Intelligent Storage Solutions
Producing Efficient Scalable Systems

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Flash Memory Summit
BEST OF SHOW WINNER
A Real World Problem – Needle in a Haystack

For the first time, scientists were close to determining how difficult it is to actually find a needle in a haystack.
Today’s way of finding that needle...

Facing the men is an immense display with 16 screens. It conveys live images from network of 180 CCTV cameras.
Survey Question:
Where do you see the most storage performance bottlenecks?

But Why??

THE Storage!

Source: ATM Research

Networking
Array Controllers
Storage Protocol
Applications
IDK!

Biggest Bottleneck

Source: ATM Research

NGD Systems, Inc - Keynote Presentation FMS 2018
3 Factors driving the Storage Problem... Tsunami

‘Tsunami of data’ could consume one fifth of global electricity by 2025

We have a tsunami of data approaching.” — Anders S.G. Andrae

Defying the Data Tsunami

The Big Data Tsunami

Author: Matt Ferrari
Chief Technology Officer
ClearDATA
3 Factors driving the Storage Problem... Power

Gartner Says Data Center Power, Cooling and Space Issues Are Set to Increase Rapidly as a Result of New High-Density Infrastructure Deployments
STAMFORD, Conn., May 13, 2010

Free cooling
There are quite a few data centers that have embraced "free cooling" totally, i.e. using the cold air outside.
All you need is ... a mild climate

A heat-exchange process commonly used for cooling submarines to the underwater datacenter. The system pipes seawater directly through the radiators on the back of each of the 12 server racks and back out into the ocean.
3 Factors driving the Storage Problem... Near-Data Compute

PUSHED TO THE EDGE
February 19, 2018 Timothy Prickett Morgan

Three motivating factors for using Edge Computing

1. Preserve privacy
2. Reduce latency
3. Be robust to connectivity issues

NEAR-DATA PROCESSING: INSIGHTS
Near-Data Computation: Looking Beyond Bandwidth
Published in: IEEE Micro (Volume: 34, Issue: 4, July-Aug. 2014)

AI Weekly: Computing power is shaping the future of AI

NGD SYSTEMS, INC.
Bringing Intelligence to Storage
Solving the Data Growth and Compute Problem

In-Situ Processing
Challenges with Moving (Big) Data

- power density \(\text{Watts/Terabyte}\)
- volumetric density \(\text{Terabytes/cm}^3\)
- data bottleneck

bandwidth mismatch by >60X

SkinnyPipes
Using Near Data Processing to Tackle Data Bottlenecks

Seamless Programming Model

Manage Capacity Growth

Scalability

Brings harmony back to bandwidth needs
Dimensions that Enable Computational Storage

**operating system**
- bare metal
- RTOS
- 64-bit OS

**user application**
- firmware
- application software
- container virtualization

**hardware**
- 32-bit real-time processors
- HW acceleration
- 64-bit application processors

**AI acceleration**

AI applications

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In-Situ Processing Ecosystem – The Newport Platform
Delivering the Solution – NGD Systems NVMe SSD Family

New Rack-Scale Form Factors

- 8TB / 8W
- 16TB / 12W
- Up to 64TB
  16 flash channels

Traditional Storage Form Factors

- 32TB / 12W
- 64TB / 13W
Use Cases

**In-Situ Openalpr demo**

Result:

![OpenALPR](image)

**Object Tracking – Azure IoT Hub**

![Image Classification Result](image)

The Results of TensorFlow To Predict Across 1000 Labels:

- **Persian cat** (score = 0.77295)
- **tiger cat** (score = 0.03713)
- **tabby, tabby cat** (score = 0.03207)
- **Egyptian cat** (score = 0.02612)
- **lynx, catamount** (score = 0.01572)
Introducing Jae Young Do – Finding the Right Path Forward
Case Study: Conventional SSD Storage Server (1/2)

Easy to scale up

High cost of moving data

Flash SSD
Flash SSD
Flash SSD
Flash SSD
Flash SSD
Flash SSD
Flash SSD
Flash SSD
Flash SSD

PCle Switch
PCle Switch
PCle Switch

DRAM
CPU
Root complex
Case Study: Conventional SSD Storage Server (2/2)

Throughput gap of 66x!

16 lanes of PCIe = ~16 GB/s

32 channels X ~500 MB/s = ~16 GB/s

64 Flash SSDs X ~16 GB/s/SSD = ~1TB/s
Programming Attempts with standard SSDs

- Not **dev-friendly** programming environment
- Not accessible prototype devices
- Not enough **spare** processing power

```
SELECT SUM (EXTENDEDPRICE * DISCOUNT) 
FROM LINEITEM 
WHERE SHIPDATE >= 1994-01-01 AND 
SHIPDATE < 1995-01-01 AND 
DISCOUNT > 0.05 AND 
DISCOUNT < 0.07 AND 
QUANTITY < 24 
```
Disruptive Trends that Enable Intelligent SSDs

- Frugal resources inside SSD
- Abundant resources inside SSD

Today's SSD

Embedded CPU, proprietary firmware

General purpose CPU, server-like OS

(Ease of programmability inside SSD)

August 9th, 2018
NGD Systems, Inc - Keynote Presentation FMS 2018
Revisit: Conventional SSD Storage Server

16 lanes of PCIe = ~16 GB/s

Throughput gap of 66x!

16 lanes of PCIe = ~16 GB/s

~2GHz/core X 20 cores = ~40GHz

Compute capability gap of 25x!

~2GHz/core X 8 cores X 64 SSDs = ~1THz

64 Flash SSDs X ~16 GB/s/SSD = ~1TB/s
MSR SoftFlash Project

The **SoftFlash** project proposes to create a software-defined storage substrate of flash SSDs in the data center that is as programmable, agile, and flexible as the applications and operating systems accessing it from servers.

- Embrace flash SSDs as a first-class programmable platform in the cloud data center
- Add custom capabilities to storage over time
- Better bridge the gap between application needs and flash media capabilities/limitations
- Innovate in-house at cloud speed
Example Scenario with Intelligent SSDs – Image Search

What if we had Intelligent SSDs?

Required Memory Space

~4TB DRAM!!

What if we had Intelligent SSDs?
Preliminary Results: Image Query Throughput

NOTE
The I/O cost of moving data is **NOT** considered!
More interesting results are ...
Key Takeaways

- Finding the Needle Faster
  - **In-Situ Processing**
- Bigger Pipes Feed Smaller Ones
  - **Near Data Processing**
  - Efficiency Matters
- Smarter Storage Does Work
  - Microsoft
- Requires Intelligent Controllers
  - **Watts/Terabyte**
- Power is Factor - Always
  
NGD Systems Newport Platform Provides

- On Drive Linux OS, Container Support
  - Dedicated Compute Cores
- Mitigating Data Movement
- Optimizing Application Execution
- Partnerships for Success
- Real World Implementation
- Flash Agnostic – ONFI/Toggle, TLC/QLC
  - 16 Channels - Capacities to 256TB
- Power is Factor - Always
  - .35 W/TB @ 16TB
Thank You

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