DATA-CENTRIC INNOVATION SUMMIT
AUGUST 8, 2018 | SANTA CLARA, CA
DATA DEFINES THE FUTURE
From 2017:

- **~$70B**
  - Network Memory Connectivity AI

- **~$55B**
  - Intel Optane SSDs 3D NAND

- **~$30B**
  - ADAS Industrial Video Retail AI

- **~$7B**
  - ADAS Network Data Center AI

**Total TAM >$160B**

Source: 2017 Intel Revenue is based on Intel financials. 2021 TAM is based on amalgamation of analyst data and Intel analysis, based upon current expectations and available information and are subject to change without notice. Data Center includes Server, Storage, & Network computing Ethernet/OPA, Silicon Photonics and Memory. Non-Volatile Memory includes NAND and 3D XPoint™ technology. IOT includes addressable Logic ASIC/ASSP, MPU, MCU, DSP for Industrial, Transportation, Automated Driving, Retail, Video Surveillance, Healthcare, Public Sector, Office Automation, Gaming and Smart Home. PSG includes Field Programmable Logic. Forecast is soft estimate subject to significant change and revisions.
# Data-Centric Opportunity

## 2022 Data-Centric Si TAM

<table>
<thead>
<tr>
<th>Category</th>
<th>2017 Revenue</th>
<th>2017-2022 CAGR</th>
<th>2022 TAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Center</td>
<td>~$90B</td>
<td>9% CAGR</td>
<td>~$160B</td>
</tr>
<tr>
<td>Non Volatile Memory</td>
<td>~$70B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IoT + ADAS</td>
<td>~$75B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADAS</td>
<td>~$55B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FPGA</td>
<td>~$33B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Memory</td>
<td>~$30B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connectivity</td>
<td>~$8B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AI</td>
<td>~$7B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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CLOUD EXPANDING THE TAM

PUBLIC | PRIVATE | HYBRID

2/3 OF CLOUD IS TAM EXPANSION

INTEL CLOUD SP REVENUE

2013 2014 2015 2016 2017

CONSUMER

BUSINESS

BIZ: ENTERPRISE CONVERSION

BIZ: NEW

INCREASING NEED FOR CUSTOM CPUs

INTEL CLOUD SP CPU VOLUME

DATA-CENTRIC INNOVATION SUMMIT

Source: Intel
CLOUD-IFICATION OF
NETWORK • 5G • EDGE

$24B NETWORK LOGIC SILICON TAM | 2022

Source: TAM projections and growth estimates are based on an amalgamation of analyst data and Intel analysis, reflect current expectations and available information, and are subject to change without notice. Network S. TAM includes CPUs, ASICs, FPGAs, SoCs, and other types of processors for network appliances.
NEW ERA OF DATA CENTER TECHNOLOGY

DATA-CENTRIC INFRASTRUCTURE

MOVE FASTER
- Intel Silicon Photonics
- Intel Omni-Path Fabric
- Intel Ethernet

STORE MORE
- Intel Optane DC SSD
- Intel Xeon
- Intel Stratix 10
- Intel Optane DC PM

PROCESS EVERYTHING
- Intel Nervana

INNOVATION SUMMIT
DATA CENTER NETWORK TRAFFIC INCREASING

GLOBAL DATA CENTER TRAFFIC PER YEAR

25% CAGR

Source: Cisco Global Cloud Index, 2016-2021
INTEL CONNECTIVITY PORTFOLIO

CONNECTION LOGIC SILICON TAM
~25% CAGR

$11B

~$4B

2017
2022

INTEL® OMNI-PATH FABRIC
LEADING HPC FABRICS

INTEL® ETHERNET
#1 MSS HIGH SPEED¹ ETHERNET
COMING 2019
CASCADE GLACIER SMARTNIC

INTEL® SILICON PHOTONICS
SILICON INTEGRATION
SILICON MANUFACTURING
SILICON SCALE

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¹. High speed = 10Gbps and above
Source: Connectivity TAM includes Ethernet, High Performance Fabrics, and Silicon Photonics and is based on amalgamation of analyst data and Intel analysis, based upon current expectations and available information and are subject to change without notice.
NEW ERA OF DATA CENTER TECHNOLOGY

DATA-CENTRIC INFRASTRUCTURE

MOVE FASTER
- SILICON PHOTONICS
- OMNI-PATH FABRIC
- ETHERNET

STORE MORE
- OPTANE DC
- SOLID STATE DRIVE
- PERSISTENT MEMORY

PROCESS EVERYTHING
- XEON PLATINUM
- STRATIX 10
RE-ARCHITECTING THE MEMORY / STORAGE HIERARCHY

MEMORY

PERSISTENT MEMORY

IMPROVING MEMORY CAPACITY

IMPROVING SSD PERFORMANCE

DELIVERING EFFICIENT STORAGE

DRAM HOT TIER

Intel® OPTANE® DC™ PERSISTENT MEMORY

Intel® OPTANE® SSD

INTEL® 3D NAND SSD

SSD WARM TIER

HDD / TAPE COLD TIER

DATA-CENTRIC INNOVATION SUMMIT
DATA CENTER MEMORY SAM | 2022

$10B

SPARK SQL DS

8X MORE PERFORMANCE

VS. DRAM AT 2.6TB DATA SCALE

APACHE CASSANDRA

9X MORE READ TRANSACTIONS

11X MORE USERS PER SYSTEM

VS. COMPARABLE SERVER SYSTEM WITH DRAM & NAND NVME DRIVES

VALUE OF PERSISTENCE

MINUTES TO SECONDS

THREE 9s TO FIVE 9s

START TIME

AVAILABILITY

Note: Intel Optane DC Persistent Memory capacity equals 2022 data center memory SAM. Performance results are based on testing BX (8/2/2018), BX Reads/1X Users (5/24/2018), Minutes to Seconds (5/30/2018) and may not reflect all publicly available security updates. No product can be absolutely secure. See configuration disclosure for details. Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of these factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more information go to www.intel.com/benchmarks. Other names and brands may be claimed as the property of others.
BART SANO
VP OF PLATFORMS

Google Cloud
BROAD ECOSYSTEM SUPPORT
NEW ERA OF DATA CENTER TECHNOLOGY

DATA-CENTRIC INFRASTRUCTURE

MOVE FASTER
- Intel Silicon Photonics
- Intel Omni-Path Fabric
- Intel Ethernet

STORE MORE
- Intel Optane DC Persistent Memory

PROCESS EVERYTHING
- Intel Xeon Platinum
- Intel Stratix 10
- Intel Nervana
1ST ANNIVERSARY OF THE INTEL® XEON® SCALABLE PROCESSOR

LARGEST EARLY SHIP PROGRAM

FASTEST XEON RAMP TO 1M UNITS

50% OF XEON VOLUME

>2M UNITS SHIPPING PER QUARTER

LEADERSHIP PERFORMANCE

VS OTHER X86 OFFERINGS

UP TO 1.48X PER CORE

UP TO 1.72X L3 PACKET FWD

UP TO 3.2X HIGH PERF. LINPACK

UP TO 1.85X DATABASE

UP TO 1.45X MEMORY CACHING

ULTIMATE FLEXIBILITY

1,2,4,8+ SOCKETS

60 SKUS

1.7-3.6 GHZ

70-205 WATTS

$213-$10,000 PRICE POINTS

Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations, and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that products when combined with other products. For more complete information visit www.intel.com/benchmarks. Performance tests are based on testing as of 9/14/2016 and may not reflect all publically available security updates. See configuration disclosures, e.g. backdoor for details. No product can be absolutely secure. Intel’s compilers may or may not optimize to the same degree for non-Native microarchitectures for applications that are not unique to Intel microprocessors. These optimizations include SSSE2, SSE3, and SSE4.2 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations not specific to Intel microarchitecture are reserved for Intel microprocessors. Please refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice. (Notice Revision #20110804)
## REINVENTING XEON FOR AI

### INTEL OPTIMIZATION FOR CAFFE RESNET-50

<table>
<thead>
<tr>
<th>Year</th>
<th>INference Throughput (Images/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jul'17</td>
<td>1.0</td>
</tr>
<tr>
<td>Jan'18</td>
<td>2.8X</td>
</tr>
<tr>
<td>Aug'18</td>
<td>5.4X</td>
</tr>
</tbody>
</table>

### FRAMEWORK OPTIMIZATIONS

#### INT8 OPTIMIZATIONS

- **2.8X**
  - FP32

#### INTEL® XEON® SCALABLE PROCESSOR

**Intel® Optimization for Caffe ResNet-50** performance does not necessarily represent other Framework performance.

1. Intel® Optimization for Caffe ResNet-50 performance does not necessarily represent other Framework performance.
2. Based on Intel internal testing: 1X(7/7/2017), 2.8X(1/19/2018) and 5.4X(7/26/2018) performance improvement based on Intel® Optimization for Caffe ResNet-50 inference throughput performance on Intel® Xeon® Scalable Processor.
3. Intel® Xeon® Scalable Processor family has been engineered and manufactured to optimize performance over a wide range of workloads. Performance results are based on testing as of 7/7/2017(1X), 1/19/2018(2.8X) & 7/26/2018(5.4X) and may not reflect all publicly available security updates. See configuration disclosure for details ([link](#)). No product can be absolutely secure or perfectly protected. Intel® Xeon® Optimizations Notice: Intel's compilers may or may not optimize to the same degree for non-Intel microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations may not be safe for use with non-Intel microprocessors. For details, see the Internal Optimizations Notice for Intel Xeon® Scalable Processors. Other names and brands may be claimed as the property of others.
“Inference is one thing we do, but we do lots more. That's why flexibility is really essential.”

Kim Hazelwood
Head of AI Infrastructure Foundation
Facebook

“Machine learning is a big part of our heritage. It works on GPUs today, but it also works on instances powered by highly customized Intel Xeon processors.”

Bratin Saha
VP & GM, Machine Learning Platforms
Amazon AI - Amazon
In 2017 AI drove "Inference is one thing we do, but we do lots more. That's why flexibility is really essential."

Kim Hazelwood
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Facebook

"Machine learning is a big part of our heritage. It works on GPUs today, but it also works on instances powered by highly customized Intel Xeon processors."

Bratin Saha
VP & GM, Machine Learning Platforms
Amazon AI - Amazon

INTEL XEON REVENUE
>$1B

INTEL XEON PROCESSOR AI WINS

AI W I N S

INTEL® XEON® PROCESSOR AI WINS

Alibaba Cloud
AWS
bluedata
cdhi
CRAY
DELL EMC
GIGASPECS
Google Cloud
iFLYTEK
JD.COM
K Y O T O U N I V E R S I T Y
MTC
NYU Langone Medical Center
Taboola
Tencent
TOUTIAO
UCLOUD
UnionPay

Other names and brands may be claimed as the property of others.
Support For Intel® OPTANE™ DC Persistent Memory

Leadership Performance
Optimized Cache Hierarchy
Higher Frequencies

Security Mitigations
Optimized Frameworks & Libraries

NEXT INTEL® XEON® SCALABLE PROCESSOR
CASCADE LAKE
WITH INTEL® OPTANE™ DC PERSISTENT MEMORY
REINVENTING XEON FOR AI

INTEL OPTIMIZATION FOR CAFFE RESNET-50

I N T R O D U C I N G

INTEL® DEEP LEARNING BOOST

VNN VECTOR NEURAL NETWORK INSTRUCTION FOR INFERENCE ACCELERATION

FRAMEWORK & LIBRARY SUPPORT
Caffe m x n et TensorFlow

INTEL® XEON® SCALABLE PROCESSOR

FRAMEWORK OPTIMIZATIONS

5.4X INT8 OPTIMIZATIONS

2.8X FRAMEWORK OPTIMIZATIONS

1.0 FP32

INT8 OPTIMIZATIONS

11X

INFERENCE THROUGHPUT (IMAGES/SEC)

Jul'17 Jan'18 Aug'18

INTEL® XEON® SCALABLE PROCESSOR

DATA-CENTRIC INNOVATION SUMMIT

1 Intel® Optimization for Caffe Resnet-50 performance does not necessarily represent other Framework performance.
2 Based on Intel internal testing. 1X (7/11/2017), 2.8X (1/19/2018) and 5.4X (7/26/2018) performance improvement based on Intel® Optimization for Caffe Resnet-50 inference throughput performance on Intel® Xeon® Scalable Processor.
3 1X (7/11/2017) and 2.8X (1/19/2018) results have been internally validated in Intel internal testing, and provided to you for informational purposes, any difference in your system hardware, software or configuration may affect your actual performance.
4 Performance results are based on testing as of 7/11/2017 (Intel® Xeon® Scalable Processor) and may not reflect all publicly available security updates. See configuration disclosure for details (Intel®). No product can be absolutely secure. Optimization notice Intel’s compiler may or may not optimize to the same degree for non-Intel Microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets, and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations an specific instruction sets are intended for use with Intel microprocessors. Please refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice.
5 Other names and brands may be claimed as the property of others.
Intel Select Solutions

Tightly specified HW & SW components

Simplified evaluation

Pre-defined settings & system-wide tuning

Fast & easy to deploy

Designed to deliver workload optimized

Optimal performance

Intel® Select Solution configurations and benchmark results are

Intel verified
INTEL SELECT SOLUTIONS

- Intel® Select Solution configurations and benchmark results are Intel verified

- **AI:** Big DL on Apache Spark
- **Blockchain:** Hyperledger Fabric
- **SAP HANA Certified Appliance**

Tightly specified HW & SW components

Simplified evaluation

Pre-defined settings & system-wide tuning

Fast & easy to deploy

Designed to deliver optimal performance

Workload optimized

Optimized design for performance

Tightly specified HW & SW components

THE INTEL DIFFERENTIATION

TRANSISTORS & PACKAGING

ARCHITECTURE

MEMORY

INTERCONNECTS

SECURITY

SOFTWARE & SOLUTIONS
JIM KELLER
SR. VICE PRESIDENT
GM, SILICON ENGINEERING GROUP
INTEL
2018

**CASCADE LAKE**
14NM
SHIPPING Q4’18

INTEL OPTANE PERSISTENT MEMORY
INTEL DLBOOST: VNNI
SECURITY MITIGATIONS

2019

**COOPER LAKE**
14NM

NEXT GEN INTEL DLBOOST:
BFLOAT16

2020

**ICE LAKE**
10NM

14NM/10NM PLATFORM

**LEADERSHIP PERFORMANCE**
It's a new era of data-centric computing fuelled by cloud, network, 5G, edge, artificial intelligence.

The data-centric opportunity is massive. Largest opportunity in Intel's history, over $200B TAM by 2022.

Intel has unparalleled assets to fuel growth. Portfolio of leadership products to move, store and process data.
Disclosures

Statements in this presentation that refer to business outlook, future plans and expectations are forward-looking statements that involve a number of risks and uncertainties. Words such as "anticipates," "expects," "intends," "goals," "plans," "believes," "seeks," "estimates," "continues," "may," "will," "would," "should," "could," and variations of such words and similar expressions are intended to identify such forward-looking statements. Statements that refer to or are based on projections, uncertain events or assumptions also identify forward-looking statements. Such statements are based on management's current expectations, unless an earlier date is indicated, and involve many risks and uncertainties that could cause actual results to differ materially from those expressed or implied in these forward-looking statements. Important factors that could cause actual results to differ materially from the company's expectations are set forth in Intel's earnings release dated July 26, 2018, which is included as an exhibit to Intel's Form 8-K furnished to the SEC on such date. Additional information regarding these and other factors that could affect Intel's results is included in Intel's SEC filings, including the company's most recent reports on Forms 10-K and 10-Q. Copies of Intel's Form 10-K, 10-Q and 8-K reports may be obtained by visiting our Investor Relations website at www.intc.com or the SEC's website at www.sec.gov.

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CONFIGURATION DETAILS

1.48x: Per Core Performance
Intel Xeon Platinum 8180: Intel Xeon-based Reference Platform with 2 Intel Xeon 8180 (2.5GHz, 28 core) processors, BIOS ver SESC620.86B.00.01.0014.070920180847, 07/09/2018, microcode: 0x200004d, HT ON, Turbo ON, 12x32GB DDR4-2666, 1 SSD, Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline), 1-copy SPEC CPU 2017 integer rate base benchmark compiled with Intel Compiler 18.0.2 –O3, executed on 1 core using taskset and numactl on core 0. Estimated score = 6.59, as of 8/2/2018 tested by Intel

AMD EPYC 7601: Supermicro AS-2023US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32 core) processors, BIOS ver 1.1a, 4/26/2018, microcode: 0x8001227, SMT ON, Turbo ON, 16x32GB DDR4-2666, 1 SSD, Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline), 1-copy SPEC CPU 2017 integer rate base benchmark compiled with AOCC ver 1.0 -Ofast, -march=znver1, executed on 1 core using taskset and numactl on core 0. Estimated score = 4.45, as of 8/2/2018 tested by Intel

2.00x: High Performance Linpack
Intel Xeon-based Reference Platform with 2 Intel Xeon 8180 (2.5GHz, 28 core) processors, BIOS ver SESC620.86B.00.01.0014.070920180847, 07/09/2018, microcode: 0x200004d, HT ON, Turbo ON, 12x32GB DDR4-2666, 1 SSD, Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline), High Performance Linpack v2.2, compiled with Intel(R) Parallel Studio XE 2018 for Linux, Intel MPI and MKL

HT ON, Turbo ON, 12x32GB DDR4-2666, 1 SSD, Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline), High Performance Linpack v2.2, compiled with Intel(R) Parallel Studio XE 2018 for Linux, Intel MPI version 18.0.0.128, Benchmark Config: Nb=384, N=203136, P=1, Q=2, Q=4, Score = 3507.38GFs, as of July 31, 2018 tested by Intel

AMD EPYC 7601: Supermicro AS-2023US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32 core) processors, SMT OFF, Turbo ON, BIOS ver 1.1a, 4/26/2018, microcode: 0x8001227, 16x32GB DDR4-2666, 1 SSD, Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline), High Performance Linpack v2.2, compiled with Intel(R) Parallel Studio XE 2018 for Linux, Intel MPI version 18.0.0.128, AMD BUS v 0.4.0, Benchmark Config: Nb=232, N=168960, P=4, Q=4, Score = 1095GFs, as of July 31, 2018 tested by Intel

1.85x: Database
Intel Xeon-based Reference Platform with 2 Intel Xeon 8180 (2.5GHz, 28 core) processors, BIOS ver SESC620.86B.00.01.0014.070920180847, 07/09/2018, microcode: 0x200004d, HT ON (1 thread per core), Turbo ON, 12x32GB DDR4-2666, 1 SSD, Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline), Red Hat Enterprise Linux 7.4 (3.10.0-693.11.6.el7.x86_64 IBSR), HamIdB ver 2.3, PostgreSQL ver 9.6.5, Score = 2,250,481 tpm, as of 3/15/2018 tested by Intel

AMD EPYC 7601: HPE Proliant DL385 Gen10 with 2 AMD EPYC 7601 (2.2GHz, 32 core) processors, ROM ver 1.06, microcode: 0x8001227, SMT ON, Turbo ON, 16x32GB DDR4-2666, 1 x Intel DC P3700 PCI-E SSD (2TB, 1/2 Height PCIe 3.0, 20nm, MLC), Red Hat Enterprise Linux 7.4 (3.10.0-693.21.1.el7.x86_64 Retpoline), HamIdB ver 2.3, PostgreSQL ver 9.6.5, Score = 2,120,575 tpm, as of 4/12/2018 tested by Intel

1.45x: Memcached (Memory Object Caching)
Intel Xeon-based Reference Platform with 2 Intel Xeon 8180 (2.5GHz, 28C) processors, BIOS ver SESC620.86B.00.01.0014.070920180847, 07/09/2018, microcode: 0x200004d, HT ON, Turbo ON, 12x32GB DDR4-2666, 1500, 1.40Gbps PCIe XL710 Adapter, Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline), Memcached using YCSB benchmark Workloadc, YCSB 0.16.0, Memcached v1.5.9, Max throughput (ops/sec) with P99 latency < 1ms, Score = 2711265 ops/sec, as of 8/2/2018 tested by Intel

AMD EPYC 7601: Supermicro AS-2023US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32C) processors, BIOS ver 1.1a, 4/26/2018, microcode: 0x8001227, SMT ON, Turbo ON, 16x32GB DDR4-2666, 1500, 1.40Gbps PCIe XL710 Adapter, Ubuntu 18.04.1 LTS, (4.17.0-041700-generic Retpoline), Memcached using YCSB benchmark Workloadc, YCSB 0.16.0, Memcached v1.5.9, Max throughput (ops/sec) with P99 latency < 1ms, Score = 1826841 ops/sec, as of 8/2/2018 tested by Intel

1.72x: L3 Packet Forwarding
Intel Xeon Platinum 8180: Supermicro X11DPG-Qt with 2 Intel Xeon-SP 8180 (2.5GHz, 28C) processors, BIOS ver 2.0b, microcode: 0x2000043, 12x32GB DDR4-2666, 1 SSD, 2x Intel XXV710-DA2 PCI Express (2x25Gbe), DPDK L3fwd sample application (IPv4 LPM, 256B packet size, 62500 flows), DPDK 17.11, Ubuntu 17.10, (4.13.0-31-generic IBSR), HT ON, Turbo OFF, Score= 42.22 Million Packets / second, as of 8/2/2018 tested by Intel

AMDEP YCY 7601: Supermicro AS-2023US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32C) processors, BIOS ver 1.1a, microcode: 0x8001227, 16x32GB DDR4-2666, 1 SSD, 2x Intel XXV710-DA2 PCI Express (2x25Gbe), DPDK L3fwd sample application (IPv4 LPM, 256B packet size, 62500 flows), DPDK 17.11, Ubuntu 17.10 (4.13.0-36-generic Retpoline), SMT ON, Turbo (core boost) OFF, Score= 24.52 Million Packets / second, as of 8/2/2018 tested by Intel

DATA-CENTRIC INNOVATION SUMMIT

INTEL
INTEL OPTANE PERSISTENT MEMORY CONFIGURATION DETAILS

Performance results are based on testing: 8X (8/2/2018), 9X Reads/11X Users (5/24/2018), Minutes to Seconds (5/30/2018) and may not reflect all publicly available security updates. No product can be absolutely secure.

Results have been estimated based on tests conducted on pre-production systems: 8x (running OAP with 2.6TB scale factor on IO intensive queries), 9X Reads/11X Users (running Cassandra optimized for persistent memory), and Minutes to Seconds (running Aerospike Hybrid Memory Architecture optimized for persistent memory), and provided to you for informational purposes.
AI PERFORMANCE CONFIGURATION DETAILS

1x inference throughput improvement in July 2017:
Tested by Intel as of July 11th 2017: Platform: 2S Intel® Xeon® Platinum 8180 CPU @ 2.50GHz (28 cores), HT disabled, turbo disabled, scaling governor set to “performance” via intel_pstate driver, 384GB DDR4-2666 ECC RAM. CENTOS Linux release 7.3.1611 (Core), Linux kernel 3.10.0-541.10.2.el7.x86_64. SSD: Intel® SSD DC S3700 Series (800GB, 2.5in SATA 6Gb/s, 25nm, MLC). Performance measured with: Environment variables: KMP_AFFINITY=granularity=fine, compact; OMP_NUM_THREADS=56, CPU Freq set with cpupower frequency-set -d 2.5G -u 3.8G -g performance. Caffe: (http://github.com/intel/caffe/), revision f6b7597f1b2281835690a2671588b2b1505c. Inference measured with “caffe time --forward_only” command, training measured with “caffe time” command. For “ConvNet” topologies, dummy dataset was used. For other topologies, data was stored on local storage and cached in memory before training. Topology specs from https://github.com/intel/caffe/tree/master/models/intel_optimized_models (ResNet50), and https://github.com/soumith/convnet-benchmarks/tree/master/caffe/imagenet_winners (ConvNet benchmarks; files were updated to use newer Caffe prototxt format but are functionally equivalent). Intel C++ compiler version 17.0.2 20170123, Intel MKL small libraries version 2018.0.20170425. Caffe run with “numactl -l”. 2x inference throughput improvement in January 2018:
Tested by Intel as of Jan 19th 2018 Processor: 2 socket Intel(R) Xeon(R) Platinum 8180 CPU @ 2.50GHz / 28 cores HT ON , Turbo ON Total Memory 376.46GB (12slots / 32 GB / 2666 MHz). CENTOS Linux-7.3.1611-Core, SSD sda RS3WC080 HDD 744.1Gb,ssd RS3WC080 HDD 1.5TB,ssd RS3WC080 HDD 5.5TB, Deep Learning Framework Intel® Optimization for Caffe version:6d01fbee9377027e3e3796a4b89c612365a6341 Topology:resnet_50_v1 BIOS:SE5C620.86B.01.0005.101920177742.MKLDNN: version: ae01012e55e6f095e536957752a98ed57c1 NoDataLayer: revision 5dd24f46c2f38f8d923257f9205b97e4. Measured: 652.68 imgs/sec vs Tested by intel as of July 11th 2017: Platform 2S Intel® Xeon® Platinum 8180 CPU @ 2.50GHz (28 cores), HT disabled, turbo disabled, scaling governor set to “performance” via intel_pstate driver, 384GB DDR4-2666 ECC RAM. CENTOS Linux release 7.3.1611 (Core), Linux kernel 3.10.0-541.10.2.el7.x86_64. SSD: Intel® SSD DC S3700 Series (800GB, 2.5in SATA 6Gb/s, 25nm, MLC). Performance measured with: Environment variables: KMP_AFFINITY=granularity=fine, compact, OMP_NUM_THREADS=56, CPU Freq set with cpupower frequency-set -d 2.5G -u 3.8G -g performance. Caffe: https://github.com/intel/caffe/), revision f6b7597f1b2281835690a2671588b2b1505c. Inference measured with “caffe time --forward_only” command, training measured with “caffe time” command. For “ConvNet” topologies, dummy dataset was used. For other topologies, data was stored on local storage and cached in memory before training. Topology specs from https://github.com/intel/caffe/tree/master/models/intel_optimized_models (ResNet50), and https://github.com/soumith/convnet-benchmarks/tree/master/caffe/imagenet_winners (ConvNet benchmarks). Intel C++ compiler version 17.0.2 20170213, Intel MKL small libraries version 2018.0.20170425. Caffe run with “numactl -l”. 5x4 inference throughput improvement in August 2017:
Tested by Intel as of measured July 26th 2018: 2 socket Intel(R) Xeon(R) Platinum 8180 CPU @ 2.50GHz / 28 cores HT ON , Turbo ON Total Memory 376.46GB (12slots / 32 GB / 2666 MHz). CENTOS Linux-7.3.1611-Core, 3.10.0-86.3.117.64_ssds, SSD sda RS3WC080 HDD 744.1Gb,ssd RS3WC080 HDD 1.5TB,ssd RS3WC080 HDD 5.5TB, Deep Learning Framework Intel® Optimization for Caffe version:6d01fbee9377027e3e3796a4b89c612365a6341 Topology:resnet_50_v1 BIOS:SE5C620.86B.01.0005.101920177742.MKLDNN: version: ae01012e55e6f095e536957752a98ed57c1 NoDataLayer: revision 5dd24f46c2f38f8d923257f9205b97e4. Measured: 652.68 imgs/sec vs Tested by intel as of July 11th 2017: Platform 2S Intel® Xeon® Platinum 8180 CPU @ 2.50GHz (28 cores), HT disabled, turbo disabled, scaling governor set to “performance” via intel_pstate driver, 384GB DDR4-2666 ECC RAM. CENTOS Linux release 7.3.1611 (Core), Linux kernel 3.10.0-541.10.2.el7.x86_64. SSD: Intel® SSD DC S3700 Series (800GB, 2.5in SATA 6Gb/s, 25nm, MLC). Performance measured with: Environment variables: KMP_AFFINITY=granularity=fine, compact, OMP_NUM_THREADS=56, CPU Freq set with cpupower frequency-set -d 2.5G -u 3.8G -g performance. Caffe: https://github.com/intel/caffe/), revision f6b7597f1b2281835690a2671588b2b1505c. Inference measured with “caffe time --forward_only” command, training measured with “caffe time” command. For “ConvNet” topologies, dummy dataset was used. For other topologies, data was stored on local storage and cached in memory before training. Topology specs from https://github.com/intel/caffe/tree/master/models/intel_optimized_models (ResNet50), and https://github.com/soumith/convnet-benchmarks/tree/master/caffe/imagenet_winners (ConvNet benchmarks). Intel C++ compiler version 17.0.2 20170213, Intel MKL small libraries version 2018.0.20170425. Caffe run with “numactl -l”.

11x inference throughput improvement with CascadeLake:
Future Intel Xeon Scalable processor (codename Cascade Lake) results have been estimated or simulated using internal Intel analysis or architecture simulation or modeling, and provided to you for informational purposes. Any differences in your system hardware, software or configuration may affect your actual performance vs Tested by Intel as of July 11th 2017: 2S Intel® Xeon® Platinum 8180 CPU @ 2.50GHz (28 cores), HT disabled, turbo disabled, scaling governor set to “performance” via intel_pstate driver, 384GB DDR4-2666 ECC RAM. CENTOS Linux release 7.3.1611 (Core), Linux kernel 3.10.0-541.10.2.el7.x86_64. SSD: Intel® SSD DC S3700 Series (800GB, 2.5in SATA 6Gb/s, 25nm, MLC). Performance measured with: Environment variables: KMP_AFFINITY=granularity=fine, compact; OMP_NUM_THREADS=56, CPU Freq set with cpupower frequency-set -d 2.5G -u 3.8G -g performance. Caffe: (http://github.com/intel/caffe/), revision f6b7597f1b2281835690a2671588b2b1505c. Inference measured with “caffe time --forward_only” command, training measured with “caffe time” command. For “ConvNet” topologies, dummy dataset was used. For other topologies, data was stored on local storage and cached in memory before training. Topology specs from https://github.com/intel/caffe/tree/master/models/intel_optimized_models (ResNet50), and https://github.com/soumith/convnet-benchmarks/tree/master/caffe/imagenet_winners (ConvNet benchmarks). Intel C++ compiler version 17.0.2 20170213, Intel MKL small libraries version 2018.0.20170425. Caffe run with “numactl -l”.

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