INTEL® XEON® SCALABLE PLATFORM

THE INDUSTRY'S
BIGGEST PLATFORM ADVANCEMENT
IN A DECADE

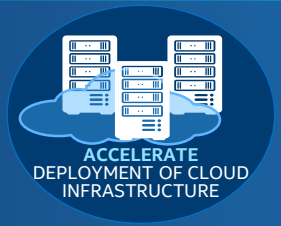
BUSINESS OPPORTUNITY FUELED BY DATA CENTER INNOVATION

CLOUD ECONOMICS

+

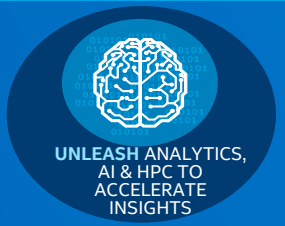
INTELLIGENT DATA PRACTICES

Data Center Growth Drivers



18% CAGR from 2017-2020[1]

114% NFV/SDN CAGR from 2014- 2020[2]



AI is the fastest growing datacenter workload[3]

1. Source: IDC Q4'16 Cloud Infrastructure Tracker
2. Source: Technology Business Research, Sept 2015
3. Source: Amalgamation of Intel financials, analyst data and Intel analysis, Intel revenue includes FPGAs.

INTEL® XEON® SCALABLE PLATFORM

The foundation of Data Center Innovation: Agile & Trusted Infrastructure

PERFORMANCE

Pervasive through compute, storage, and network

SECURITY

Pervasive data security with near zero performance overhead

AGILITY

Rapid service delivery

DELIVERS 1.65X AVERAGE PERFORMANCE BOOST OVER PRIOR GENERATION[1]

[1] Up to 1.65x Geomean based on Normalized Generational Performance going from Intel® Xeon® processor E5-26xx v4 to Intel® Xeon® Scalable processor (estimated based on Intel internal testing of OLTP Brokerage, SAP SD 2-Tier, HammerDB, Server-side Java, SPEC*int_rate_base2006, SPEC*fp_rate_base2006, Server Virtualization, STREAM* triad, LAMMPS, DPDK L3 Packet Forwarding, Black-Scholes, Intel Distribution for LINPACK

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 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 product when combined with other products. For more information go to http://www.intel.com/performance. Intel does not control or audit the design or implementation of third party benchmark data or Web sites referenced in this document. Intel encourages all of its customers to visit the referenced Web sites or others where similar performance benchmark data are reported and confirm whether the referenced benchmark data are accurate and reflect performance of systems available for purchase.

A GLIMPSE INSIDE THE INTEL® XEON® SCALABLE PLATFORM

Fabric
Intel® Omni-Path Architecture

Networking
Intel® Ethernet

Accelerators
Intel® QuickAssist
Intel® AVX-512

SSDs
Intel® Optane™ SSD DC P4800X

Complementary
Intel® FPGA

INTEGRATED OPTIONS

Workload optimized frameworks & telemetry
(e.g. Caffe*, Intel® DAAL, Intel® MKL, DPDK, SNAP*, SPDK)

PERFORMANCE

SECURITY

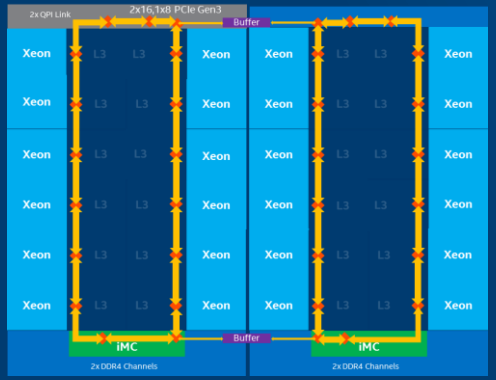
AGILITY

ADVANCING VIRTUALLY EVERY ASPECT: BRAND NEW CORE, CACHE, ON-DIE INTERCONNECTS, MEMORY CONTROLLER & MORE

Intel® Advanced Vector Extensions 512 (Intel® AVX-512)
Intel® Math Kernel Library (Intel® MKL)
Intel® Volume Management Device (Intel® VMD)
Storage Performance Development Kit (SPDK)
Intel® Data Analytics Acceleration Library (Intel® DAAL)
Data Plane Development Kit (DPDK)
Intel® Resource Director Technology (Intel® RDT)

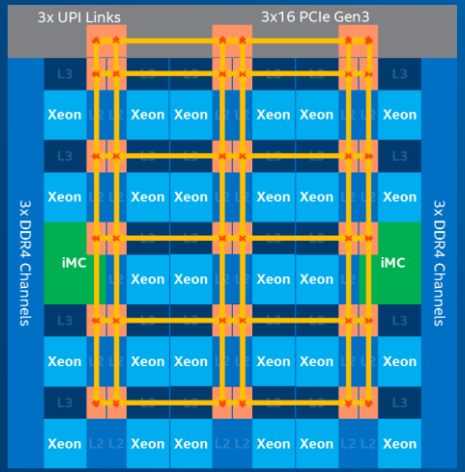
BREAKTHROUGH CPU DESIGN: INTEL® MESH ARCHITECTURE

Ring Architecture



2009-2017+

Mesh Architecture



New in 2017

- ✓ **Maximizes performance**
- ✓ **Enables consistent, low latencies**
- ✓ **Optimized for data** sharing and memory access between all CPU cores/threads for ideal memory bandwidth and capacity
- ✓ **Data flows scale efficiently** for 2, 4 & 8+ socket configurations
  - ✓ Designed for modern virtualized and hybrid cloud implementations

DESIGNED FOR NEXT-GENERATION DATA CENTERS

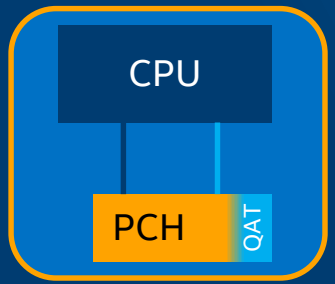
DELIVERING PERFORMANCE BEYOND BENCHMARKS

CLOUD	Baidu 百度 SEARCH	HUAWEI FUSIONSPHERE	KINGSOFT MYSQL CLOUD SERVICE	Neusoft ACLOME	Tencent 腾讯 CLOUD
	1.74X click-through-rate[1]	1.62X enterprise cloud applications[2]	1.63X OLTP database[3]	1.5X cloud monitoring[4]	1.72X video stitching[5]
AI & ANALYTICS	IBM DB2	IHS Markit ANALYTICS RISK ENGINE	LAMMPS	SAP HANA	sas
	1.47X in-memory analytics[6]	1.68X enterprise risk management[7]	1.72X molecular dynamics[8]	1.59X database transactions[9]	2X business analytics[10]
NETWORK	AsiaInfo VERIS	eBrisk EBLIVE	ERICSSON MEDIAFIRST	sandvine VIRTUAL SERIES	Telefónica VIRTUAL BNG
	2.21X business support system[11]	1.9X HEVC video encoding[12]	1.5X video transcoding[13]	1.64X packet inspection[14]	1.67X routing[15]

Other names and brands may be claimed as the property of others.. 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 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 product when combined with other products. For more complete information visit: http://www.intel.com/performance.

1. *Baidu Search Click-Through-Rate (CTR) : OS: CentOS Linux release 7.3.1611. Testing by Intel June 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8180.*
2. *Huawei FusionSphere virtualized cloud Platform: OS: RHEL 7.2. Testing by Intel May 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8180.*
3. *Kingsoft Cloud Image Processing and MySQL Cloud Service: OS: CentOS 7.3.1611. Testing by Intel May 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8180.*
4. *Neusoft SaCa Aclome: SaCa Aclome workload (for general performance) and compressing/decompressing workload (for QAT). OS: CentOS 7.3.1611. Testing by Intel and Neusoft May 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8180.*
5. *Tencent Business Analytics: Video Stitching workload. OS: CentOS 7.3.1611 Linux kernel 4.9.8. Testing by Intel April 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8180.*
6. *IBM DB2: DB2 v11.1.1.1. The IBM Big Data Insights Internal Heavy Multiuser Workload (BDInsights) is a multi-user data warehousing workload based on a retail environment. Testing by Intel and IBM April/May 2017. 4S Intel® Xeon® processor E7-8890 v4 vs 4S Intel® Xeon® Platinum processor 8180.*
7. *IHS Markit Analytics Risk Engine: internal synthetic portfolio. OS: Windows server 2016. Testing by Intel and IHS Markit May 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8168.*
8. *LAMMPS: Testing by Intel June 2017. 2S Intel® Xeon® processor E5-2697 v4 vs 2S Intel® Xeon® Platinum processor 8168.*
9. *SAP HANA: 1-Node, 4S Intel® Xeon® Processor E7-8890 v4 on Grantley-EX-based platform with 1024 GB Total Memory on SLES12SP1 vs. estimates based on SAP internal testing on 1-Node, 4S Intel® Xeon® Scalable family.*
10. *SAS Business Analytics: SAS 9.4 m4 application running the 30 session SAS Mixed Analytics workload. OS: CentOS 7.2 kernel 3.10.0. ntel and SAS May 2017. 2S Intel® Xeon® E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8180.*
11. *AsiaInfo Telco BSS: AsiaInfo Telco BSS workload. OS: RHEL 7.3. Testing by Intel & AsiaInfo May 2017. 4S Intel® Xeon® processor E7-8890 v4 vs 4S Intel® Xeon® Platinum processor 8180.*
12. *eBrisk: OS: Windows Server 2012 R2 Standard Build 9600. Test clips: https://media.xiph.org/video/derf/ . Testing by Intel May 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8180.*
13. *Ericsson MediaFirst Video Processing UHD HEVC transcoding workload. OS: CentOS Linux* 7.2 kernel 3.10.0. Testing by Ericsson in May 2017. 2S Intel® Xeon® processor E5-2699 v4 vs 2S Intel® Xeon® Platinum processor 8168.*
14. *Sandvine Virtual Series OS: CentOS Linux release 7.3.1611 Kernal: Linux 3.10.0-514.6.2.el7.x86_64 Hypervisor: qemu-kvm-1.5.3-126.el7_3.3.x86_64 VNF sizing: 3vCPU (6 pCPU threads), 128 GB RAM Testing by Sandvine, June 2017. 2S Intel® Xeon® processor E5-2699 v3 vs 2S Intel® Xeon® Gold processor 6150.*
15. *Telefonica: Testing by Telefonica, 2S Intel® Xeon® processor E5-2600 v4 vs 2S Intel® Xeon® Platinum processor 8168.*

CONVERGED "HIGHLY INTEGRATED" PLATFORM FOR THE NETWORK

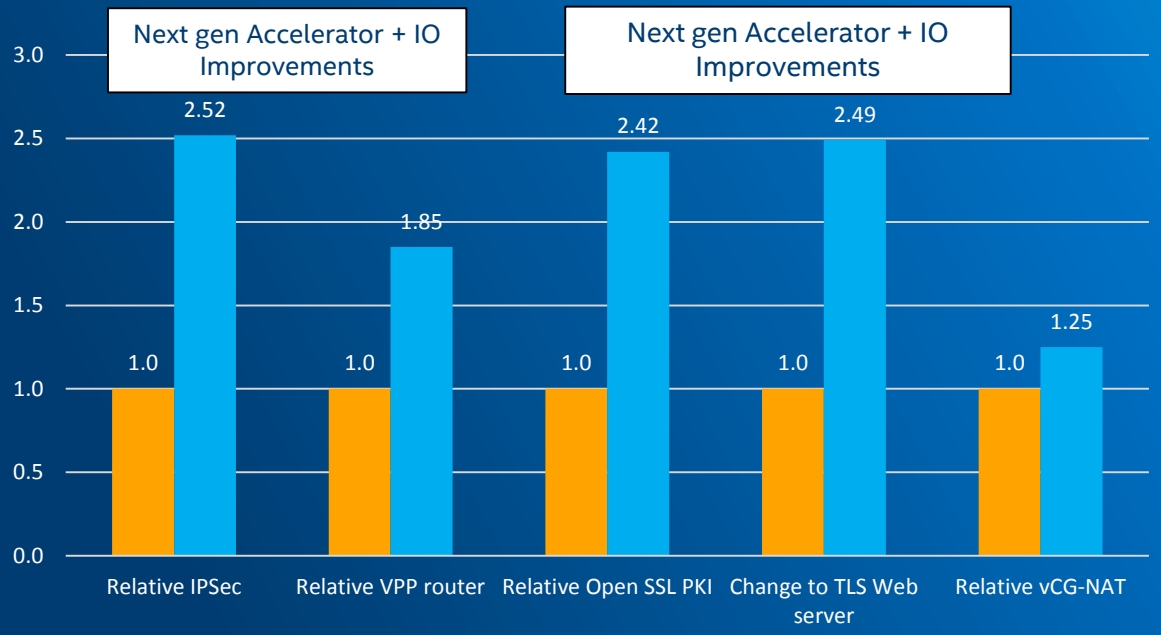


Intel® Xeon® Scalable processor with Server PCH + QAT

COMMS

CLOUD

ENTERPRISE



APPLICATION & ARCHITECTURAL LEVEL PERFORMANCE COMPARISON

Results have been estimated based on internal Intel analysis and are provided for informational purposes only. Any difference in system hardware or software design or configuration may affect actual performance. 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 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 product when combined with other products. For more information go to http://www.intel.com/performance/datacenter.

INTEL® XEON® PLATINUM AND INTEL® OPTANE™ SSDS FOR STORAGE INFRASTRUCTURE

- **Intel Optane SSD P4800 Series:** High performance, low latency storage
- **Intel® Volume Management Device:** Hot-swap of drives with standardized LED management
- **Software tools for optimized storage**
  - Intel® Intelligent Storage Acceleration Library (ISA-L)
  - Intel® Storage Performance Development Kit (SPDK)

sas

2X PERFORMANCE INCREASE

VS PRIOR GENERATION[1]

Business impact

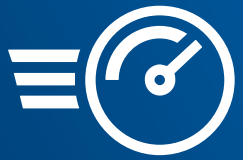
- ✓ Faster data analytics results
- ✓ More complex analyses
- ✓ Deeper data insights

[1] 2x claim based on SAS Business Analytics: SAS 9.4 m4 application running the 30 session SAS Mixed Analytics workload. OS: CentOS 7.2 kernel 3.10.0. Testing by Intel and SAS May 2017. 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 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 product when combined with other products. For more complete information visit http://www.intel.com/performance. *Other names and brands may be claimed as the property of others.

INTEL® XEON® SCALABLE PROCESSORS FOR AI

Scalable performance for widest variety of AI & other datacenter workloads – including deep learning

MOST AGILE AI PLATFORM



BUILT-IN ROI

Begin your AI journey today using existing, familiar infrastructure

POTENT PERFORMANCE

*Train in ~~days~~ HOURS with up to **113X[2] perf vs. Intel Xeon processor E5 v3** (2.2x excluding optimized SW[1])*

PRODUCTION-READY

Robust support for full range of AI deployments

[1,2]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 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 product when combined with other products. For more complete information visit: http://www.intel.com/performance Source: Intel measured as of November 2016. Optimization 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 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. See slide 15 for configuration details.

INTEL® XEON® SCALABLE PROCESSORS

THE FOUNDATION FOR AGILE, SECURE, WORKLOAD-OPTIMIZED HYBRID CLOUD

BEST

UP TO 28 CORES

UP TO 2, 4 & 8 SOCKET SUPPORT WITH UP TO **3 UPI LINKS**

DDR4 2666 MHZ WITH UP TO **1.5 TB** TOPLINE MEMORY CHANNEL BANDWIDTH

HIGHEST ACCELERATOR THROUGHPUT

GREAT

UP TO 22 CORES

2 & 4 SOCKET SUPPORT

UP TO 3 UPI LINKS

ADVANCED RELIABILITY, AVAILABILITY AND SERVICEABILITY

GOOD SCALABLE PERFORMANCE AT LOW POWER
STANDARD RAS

MODERATE TASKS

INTEL® TURBO BOOST TECHNOLOGY AND INTEL® HYPER-THREADING TECHNOLOGY FOR MODERATE WORKLOADS

ENTRY SCALABLE PERFORMANCE
HARDWARE-ENHANCED SECURITY
STANDARD RAS

LIGHT TASKS

ENTRY PERFORMANCE, PRICE SENSITIVE FOR LIGHT WORKLOADS

MAINSTREAM | EFFICIENT | ENTRY

INTRODUCING

intel select solution

WORKLOAD-OPTIMIZED REFERENCE ARCHITECTURES

REFERENCE DESIGNS

vmware vSAN

Microsoft SQL Server

ubuntu NFVi

DELIVERED BY

ERICSSON

Hewlett Packard Enterprise

HUAWEI

inspur 浪潮

Lenovo

Sugon 中科曙光

QCT

SUPERMICRO

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THE INTEL® XEON® SCALABLE DATA CENTER ADVANTAGE

PROVEN PERFORMANCE AND INNOVATION

- Up to 1.65X average generational gains[1]
- Up to 8.2X boost in HPC over installed base[2]

ARCHITECTED FOR THE DATA CENTER

- Single-die implementation maximizes performance and reduces latency
- Workload optimized acceleration

UNMATCHED GLOBAL ECOSYSTEM

- Intel Select Solutions
- Decades of investment in software, validation, optimizations and security
- Intel® Architecture advantage: Fully interoperable with other Intel virtualized server pools and products

ANOTHER MAJOR MILESTONE FOR INTEL'S 20+ YEARS OF DATA CENTER INNOVATION

[1] **Up to 1.65x** Geomean based on Normalized Generational Performance going from Intel® Xeon® processor E5-26xx v4 to Intel® Xeon® Scalable processor (estimated based on Intel internal testing of OLTP Brokerage, SAP SD 2-Tier, HammerDB, Server-side Java, SPEC*int_rate_base2006, SPEC*fp_rate_base2006, Server Virtualization, STREAM* triad, LAMMPS, DPDK L3 Packet Forwarding, Black-Scholes, Intel Distribution for LINPACK

[2] **Up to 8.2x claim based on Intel® Distribution for LINPACK Benchmark**: 1-Node, 2 x Intel® Xeon® Processor E5-2690 on Intel® Server Board S2600CP2 with 32 GB Total Memory on Red Hat Enterprise Linux* 6.0 (Santiago) kernel version 2.6.32-504.el6.x86_64 using Intel® Distribution for LINPACK Benchmark using 56000 problem size. Score: 366.0 GFLOPS/s vs. 1-Node, 2 x Intel® Xeon® Platinum 8180 Processor on Purley-EP (Lewisburg) with 192 GB Total Memory on Ubuntu 17.04 using MKL 2017 Update 2. Data Source: Request Number: 2535, Benchmark: Intel® Distribution for LINPACK Benchmark, Score: 3007.8 GFLOPS/s Higher is better.

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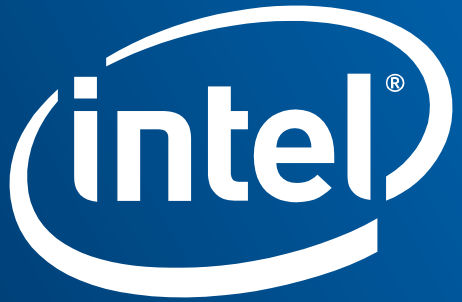
intel

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Notice revision #20110804

PERFORMANCE DISCLOSURES [1/2]

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Results are based on internal testing and are provided to you for informational purposes. Any differences in your system hardware, software or configuration may affect your actual performance.

Up to 4.2x more VMs based on virtualization consolidation workload: Based on Intel® internal estimates 1-Node, 2 x **Intel® Xeon® Processor E5-2690** on Romley-EP with 256 GB Total Memory on VMware ESXi* 6.0 GA using Guest OS RHEL6.4, glassfish3.1.2.2, postgresql9.2. Data Source: Request Number: 1718, Benchmark: server virtualization workload, Score: 377.6 **@ 21 VMs** Higher is better vs. 1-Node, 2 x **Intel® Xeon® Platinum 8180 Processor** on Wolf Pass SKX with 768 GB Total Memory on VMware ESXi6.0 U3 GA using Guest VM's utilize RHEL 6 64bit OS. Data Source: Request Number: 2563, Benchmark: server virtualization workload, Score: 1580 @ **90 VMs** Higher is better.

Up to 8.2x claim based on Intel® Distribution for LINPACK Benchmark: 1-Node, 2 x Intel® Xeon® Processor E5-2690 on Intel® Server Board S2600CP2 with 32 GB Total Memory on Red Hat Enterprise Linux* 6.0 (Santiago) kernel version 2.6.32-504.el6.x86_64 using Intel® Distribution for LINPACK Benchmark using 56000 problem size. Score: 366.0 GFLOPS/s vs. 1-Node, 2 x Intel® Xeon® Platinum 8180 Processor on Purley-EP (Lewisburg) with 192 GB Total Memory on Ubuntu 17.04 using MKL 2017 Update 2. Data Source: Request Number: 2535, Benchmark: Intel® Distribution for LINPACK Benchmark, Score: 3007.8 GFLOPS/s Higher is better.

Up to 1.65x Geomean based on Normalized Generational Performance going from Intel® Xeon® processor E5-26xx v4 to Intel® Xeon® Scalable processor (estimated based on Intel internal testing of OLTP Brokerage, SAP SD 2-Tier, HammerDB, Server-side Java, SPEC*int_rate_base2006, SPEC*fp_rate_base2006, Server Virtualization, STREAM* triad, LAMMPS, DPDK L3 Packet Forwarding, Black-Scholes, Intel Distribution for LINPACK

Up to 2.2x and 113x AI performance. 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 3.10.0-514.10.2.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. Compared with Platform: 2S Intel® Xeon® CPU E5-2699 v3 @ 2.30GHz (18 cores), HT enabled, turbo disabled, scaling governor set to "performance" via intel_pstate driver, 256GB DDR4-2133 ECC RAM. CentOS Linux release 7.3.1611 (Core), Linux kernel 3.10.0-514.el7.x86_64. OS drive: Seagate* Enterprise ST2000NX0253 2 TB 2.5" Internal Hard Drive.Performance measured with: Environment variables: KMP_AFFINITY='granularity=fine, compact,1,0', OMP_NUM_THREADS=36, CPU Freq set with cpupower frequency-set -d 2.3G -u 2.3G -g performance. Intel Caffe: (http://github.com/intel/caffe/), revision b0ef3236528a2c7d2988f249d347d5fdae831236. 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 (GoogLeNet, AlexNet, and ResNet-50), GCC 4.8.5, MKLML version 2017.0.2.20170110. BVLC-Caffe: https://github.com/BVLC/caffe, Inference & Training measured with "caffe time" command. For "ConvNet" topologies, dummy dataset was used. For other topologies, data was st ored on local storage and cached in memory before training BVLC Caffe (http://github.com/BVLC/caffe), revision 91b09280f5233cafc62954c98ce8bc4c204e7475 (commit date 5/14/2017). BLAS: atlas ver. 3.10.1.
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 3.10.0-514.10.2.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. Compared with Platform: 2S Intel® Xeon® CPU E5-2699 v4 @ 2.20GHz (22 cores), HT enabled, turbo disabled, scaling governor set to "performance" via acpi-cpufreq driver, 256GB DDR4-2133 ECC RAM. CentOS Linux release 7.3.1611 (Core), Linux kernel 3.10.0-514.10.2.el7.x86_64. SSD: Intel® SSD DC S3500 Series (480GB, 2.5in SATA 6Gb/s, 20nm, MLC). Performance measured with: Environment variables: KMP_AFFINITY='granularity=fine, compact,1,0', OMP_NUM_THREADS=44, CPU Freq set with cpupower frequency-set -d 2.2G -u 2.2G -g performance. Neon: ZP/MKL_CHWN branch commit id:52bd02acb947a2adabb8a227166a7da5d9123b6d. Dummy data was used. The main.py script was used for benchmarking , in mkl mode. ICC version used : 17.0.3 20170404, Intel MKL small libraries version 2018.0.20170425; Inference and training throughput uses FP32 instructions

PERFORMANCE DISCLOSURES [2/2]

Intel® Xeon® Platinum processor "Best Performance, Hardware-Enhanced Security, Outstanding Business Agility": Comparing Intel® Xeon® Platinum processor vs. Intel® Xeon® Gold processor including core count, socket support and other platform capabilities. Results have been estimated based on internal Intel analysis and are provided for informational purposes only.

Intel® Xeon® Gold processor "Great Performance, Fast Memory, More Interconnect/Accelerator Engines, Advanced Reliability": Comparing Intel® Xeon® Gold processor vs. Intel® Xeon® Silver processor including core count, socket support and other platform capabilities. Results have been estimated based on internal Intel analysis and are provided for informational purposes only.

Intel® Xeon® Silver processor "Efficient Performance": Comparing Intel® Xeon® Silver processor vs. Intel® Xeon® Bronze processor including core count, socket support and other platform capabilities. Results have been estimated based on internal Intel analysis and are provided for informational purposes only.

Intel® Xeon® Bronze processor "Entry Performance": Comparing Intel® Xeon® Bronze processor vs. Intel® Xeon® processor E3-1200 v6 processor including core count, socket support and other platform capabilities. Results have been estimated based on internal Intel analysis and are provided for informational purposes only.