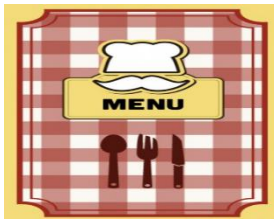
•Building an Open Memory-Centric Computing Architecture using Intel Optane

•Frank Ober
•Efstathios Efstathiou

•Oracle Open World 2017 – October 3, 2017

Open MCCA

Agenda



- The legal stuff
- Why Memory Centric Computing?
- Overview of Open Memory Centric Computing Architecture (OpenMCCA)
- Optane SSDs performance capabilities (Frank Ober, Intel)
- OpenMCCA: Technical Demos
- Summary with Q/A

The legal stuff

Disclaimer for Efstathios Efstathiou

- In this presentation I express my view of things based on my expertise as gathered as Expert for Oracle Technology, which may in some aspects be different from the strategic decisions of my employer
- Part of my research is based on project work for the Swiss Government, while some work and studies were done in my personal free time for my personal education
- OpenMCCA was developed entirely on my personal free time

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•Why Memory Centric Computing?

•History

- Started as Engineering task to better understand Infiniband
- Create an NVMe Storage Server using a PCIe Switch Chip
- Experimented with PCIe NTB and Device Sharing
- Goal is to build Fabric Attached Memory Concept

•Engineering Work (Work Time)

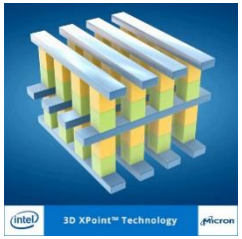
•Saturday's Club Work (Private Time)

INFINIBAND TRADE ASSOCIATION

nvm EXPRESS

flashgrid

PLEXISTOR



PCI EXPRESS

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A

•2016

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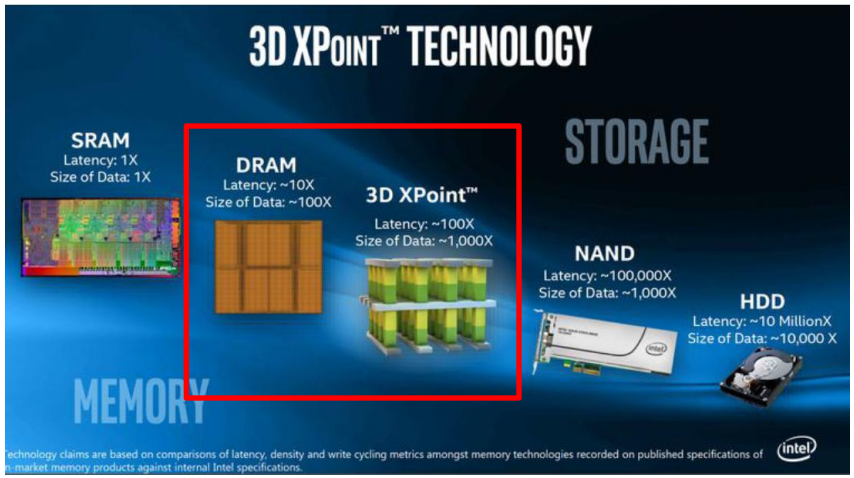
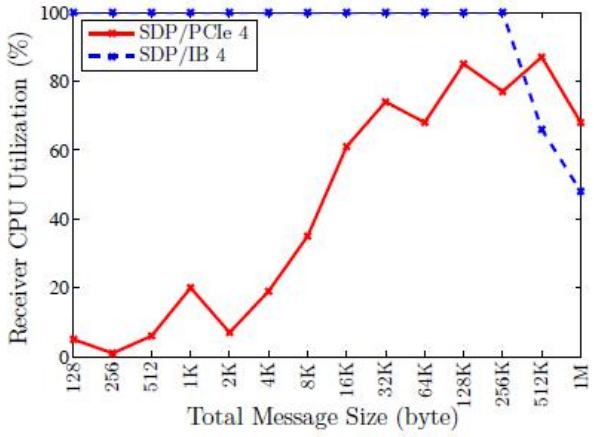
•Why Memory Centric Computing?

•Technical toughts

- Ideally everything would be memory
- Network ist the bottleneck (latency)
- Multiple protocols (transport, storage, interconnect)
- Why not use what's already there?

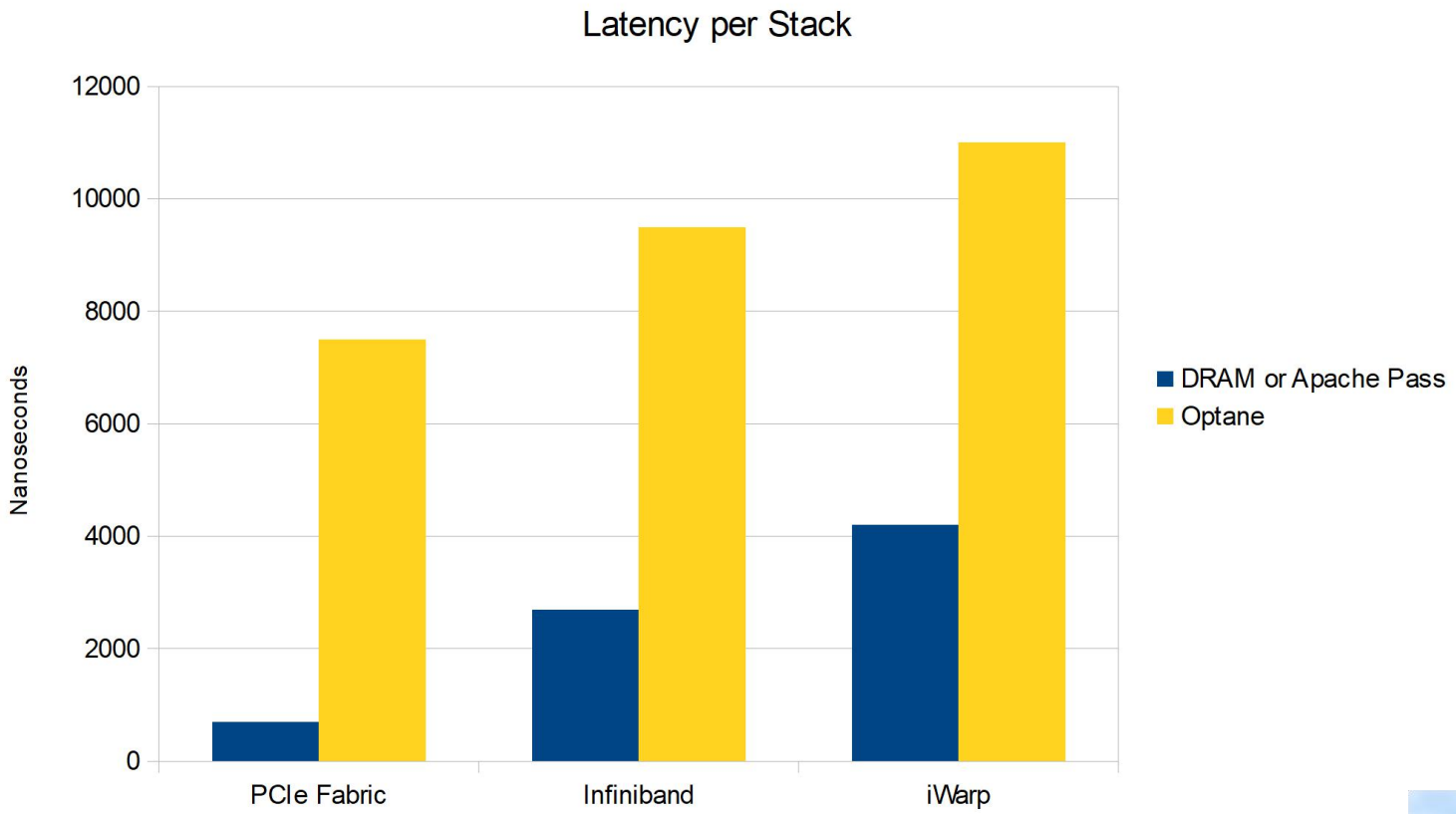




(g) Receiver, four concurrent connections

•Why Memory Centric Computing?

•Technical toughts



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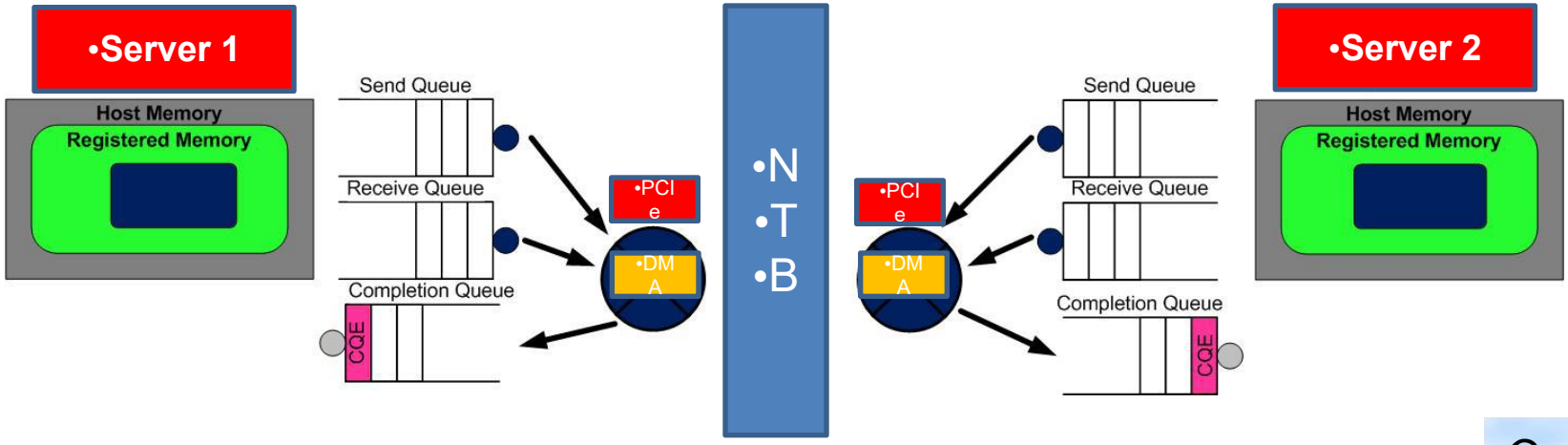
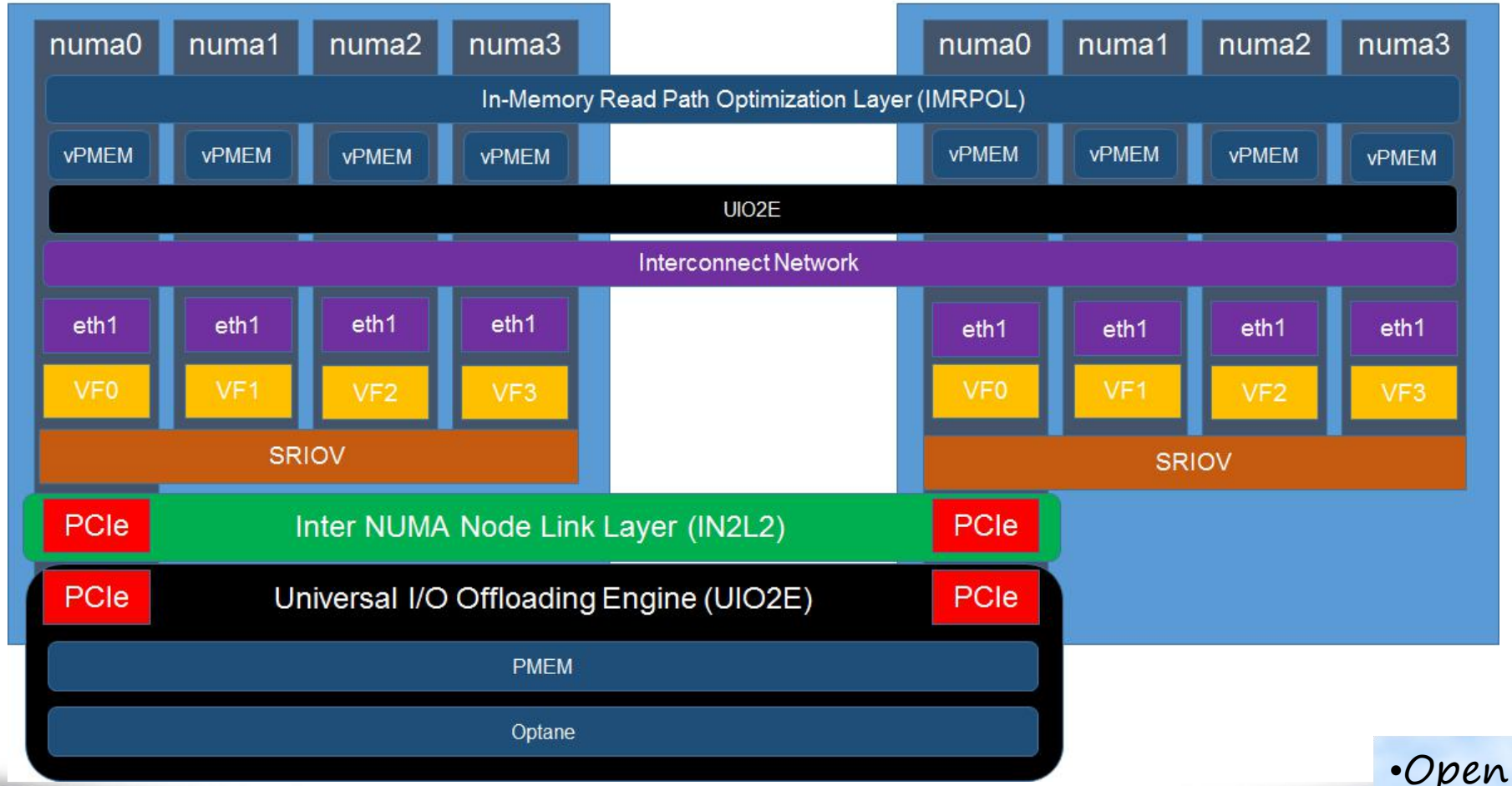
•Why Memory Centric Computing?

•Decisions

- Use PCIe as a unified fabric
- Use DMA engines to offload I/O work like we have with IB
- Combine tiering and remote adressable memory



•Overview of Open Memory Centric Computing Architecture (OpenMCCA)



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•Overview of Open Memory Centric Computing Architecture (OpenMCCA)

Features

- In-Memory Read Path Optimization (IMRPOL)
  - Access the fastest copy of your data using the shortest path in the best tier when using Software Defined Memory
- Universal I/O Offloading Engine
  - Save CPU cycles and licenses on your database host
  - Optimize your data center rack design
  - Add hardware accelerators on the fly using PCIe Device lending / MR-IOV
  - OptaneGRID I/O-modules for maximum performance

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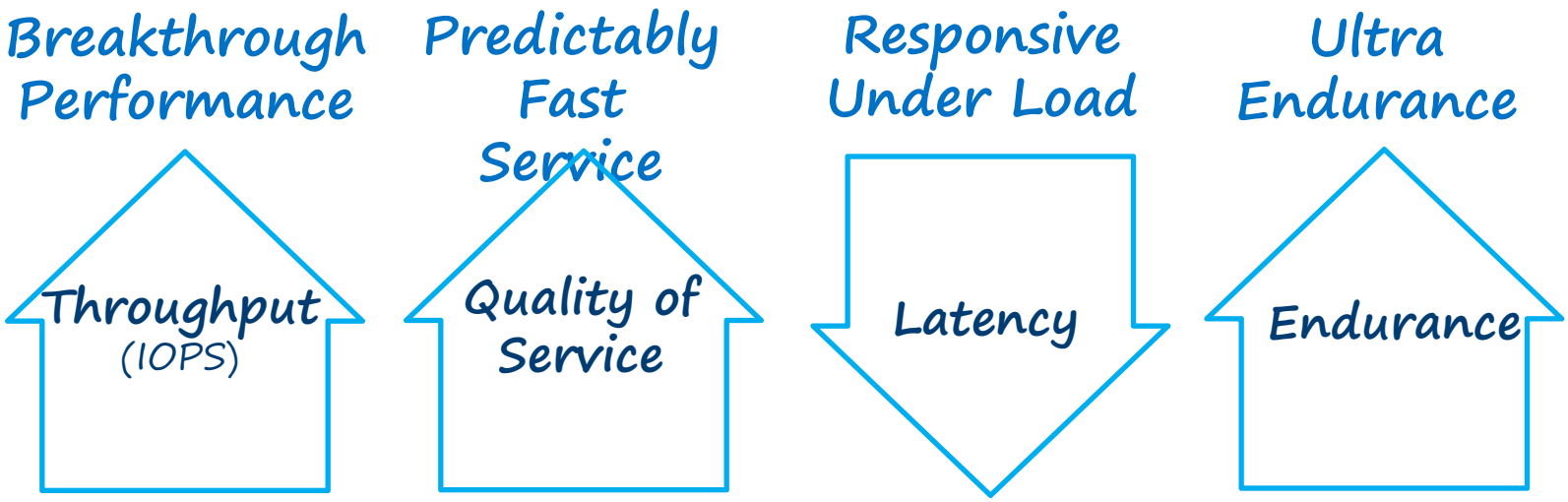
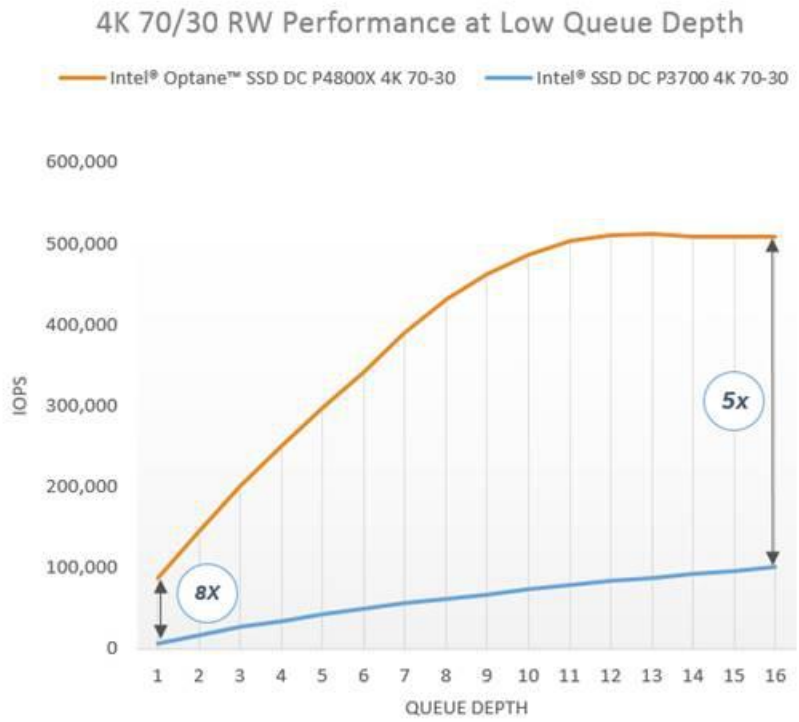
Optane SSDs performance capabilities

Intel® Optane™ SSD DC P4800X



•Breakthrough Performance

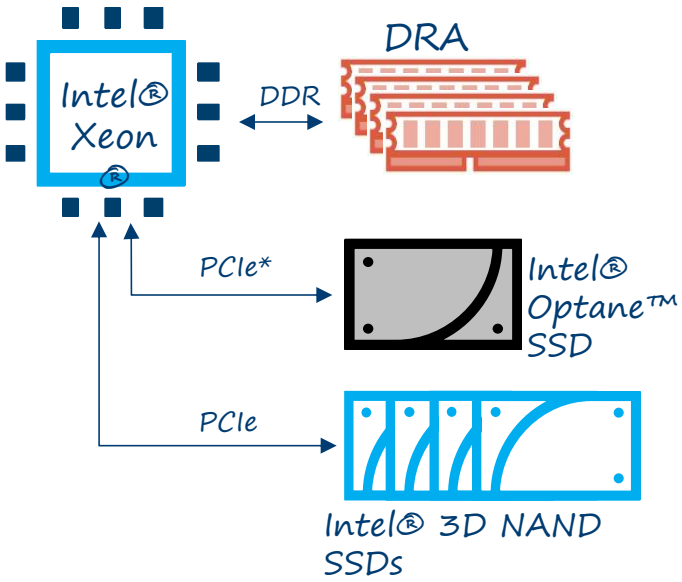


- •5-8x faster at low Queue Depths[1]
- •Vast majority of applications generate low QD storage workloads

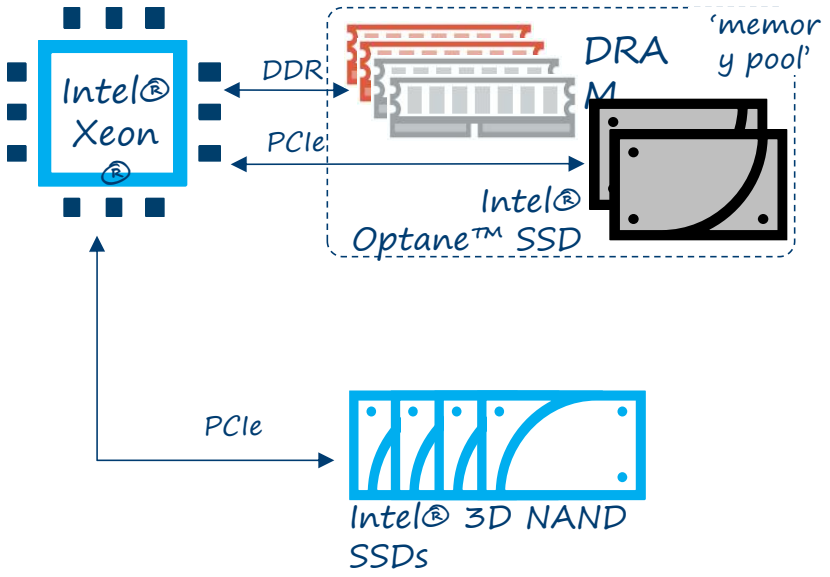
1. Common Configuration - Intel 2U Server System, OS CentOS 7.2, kernel 3.10.0-327.el7.x86_64, CPU 2 x Intel® Xeon® E5-2699 v4 @ 2.20GHz (22 cores), RAM 396GB DDR @ 2133MHz. Configuration – Intel® Optane™ SSD DC P4800X 375GB and Intel® SSD DC P3700 1600GB. Performance – measured under 4K 70-30 workload at QD1-16 using fio-2.15. Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance.

Intel® Optane™ SSD Use Cases

Fast Storage



Extend Memory



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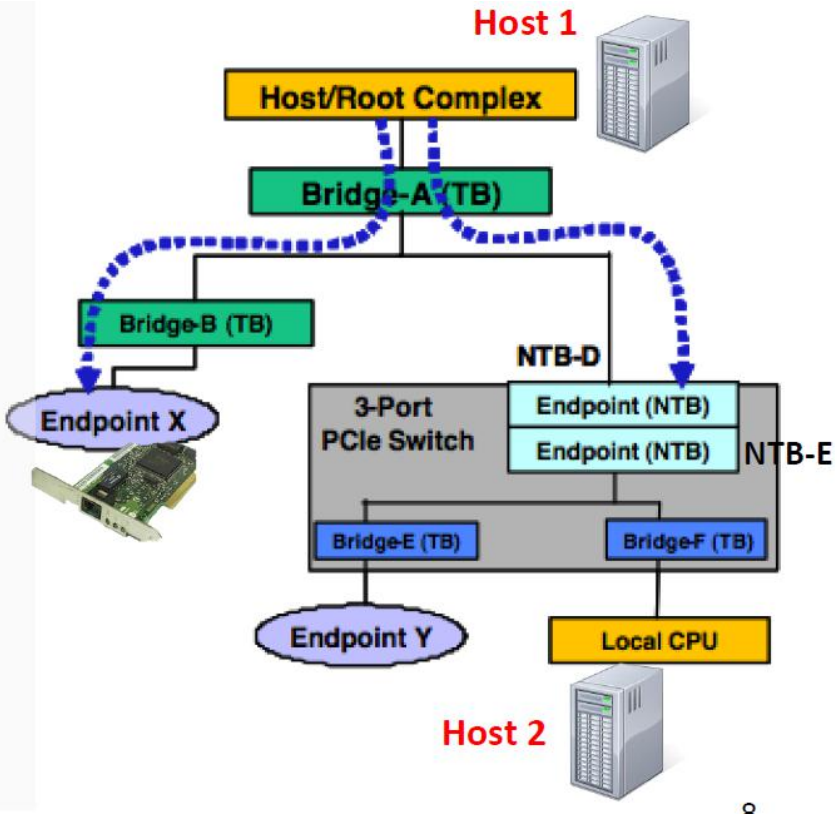
•OpenMCCA: Technical Demos

Setup for Demo 1: Diagram



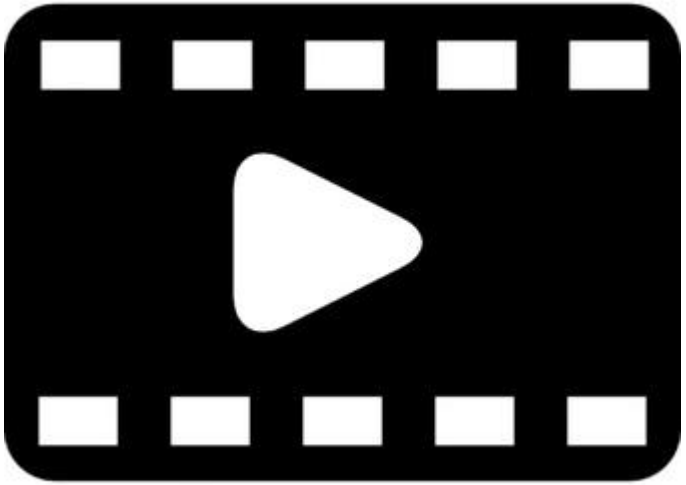
•OpenMCCA: Technical Demos

Setup for Demo 1: Technical Explanation

- PCIe Device Sharing
  - Node 1 has an Intel quad port PCIe NIC
  - Node 1 is acting as device lending host (target)
  - Node 1 enabled SRIOV on the nic and allows sharing through PCIe
  - Node 2 acts as client and can now use the nic from Host1 trough PCIe

•OpenMCCA: Technical Demos

•Demo 1: PCIe Device Sharing



•Our inspiration

•https://www.youtube.com/watch?v=GPh0Ms3dfPo

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•OpenMCCA: Technical Demos

Setup for Demo 2: Technical Explanation

- FIO Benchmark
  - Node 1 has a direct attached PCIe switch based NVMe JBOF containing a single OptaneGrid Module
  - Node 1 is the client executing fio

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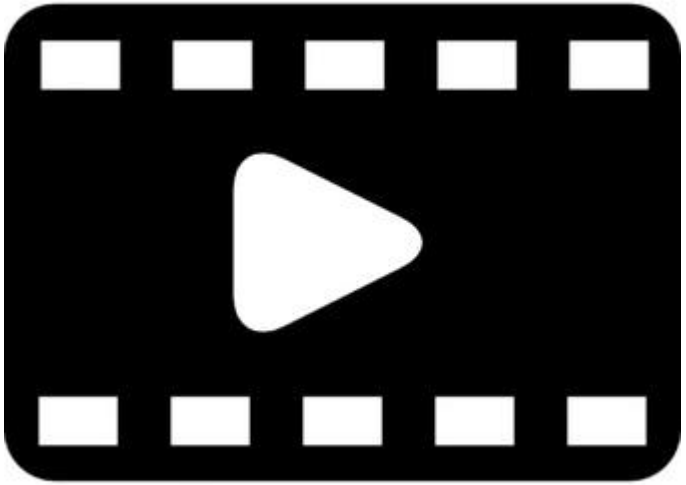
•Demo 2: Local Storage Tier Performance



•Single Node Performance, with «Wasted Cores» Scheduler

•https://github.com/Turbine1991/build_ubuntu_kernel_wastedcores

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Setup for Demo 3: Technical Explanation

- FIO Benchmark
  - Node 1 has a direct attached PCIe switch based NVMe JBOF containing a single OptaneGrid Module
  - Node 1 is the device lending host (target)
  - Node 2 is accessing Host 1's locally attached NVMe devices trough PCIe NTB
  - Node 2 is the client executing fio

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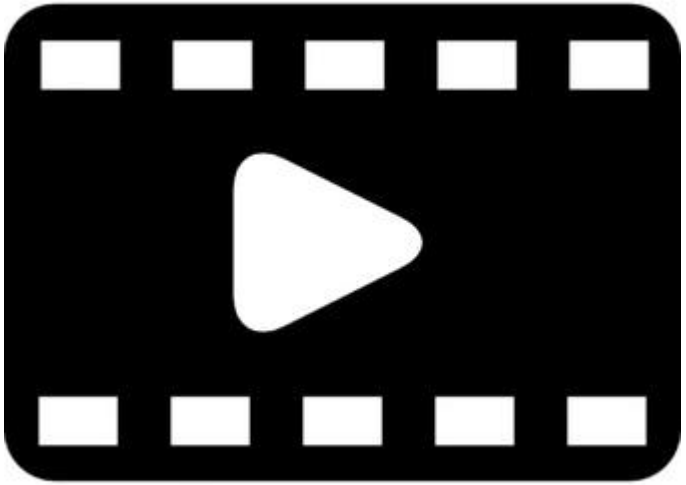
•Demo 3: I/O Offloading



•Use PCI Switch DMA Engine

•https://stackoverflow.com/questions/27470885/how-does-dma-work-with-pci-express-devices

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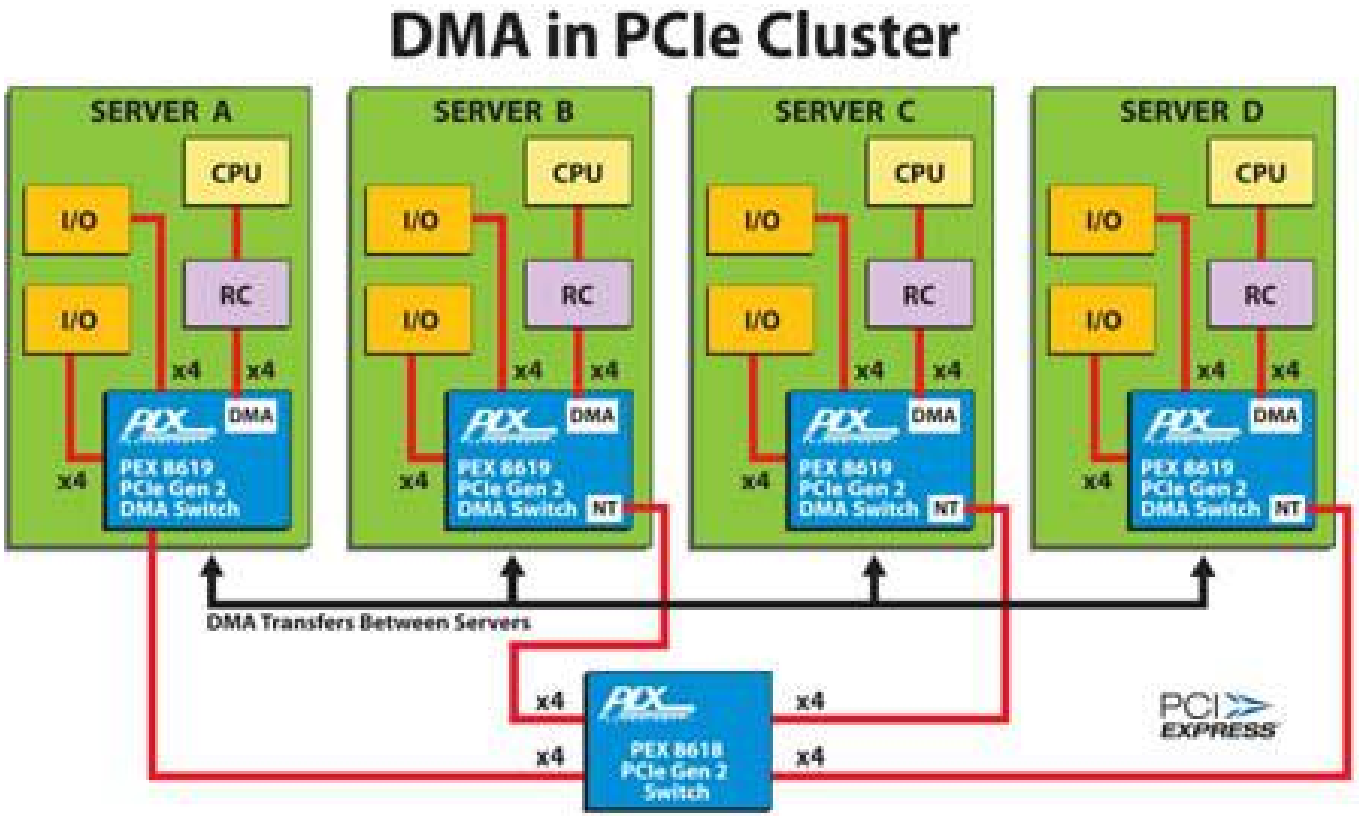
•OpenMCCA: Technical Demos

•Setup for Demo 4: Diagram



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Setup for Demo 4: Technical Explanation

- Oracle RAC Cluster with ASM
  - 2 DB nodes with 8 hard partitioned cpu cores each
    - 1x PCIe Fabric Switch
    - 4x Device/Memory lending host
    - Using OptaneGrid devices for Memory Expansion
    - DB-Server DRAM as Cache mirrored using PCIe NTB

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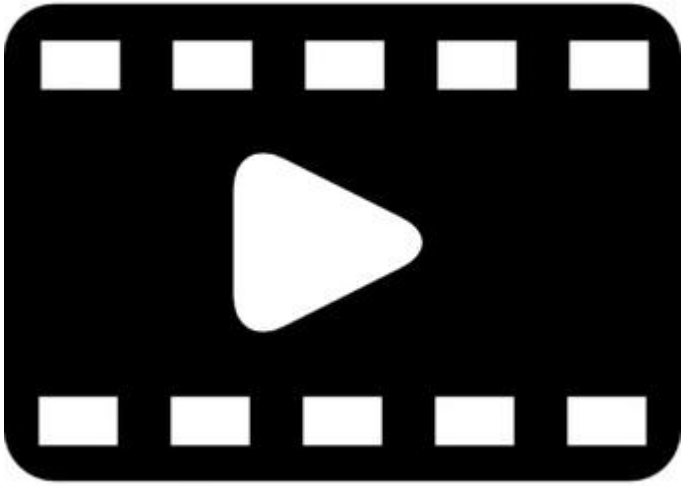
•Demo 4: Oracle RAC + OpenMCAA



•Aggregate multiple nodes using Oracle RAC and ASM

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•Demo 4: Oracle RAC + OpenMCAA

•RESULTS

```
[oracle@vscale07 ~]$ f_bench_rac

SQL*Plus: Release 12.2.0.1.0 Production on Mon Sep 25 22:17:43 2017

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Verbunden mit:
Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 - 64bit Production

SQL>
max_iops = 5239220
latency  = 0
max_mbps = 202623

PL/SQL-Prozedur erfolgreich abgeschlossen.

SQL> Verbindung zu Oracle Database 12c Enterprise Edition Release 12.2.0.1.0 - 64bit Production beendet
```

•Aggregate multiple nodes using Oracle RAC and ASM

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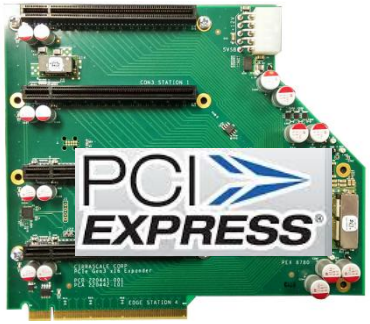
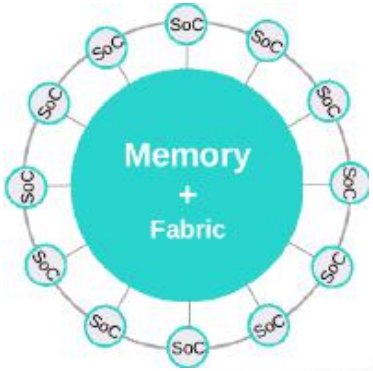
•Summary

- OpenMCCA Fabric Attached Memory using Intel Optane give you:
  - **Best in class per licensed cpu core performane (25 GB/s)**
  - Using:
    - **Less Hardware**
    - **Less SGA Memory (data is already in DRAM)**
- **PCIe is the „Mother of all Fabrics“** (unbeaten in latency)
- OptaneGRID 3DXpoint can further cut latency getting very close to DRAM (700ns)





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•Q&A


IDEA KILLER
BINGO
But...
We've already tried that before.
It'll never fly.
Let me play devil's advocate here...
Let's not go off on a tangent.
You're setting yourself up for failure.
Sure it will...
In THIS economy?
Do you think we're made of money?
That's not a high priority right now.
Have you really thought about the implications?
That won't work because...
FREE
The only problem with that is...
Run an ROI, and get back to us.
Is this in line with our strategy?
The front line will never go for it.
You're kidding... right?
Yes, but...
Does anyone really care about that?
What you are really saying...
If it ain't broke...
Sure, in theory... but you don't think it'll really work
But how much is this idea worth?
Do we really have the resources for this?

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•Thanks to our supporters

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•Special thanks go to

Tim Reuter aka „Gyro Gearloose”

Lars Kristiansen

Alain Fournial

Amit Golander

Artem Danielov

Andy Du

Joerg Roskowetz

YT Huang

Stephen Bates

Gregory Eckert

Pilar Aguado

Gert Pauwels

Anastasios Panagou

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thank you
danke
謝謝
ngiyabonga
شكراً جزيلاً
рахмат
Баярлалаа
спасибо
teşekkür ederim
gracias
dank je
merci
obrigado
dziękuję
bedankt
go raibh maith agat
mochchakkeram
sukriya
kop khun krap
grazie
arigatô
dakujem
terima kasih
ありがとう
감사합니다
ευχαριστώ
мерси
takk
taiku
sagolun
mauruuru
hvala
tapadh leat
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barka
welalin
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vinaka
спасибі
blagodaram
misaotra
matondo
paldies
grazzi
mahalo
хвала
asante
manana
obrigada
tenki
murakoze
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köszönöm
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bayarlalaa
enkosi
sobodi
dēkuji
mèsi
didi madloba
najis tuke
kam sah hamnida
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