THE ERA OF DATA-CENTRIC COMPUTING

Vipul Shah - Regional Director, Intel Asia Pacific
April 16, 2019
NOTICES & DISCLAIMERS

All information in this presentation reflects management's views as of August 8, 2018. Intel does not undertake, and expressly disclaims any duty, to update any statement made in this presentation, whether as a result of new information, new developments or otherwise, except to the extent that disclosure may be required by law.

Intel technologies’ features and benefits depend on system configuration and may require enabled hardware, software or service activation. Performance varies depending on system configuration.

No computer system can be absolutely secure.

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

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 www.intel.com/benchmarks.

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. For more complete information about performance and benchmark results, visit http://www.intel.com/benchmarks.

Intel does not control or audit third-party benchmark data or the web sites referenced in this document. You should visit the referenced web site and confirm whether referenced data are accurate.

All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest Intel product specifications and roadmaps.

Arria, Intel, the Intel logo, Intel Atom, Intel Nervana, Intel Optane, Intel Xeon, Movidius, Myriad, Stratix and the Stratix logo are trademarks of Intel Corporation in the U.S. and/or other countries.

*Other names and brands may be claimed as property of others.

© Copyright 2019 Intel Corporation.
DATA DEFINES THE FUTURE

*Other names and brands may be claimed as property of others.
DECREASING COST OF TECHNOLOGY

COST OF COMPUTE
56%
2012-2017

COST OF STORAGE
77%
2012-2017

41X PERFORMANCE INCREASE

1 Source: Amalgamation of analyst data and Intel analysis.
2 Source: Intel
INNOVATION ACROSS INDUSTRIES

FLEXIBLE CLOUD SERVICES

HIGH CAPACITY NETWORKS

DEEPER INSIGHTS WITH AI
NEW ERA OF DATA CENTER TECHNOLOGY

DATA-CENTRIC INFRASTRUCTURE

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

STORE MORE
- OPTANE DC
- SOLID STATE DRIVE

PROCESS EVERYTHING
- STRATIX 10
- XEON PLATINUM
- NERVANA

SOFTWARE & SYSTEM-LEVEL OPTIMIZED
NEW ERA OF DATA CENTER TECHNOLOGY

DATA-CENTRIC INFRASTRUCTURE

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

STORE MORE
- OPTANE® DC SSD
- STRATIX® 10 FPGA
- XEON® PLATINUM CPU
- ATOM® Processor
- MOVIDIUS® Accelerator

PROCESS EVERYTHING
- NERVANA® Accelerator

SOFTWARE & SYSTEM-LEVEL OPTIMIZED
RE-ARCHITECTING THE MEMORY / STORAGE HIERARCHY

MEMORY

PERSISTENT MEMORY
Improving memory capacity

STORAGE
Improving SSD performance

Delivering efficient storage

DRAM
HOT TIER

HDD / TAPE
COLD TIER

SSD
WARM TIER

INTEL® 3D NAND SSD

Intel® Optane DC™
PERSISTENT MEMORY

Intel® Optane DC™
SOLID STATE DRIVE
<table>
<thead>
<tr>
<th>Feature</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIG AND AFFORDABLE MEMORY</td>
<td>128, 256, 512GB</td>
</tr>
<tr>
<td>HIGH PERFORMANCE STORAGE</td>
<td>DDR4 PIN COMPATIBLE</td>
</tr>
<tr>
<td>DIRECT LOAD/STORE ACCESS</td>
<td>HARDWARE ENCRYPTION</td>
</tr>
<tr>
<td>NATIVE PERSISTENCE</td>
<td>HIGH RELIABILITY</td>
</tr>
</tbody>
</table>
DELIVERING BREAKTHROUGH VALUE...

OPTANE™ DC PERSISTENT MEMORY

Note: Intel Optane DC Persistent Memory opportunity equals 2022 data center memory SAM. 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. 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 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 www.intel.com/benchmarks. *Other names and brands may be claimed as the property of others.
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
- Intel Optane DC Solid State Drive

PROCESS EVERYTHING
- Intel Stratix 10 SoC
- Intel Xeon Platinum inside
- Intel Nervana inside
- Intel Atom inside
- Intel Movidius inside

SOFTWARE & SYSTEM-LEVEL OPTIMIZED
2ND GENERATION
INTEL® XEON® SCALABLE PROCESSORS

>50 STANDARD SKUS
DOZENS CUSTOM SKUS
8 TO 56 CORES PER SOCKET
4.5TB MEMORY PER SOCKET
1 TO 8 SOCKETS

INTEL® OPTANE™ DC PERSISTENT MEMORY
INTEL® DEEP LEARNING BOOST
INTEL® SPEED SELECT TECHNOLOGY
NETWORK-OPTIMIZED SKUS
CLOUD-OPTIMIZED SKUS
SECURITY MITIGATIONS

BUILDING ON 20 YEARS OF DATA CENTER PROCESSOR INNOVATION
SECOND GENERATION INTEL® XEON® SCALABLE PROCESSORS

PERFORMANCE TO PROPEL INSIGHTS

INTEL® XEON® PLATINUM 8200 PROCESSORS

INTEL® XEON® GOLD 6200 & 5200 PROCESSORS

INTEL® XEON® SILVER 4200 PROCESSORS

INTEL® XEON® BRONZE 3200 PROCESSORS

---

UP TO 3.50X

5-YEAR REFRESH PERFORMANCE IMPROVEMENT

COMPARSED TO INTEL® XEON® ES-2600V4 PROCESSOR

---

UP TO 1.33X

AVERAGE PERFORMANCE IMPROVEMENT

COMPARSED TO INTEL® XEON® E5-2600V4 PROCESSOR

---

UP TO 14X

AI PERFORMANCE WITH INTEL® DL BOOST

COMPARSED TO INTEL® XEON® PLATINUM 8180 PROCESSORS (JULY 2017)

---

UP TO 3.1X

BETTER PERFORMANCE THAN AMD EPYC 7601

COMPARSED TO INTEL® XEON® PLATINUM 8279 PROCESSORS RUNNING LINPACK

---

MITIGATIONS FOR SIDE-CHANNEL METHODS

ENCRYPTION + ACCELERATORS

INTEL® SECURITY LIBRARIES

INTEL® DEEP LEARNING BOOST

INTEL® SPEED SELECT TECHNOLOGY

INTEL® INFRASTRUCTURE MANAGEMENT TECHNOLOGIES

BUSINESS RESILIENCE WITH HARDWARE-ENHANCED SECURITY

AGILE SERVICE DELIVERY WITH ENHANCED EFFICIENCY

Intel® Speed Select Technology is available on select processors.

Performance results are based on testing as of dates shown in configuration and may not reflect all publicly available security updates. Configurations and benchmark details can be found on slide/page 50 and 51. No product or component can be absolutely secure. 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 www.intel.com/benchmarks.
CISCO UCS M5 SYSTEMS

2nd Gen Intel® Xeon® Scalable Processor

5 WORLD RECORDS AND COUNTING...

AI COMPUTE FROM CLOUD TO DEVICE

ALL PURPOSE
- Intel® Xeon® Scalable Processor Family

FLEXIBLE ACCELERATION
- Intel® FPGA

TRAINING & INFERENCEN
- Intel® Nervana™ Neural Network Processor

EDGE INFEERENCE
- Intel® Movidius™ Myriad™ Technology

100s WATTS  mWATTS

COMING 2019
## LAUNCHED ON APRIL 2, 2019

### DATA-CENTRIC PORTFOLIO

<table>
<thead>
<tr>
<th>MOVE FASTER</th>
<th>STORE MORE</th>
<th>PROCESS EVERYTHING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INTEL® ETHERNET 800 SERIES ADAPTER</strong></td>
<td><strong>INTEL® SSDs</strong></td>
<td><strong>2ND GENERATION INTEL® XEON® SCALABLE</strong></td>
</tr>
<tr>
<td><img src="image" alt="Network Adapter" /></td>
<td><img src="image" alt="SSD" /></td>
<td><img src="image" alt="CPU" /></td>
</tr>
<tr>
<td><img src="image" alt="Optane DC Persistent Memory" /></td>
<td><img src="image" alt="Optane DC Persistent Memory" /></td>
<td><img src="image" alt="Optane DC Persistent Memory" /></td>
</tr>
<tr>
<td><strong>INTEL® OPTANE™ DC PERSISTENT MEMORY</strong></td>
<td><strong>INTEL® XEON® D-1600</strong></td>
<td><strong>INTEL® AGILEX™</strong></td>
</tr>
<tr>
<td><img src="image" alt="Optane DC Persistent Memory" /></td>
<td><img src="image" alt="CPU" /></td>
<td><img src="image" alt="FPGA" /></td>
</tr>
</tbody>
</table>

*#datacentric intel select solution*
### Cisco & Intel: Driving Datacenter Modernization

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>UCS</td>
<td>Cohesive next-gen datacenter platform combining Compute, network, storage, and virtualization to reduce TCO and increase business agility</td>
</tr>
<tr>
<td>ACI</td>
<td>Innovative architecture to simplify, optimize, &amp; accelerate the application deployment lifecycle</td>
</tr>
<tr>
<td>Big Data</td>
<td>Highly efficient infrastructure built to deliver big data and analytics solutions at the network core, network edge, and in the cloud</td>
</tr>
<tr>
<td>Cloud/SDI</td>
<td>Suite of solutions to accelerate SDI and build and deploy secure private cloud infrastructures</td>
</tr>
<tr>
<td>HyperFlex</td>
<td>Next-gen hyperconvergence offering with robust, fabric-centric infrastructure that scales efficiently &amp; supports a broad range of applications</td>
</tr>
<tr>
<td>Tetration</td>
<td>Real-time data center analytics, combines network and server sensors to simplify SDN, migration to the cloud, and white-list security.</td>
</tr>
<tr>
<td>NFVi</td>
<td>Carrier-class Network Functions Virtualization infrastructure that allows Service Providers deploy new services faster, reduce TCO &amp; maintain service availability</td>
</tr>
</tbody>
</table>

### Leading Edge Intel Xeon Benefits
- Performance Leadership
- Works closely with storage and networking to reach new solutions
- Delivers features enabling better virtualization experience
INTRODUCING ALL NVME HYPERFLEX

- All NVMe with 40 GbE Integrated Fabric Networking
- RAS with Intel VMD for Hot-Plug, Surprise Removal etc.
- NVMe Optane Cache 375 GB Capacity, NVMe Capacity (up to 32TB/Node)
THE NEW HYPERFLEX EDGE

The Power of Cloud-Managed Computing

- Lights out, multi-site parallel deployment
- Rapid cluster profile creation and full stack upgrades
- Flexible scalability and investment protection
- Connected TAC Support
- Cloud Witness Service
- Three-node cluster quorum without physical 3rd node!
WE ARE IN A NEW ERA OF DATA-CENTRIC COMPUTING

IT MUST MOVE FASTER, STORE MORE, & PROCESS EVERYTHING

CISCO / INTEL ARE COLLABORATING DEEP & WIDE TO DELIVER DATA-CENTRIC PLATFORMS FOR YOUR NEEDS

VISIT OUR BOOTH
MEET OUR EXPERTS VINOD, RUSHI, FRANCIS – AI ON INTEL & CISCO UCS
BENCHMARK & CONFIGURATION DETAILS
INTEL® XEON® SCALABLE PROCESSOR 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 vers SE5C620.86B.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 -03, executed on 1 core using taskset and numaclon on core 0. Estimated score = 6.59, as of 8/2/2018 tested by Intel.

AMP EPYC 7601: Supermicro AS-2033US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32 core) processors. BIOS vers. 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 vers 1.0, -nost, -march=znver1, executed on 1 core using taskset and numaclon on core 0. Estimated score = 4.45, as of 8/2/2018 tested by Intel.

3.20x: High Performance Linpack
Intel Xeon Platinum 8180: Intel Xeon-based Reference Platform with 2 Intel Xeon 8180 (2.5GHz, 28 core) processors. BIOS vers SE5C620.86B.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). High Performance Linpack v2.1, compiled with Intel(R) Parallel Studio XE 2018 for Linux, Intel MPI and MKL. Benchmark Config: Nb=384, N=203136, P=1, Q=2, Q=4, Score = 3569.06 GMPS, as of July 31, 2018 tested by Intel.

AMP EPYC 7601: Supermicro AS-2033US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32 core) processors. SMT OFF. Turbo ON. BIOS vers. 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). High Performance Linpack v2.2, compiled with Intel(R) Parallel Studio XE 2018 for Linux, Intel MPI version 18.0.0.128, AMD BLIS vers 0.4.0, Benchmark Config: Nb=232, N=168960, P=4, Q=4, Score = 1095GFs, as of July 31, 2018 tested by Intel.

1.65x: Database
Intel Xeon Platinum 8180: Intel Xeon-based Reference Platform with 2 Intel Xeon 8180 (2.5GHz, 28 core) processors. BIOS vers SE5C620.86B.00.01.0015.02820180604, microcode: 0x2000043, HT ON, Turbo ON, 24x32GB DDR4-2666, 1 x Intel DC P3700 PCIe-SSD (2TB, 1/2 Height PCIe 3.0, 20nm, MLC). Red Hat Enterprise Linux 7.4 (3.10.0-693.11.6.el7.x86_64 IRRS). HammerDB ver 2.3, PostgreSQL ver 9.6.5, Score = 2,250,481 tpm, as of 3/15/2018 tested by Intel.

AMP EPYC 7601: HPE Proliant DL385 Gen10 with 2 AMD EPYC 7601 (2.2GHz, 32 core) processors. ROM vers. 1.06, microcode: 0x8001227, SMT ON, Turbo ON, 16x32GB DDR4-2666, 1 x Intel DC P3700 PCIe-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), HammerDB ver 2.3, PostgreSQL vers 9.6.5, Score = 1,261,075 tpm, as of 4/12/2018 tested by Intel.

1.45x: Memcached (Memory Object Caching)
Intel Xeon Platinum 8180: Intel Xeon-based Reference Platform with 2 Intel Xeon 8180 (2.5GHz, 28C) processors. BIOS vers SE5C620.86B.00.01.0014.070920180847, 07/09/2018, microcode: 0x200004d. HT ON, Turbo ON, 12x32GB DDR4-2666, 1 SSD, 1 400GB PCIe X710 Adapter. Ubuntu 18.04.1 LTS (4.17.0-041700-generic Retpoline). Memcached using YCSB Benchmark Workloads. YCSB 0.16.0, Memcached v1.5.9, Max throughput (ops/sec) with 128 latency < 1ms, Score = 2711256 ops/sec, as of 8/2/2018 tested by Intel.

AMP EPYC 7601: Supermicro AS-2033US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32C) processors. BIOS vers. 1.1a, 4/26/2018, microcode: 0x8001227. SMT ON, Turbo ON, 16x32GB DDR4-2666, 1 SSD, 1 400GB PCIe X710 Adapter, Ubuntu 18.04 LTS (4.17.0-041700-generic Retpoline), Memcached using YCSB benchmark Workloads, YCSB 0.16.0, Memcached v1.5.9, Max throughput (ops/sec) with 128 latency < 1ms, Score = 1862841 ops/sec, as of 8/2/2018 tested by Intel.

1.72x: L3 Packet Forwarding
Intel Xeon Platinum 8180: Supermicro X11DPG-OT with 2 Intel Xeon-SP 8180 (2.5GHz, 28C) processors. BIOS vers 2.0b, microcode: 0x2000043. 12x32GB DDR4-2666, 1 SSD, 2x Intel XYY710-DA2 PCI Express (2x25GbE), DPDK L3fwd sample application (IPv4 LPM, 256B packet size, 65536 flows), DPDK 17.11, Ubuntu 17.10, (4.13.0-31-generic IRRS), HT ON. Turbo OFF, Score = 42.22 Million Packets / Second, as of 8/2/2018 tested by Intel.

AMP EPYC 7601: Supermicro AS-2033US-TR4 with 2 AMD EPYC 7601 (2.2GHz, 32C) processors. BIOS vers. 1.1a, microcode: 0x8001227. 16x32GB DDR4-2666, 1 SSD, 2x Intel XYY710-DA2 PCI Express (2x25GbE), DPDK L3fwd sample application (IPv4 LPM, 256B packet size, 65536 flows), DPDK 17.11, Ubuntu 17.10, (4.13.0-31-generic Retpoline), SMT OFF. Turbo (core boost) OFF, Score = 24.52 Million Packets / Second, as of 8/2/2018 tested by 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.