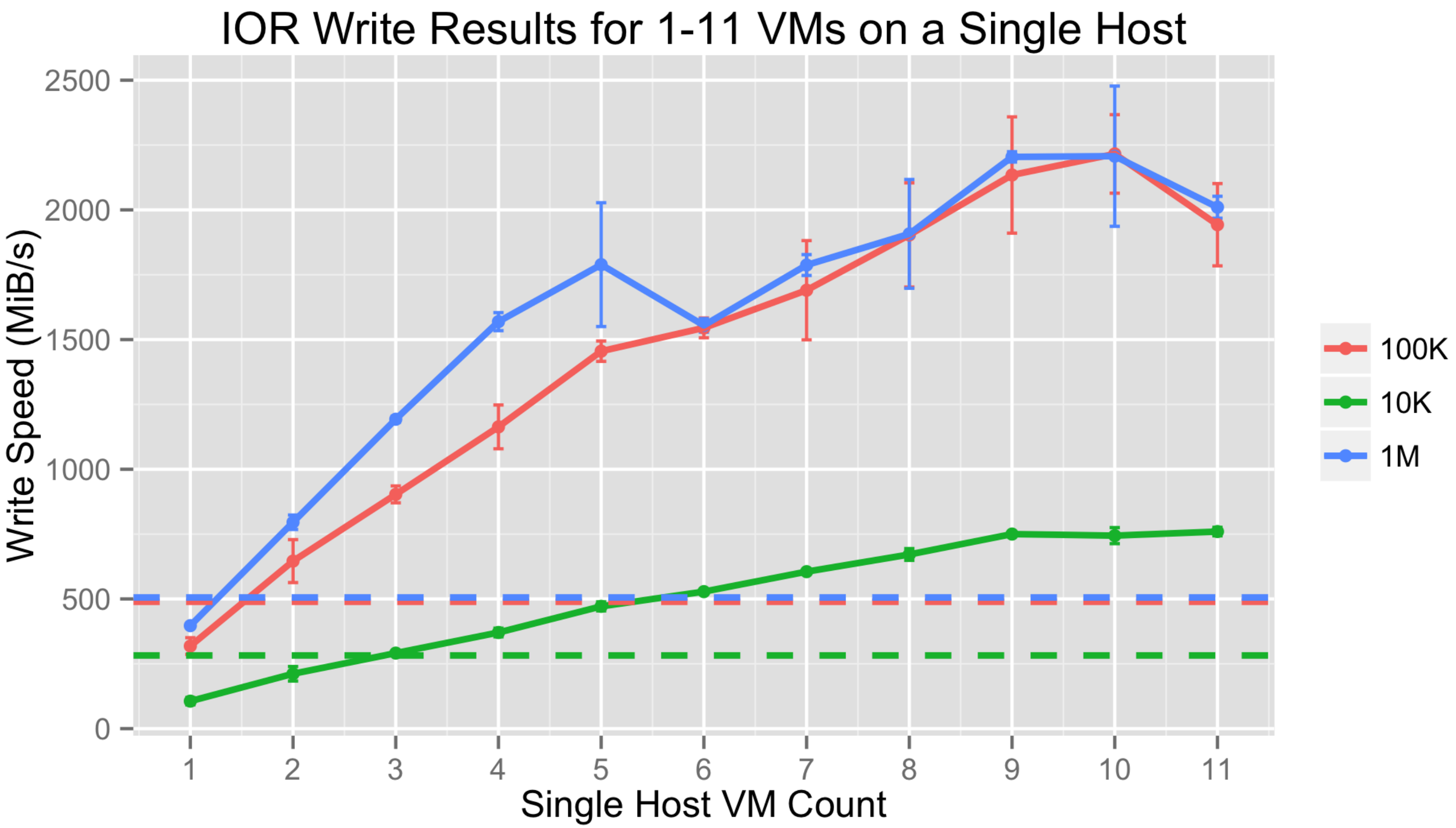
Multiple Lustre Clients via Virtualization

- Enable SR-IOV
- KVM hypervisor with Centos 6.6 VMs on top
- Attach *n* Virtual Functions (VF) to the Physical Function (the device)
  - Virtual Functions just interfaces
  - $n \in [1\text{-}11]$

Testing Client Performance

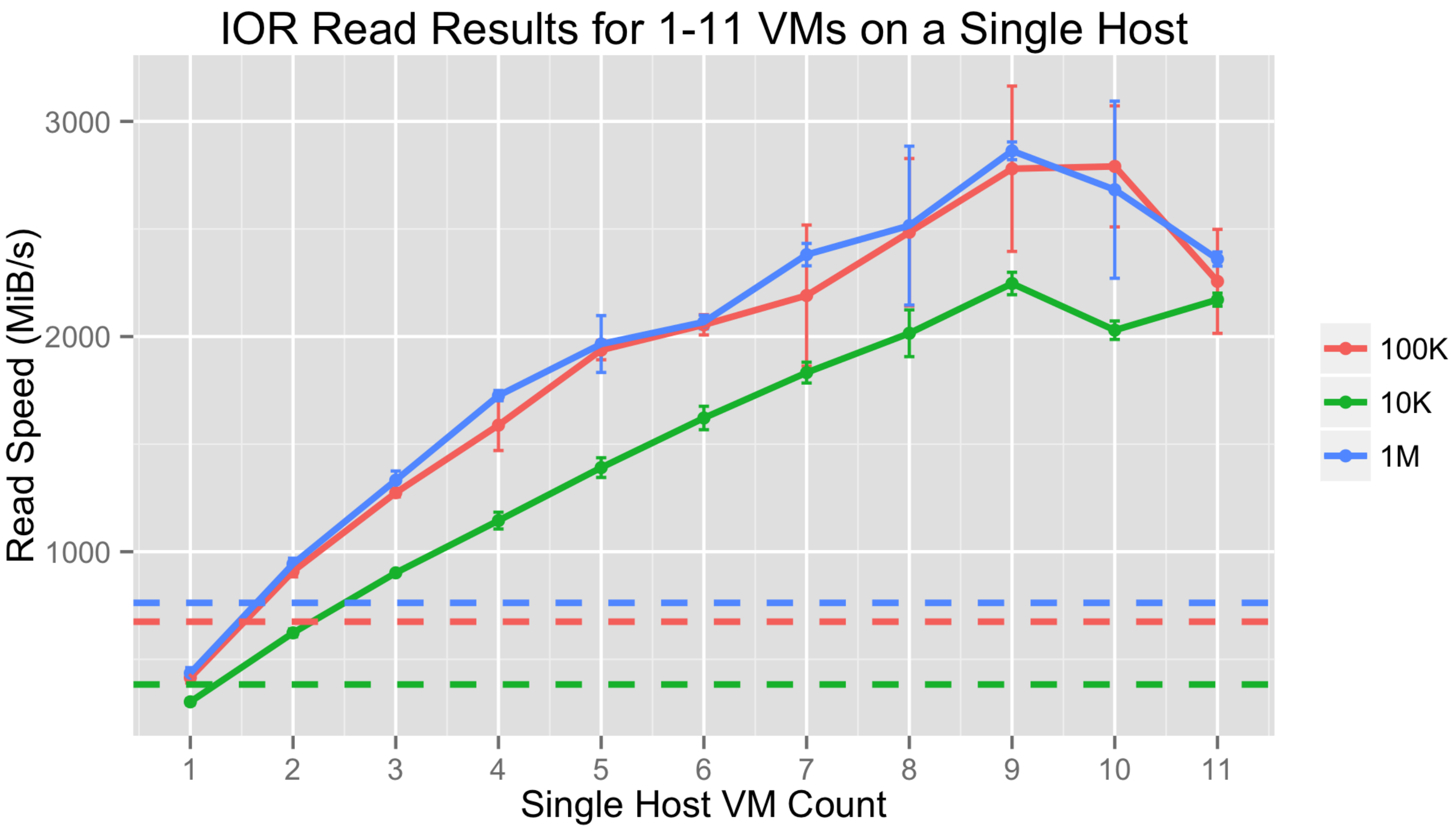
- IOR
- Trinity Test from NERSC
  - POSIX Only
- N to N writes/reads
  - 44.7 GiB File per Client
- 10K, 100K, 1MB transfer sizes

IOR Write Results



(dashed lines are native installs)

IOR Read Results



(dashed lines are native installs)

VM Problems

- Hardware Restrictions
  - More than 2GB Ram Needed
  - Only 12 physical Cores
- IB Subnet Manager Needed on Host
- VMware's ESXi Hypervisor
  - Mellanox drivers for ESXi didn't support SR-IOV, only pass-through
  - Not Free

Conclusions

- MDS Tracing
  - Large Overhead or Not Extensive
- MDS Hardware
  - Improvements << Cost
- Virtualization of Clients
  - Scalable!
  - Worth Further Exploration

Future Work

- More Virtualization!
  - Put VMs in a VM so we can virtualize our virtualization allowing us to virtualize while we virtualize (and manage SR-IOV better)
    - Changing the number of VFs requires a reboot which is slow
  - Greater number of VMs (>11)
- Local subnet on each host
- SR-IOV with verbs on ESXi

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Questions?

such fast
many vm
many GBs
such bandwidth
quite speedy
lots storage
wow verbs wow
wow
much Lustres
hi lester
so questions
such professional
such verbs