Николай Местер, директор по развитию корпоративных проектов
Иван Кузьмин, руководитель отдела разработки высокопроизводительных библиотек
The HPC Opportunity

MODELING & SIMULATION

$515 average return per $1 of HPC investment\(^1\)

HPC DATA ANALYTICS

18% revenue CAGR; >$3 billion in 2020\(^2\)

ARTIFICIAL INTELLIGENCE

55% revenue CAGR; >$47 billion in 2020\(^3\)

VISUALIZATION

30% revenue CAGR; >$1.6 billion in 2020\(^4\)

1 Source: Source: IDC HPC and ROI Study Update, September 2015
2 Source IDC Worldwide High-Performance Data Analytics Forecast 2016-2020, June 2016
4 Source: MarketsandMarkets Visualization and 3D Rendering Software Market by Application, March 2016

Intel and the Intel logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries. Other names and brands may be claimed as the property of others. All products, dates, and figures are preliminary and are subject to change without notice. Copyright © 2013, Intel Corporation.
A Holistic Architectural Approach is Required

Innovative Technologies

Compute

Performance

Time

Memory
Fabric
Storage
System Software

Tighter Integration

Cores
Memory
FPGA
I/O

Fabric
Graphics

System
Application

Modernized Code

Community
ISV
Proprietary

Software

Performance

Time

Compute
Key Elements of Intel® SSF

INTEL® SCALABLE SYSTEM FRAMEWORK

- MARKET LEADING
- HIGHLY PARALLEL
- INTEL® OMNI-PATH ARCHITECTURE
- INTEL® HPC ORCHESTRATOR
- INTEL® SSD SUPPORTED
- FLEXIBILITY & STABILITY
- EXTREME SCALABILITY

* Other names and brands may be claimed as the property of others. ¹ Source: Intel estimates.
Intel® Xeon® Scalable Processor Enables Amazing Discoveries through HPC
Наибольшее количество улучшений платформы за декаду

✓ Существенное улучшение производительности на ядро
✓ Intel® Advanced Vector Extension 512 (Intel® AVX-512):
  ✓ до 2X FLOPs/second peak performance по сравнению с предыдущей архитектурой
✓ Ускорение IO за счет Intel® Omni-Path Architecture (Fabric)
✓ Интегрированная технология Integrated Intel® QuickAssist Technology (crypto & compression offload)
✓ Улучшеные RAS свойства (Reliability, Availability, Serviceability)
✓ Intel® Resource Director Technology (Intel® RDT) для эффективности Efficiency и TCO

A GLIMPSE INSIDE THE INTEL® XEON® SCALABLE PROCESSOR PLATFORM

INTEGRATED OPTIONS

Fabric
Intel® Omni-Path Architecture

Networking
Intel® Ethernet

Accelerators
Intel® QuickAssist
Intel® AVX-512

SSDs
Intel® Optane™ SSD
DC P4800X
Intel® SSD DC P4600
Intel® VMD

Complementary
Intel® FPGA
Intel® Xeon Phi™
Intel® Silicon Photonics

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

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

Intelli® Advanced Vector Extensions 512 (Intel® AVX-512)
Intel® Volume Management Device (Intel® VMD)
Intel® Data Analytics Acceleration Library (Intel® DAAL)
Intel® Math Kernel Library (Intel® MKL)
Storage Performance Development Kit (SPDK)

Data Plane Development Kit (DPDK)
Intel® Resource Director Technology (Intel® RDT)
Skylake Server Processor

- 14nm Process Technology
- PCI Express* 3.0 48 Lanes
- Intel® Hyper-Threading Technology (2 threads/core)
- Intel® Turbo Boost Technology
- Up to 28 Cores
- Integrated Voltage Regulator
- New Skylake Server Feature
- Existing Feature

Power Management:
- Per Core P-State (PCPS)
- Uncore Frequency Scaling (UFS)
- Energy Efficient Turbo (EET)
- On die PMAX detection (NEW)
- Intel® Speed Shift Technology (HWP) (NEW)

Memory Technology:
- 6xDDR4 channels
- 2133, 2400, 2666 MT/s
- RDIMM, LRDIMM, Apache Pass

Rebalanced Cache Hierarchy:
- Increased MLC
- 1.375 MB Last Level Cache/Core

Intel® AVX-512

Intel® UPI

Integrated Fabric: Intel® Omni-Path Architecture

PCI Express* 3.0
System Agent
Core
LLC
Core
LLC
Core
LLC
Core
LLC
Core
LLC
Intel® UPI

Fabric
INTEL® XEON® SCALABLE PROCESSORS

THE FOUNDATION FOR AGILE, SECURE WORKLOAD-OPTIMIZED HYBRID CLOUD

**BEST**
- SCALABLE PERFORMANCE
- HARDWARE-ENHANCED SECURITY
- ADVANCED RAS
- OPTIMIZED FOR WIDEST RANGE OF EVOLVING/MULTI WORKLOADS
- MISSION-CRITICAL, VIRTUALIZATION/CONSOLIDATION, REAL-TIME ANALYTICS AND ARTIFICIAL INTELLIGENCE

**GREAT**
- SCALABLE PERFORMANCE
- MEMORY PERFORMANCE
- ADVANCED RAS
- WORKLOAD-OPTIMIZED + EFFICIENCY & AGILITY
- PERFORMANCE FOR GENERAL-PURPOSE COMPUTE, STORAGE AND NETWORKING

**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**
# INTEL® XEON® SCALABLE PROCESSOR

**The Foundation for Agile, Secure Workload-Optimized Hybrid Cloud**

## INTEL® XEON® PLATINUM 81xx PROCESSORS

- Most cores (28C, 56T)
- Highest frequency (up to 3.6 GHz, 4C)
- Most Socket flexibility (2, 4, 8+)
  - Elite IO/memory (48 PCIe 3.0 lanes, 6 memory channels)
  - Most/fastest 3 UPI (Ultra Path Interconnects, 10.4 GT/s)
  - Fastest Memory (DDR4-2666 MHz)
  - Highest Intel® AVX-512 with 2 FMA per core
  - Intel® Turbo Boost and Intel® Hyper-Threading Technology
  - New Advanced RAS
  - Node Controller Support to assist in scaled node management

### RESULT:

- Best workload-optimized performance for general purpose compute across virtualized environments and hybrid cloud deployments
- Best choice for mission-critical, traditional DC apps, real-time analytics, and AI/deep learning inference workloads; smart path for DL training
- Best performance for the most demanding storage and networking workloads

**RAS: Reliability, Availability, and Serviceability**

### Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cores</td>
<td>Up to 28</td>
</tr>
<tr>
<td>Sockets</td>
<td>Up to 2, 4, 8</td>
</tr>
<tr>
<td>Memory</td>
<td>1.5 TB</td>
</tr>
<tr>
<td>Frequency</td>
<td>Up to 3.6 GHz</td>
</tr>
<tr>
<td>DDR4</td>
<td>2666 MHz</td>
</tr>
<tr>
<td>Lanes</td>
<td>3 UPI</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>10.4 GT/s</td>
</tr>
<tr>
<td>AVX-512</td>
<td>With 2 FMA per core</td>
</tr>
<tr>
<td>Turbo Boost</td>
<td>Yes</td>
</tr>
<tr>
<td>Hyper-Threading</td>
<td>Yes</td>
</tr>
<tr>
<td>Advanced RAS</td>
<td>Yes</td>
</tr>
<tr>
<td>Node Controller Support</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Mainstream**

**Entry**

**Moderate**

**Dedicated Tasks**

**Optimized Hybrid Cloud**
Intel® Xeon Phi™ Processor – TCO Solution for HPC & AI
A Key Element of HPC, AI, and Mixed Workload Clusters

- Total Cost of Ownership
- Optimized for HPC & AI
- Complements Intel® Xeon®

Price Performance
Power Efficiency
Performance

Highly-Parallel
No PCIe Bottlenecks
Scalability

Common Programming
Mixed Clusters
Runs x86 code

Reduces total cost of ownership, designed for HPC & AI, protects investment
Intel® Xeon Phi™ Processor Architecture

Self-Boot Processor
Binary-compatibility with Xeon, 3+ TFLOPS\(^1\) (DP)

On-package memory
16GB, up to 490 GB/s STREAM TRIAD

Platform Memory
Up to 384GB (6ch DDR4-2400 MHz)

Other Key Features
- 2D Mesh Architecture
- Out-of-Order Cores
- 3X Single-Thread vs. KNC
- Intel® AVX-512 Instructions
- Scatter/Gather Engine
- Integrated Fabric - OPA

1 Theoretical peak performance
Intel® Xeon Phi™ Product Family x200

Intel® Xeon Phi™ Processor

Host Processor in Groveport Platform

Self-boot Intel® Xeon Phi™ processor

with integrated Intel® Omni-Path Fabric
Intel® Xeon Phi™ Target Segments & Applications

**Deep Learning Training**

- **Material Science:** VASP*, NWCHEM*, GTC-P*
- **QCD:** QPHIX*, MILC*, CHROMA*, CCS QCD*
- **CFD/Mfg:** OPENFOAM*, CLOVERLEAF*, LSTC LS-DYNA*, CONVERGENT SCIENCE CONVERGE CFD*
- **Weather/Climate/Cosmology:** WRF*, NEMO*, WALLS*
- **Energy:** ISO3DFD*
- **FSI:** STAC A2*, MONTE CARLO*, BLACK SCHOLES*, BINOMIAL OPTIONS*
- **MD:** LAMMPS*, NAMD*, GROMACS*, AMBER*

**Features Driving Perf & Perf/$/W**

- 16GB MCDRAM
- High memory (MCDRAM) BW (< 490 GB/s)
- Intel® AVX-512 ER
- High system memory (< 400 GB)
- High number of physical cores (< 72)
- High number of threads (< 288)
- Lower system price (~$4700)¹
- Lower system price (~$4700)¹

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

¹Software 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. Configurations: See Slides 40-52.
Intel® Xeon Phi™ Utilization Value

Intel® Xeon Phi™ Utilization Benefits
- Runs optimized applications best
- Runs all x86 applications
- Doesn't reduce resources for some applications

GPU Utilization Limitations
- Requires coding to run application, requires optimization to run best
- Doesn't run x86 applications
- Dedicated resource reduces cluster performance for some applications
World’s Most Responsive Data Center SSD

Delivering an industry leading combination of low latency, high endurance, QoS and high throughput, the Intel® Optane™ SSD is the first solution to combine the attributes of memory and storage. This innovative solution is optimized to break through storage bottlenecks by providing a new data tier. It accelerates applications for fast caching and storage, increasing scale per server and reducing transaction cost. Data centers based on the latest Intel® Xeon® processors can now also deploy bigger and more affordable datasets to gain new insights from larger memory pools.

1. Responsiveness defined as average read latency measured at Queue Depth 1 during 4k random write workload. Measured using FIO 2.15. 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. Intel drives evaluated - Intel® Optane™ SSD DC P4800X 375GB and Intel® SSD DC P3700 1600GB. Samsung* drives evaluated – Samsung SSD PM1725a, Samsung SSD PM1725, Samsung PM963, Samsung PM953. Micron* drive evaluated – Micron 9100 PCIe* NVMe* SSD. Toshiba* drives evaluated – Toshiba ZD6300. Test – QD1 Random Read 4K latency, QD1 Random RW 4K 70% Read latency, QD1 Random Write 4K latency using FIO 2.15.

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

4K 70/30 RW Performance at Low Queue Depth

- Intel® Optane™ SSD DC P4800X 4K 70-30
- Intel® SSD DC P3700 4K 70-30

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

1. Common Configuration - Intel 2U PCSD Server ("Wildcat Pass"), 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.
Predictably Fast Service

Read QoS in Mixed Workload

- Intel® SSD DC P3700 Read Latency
- Intel® Optane™ SSD DC P4800X Read Latency

.up to 60X better at 99% QoS

Ideal for critical applications with aggressive latency requirements

1. Common Configuration - Intel 2U PCSD Server ("Wildcat Pass"), 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. QoS – measures 99% QoS under 4K 70-30 workload at QD1 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.
Responsive Under Load

Average Read Latency under Random Write Workload

- Intel® SSD DC P3700 Avg Read Latency
- Intel® Optane™ SSD DC P4800X Avg Read Latency
- Random Write

Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance.

1. Responsiveness defined as average read latency measured at queue depth 1 during 4k random write workload. Measured using fio 2.15. Common Configuration - Intel 2U PCSD Server ("Wildcat Pass"), 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. Latency – Average read latency measured at QD1 during 4K Random Write operations using fio-2.15.
ACCELERATING THE FUTURE FOR ANALYTICS AND AI WITH INTEL TECHNOLOGIES

IVAN KUZMIN
OUR COMMITMENT IS TO ENABLE THE BEST ANALYTICS EXPERIENCE, FROM HW TO SW
Enabling Best Performance and Security

**PERFORMANCE**

- **4X** MLlib* thru Intel® for Intel Math Kernel Library
- **5.6X** HBase off-heap read
- **8X** HDFS Erasure Coding codec thru Intel® Intelligent Storage Acceleration Library

**SECURITY**

- **1.28X** Spark shuffle file encryption
- **1.35X** Spark* shuffle RPC encryption

Intel + Cloudera®
ENABLING BEST SCALABILITY FOR MACHINE LEARNING

>10X

SCALABILITY IMPROVEMENT FOR CUSTOMER ANALYSIS USING K-MEANS CLUSTERING

https://github.com/intel-analytics/SparseSpark

>10X

SCALABILITY IMPROVEMENT FOR TOPIC MODELING USING LATENT DIRICHLET ALLOCATION

https://github.com/intel-analytics/TopicModeling
ADVANCE SOLUTIONS FOR NEW NEEDS (DEEP LEARNING)

DISTRIBUTED DATA

EFFICIENT SCALABILITY

LOWER TCO

HIGH PERFORMANCE
BigDL

ANSWERING THE NEW NEEDS

Working with Xeon clusters

**Feature Parity** with Caffe* and Torch*

Drives Spark/Hadoop as Unified Data Analytics Platform, Giving **Easy Experience and Lower TCO**

Deep Learning on Big Data Platform, Enabling **Efficient Scale-Out**

**High Performance** at Single-Node
BIGDL READY FOR WIDE ADOPTION
INTEL® NERVANA™ PORTFOLIO

**EXPERIENCES**
- Intel® DL Training & Deployment
- Intel® Nervana™ DL Software & Cloud
- Intel® Computer Vision SDK
- Intel® GO™ Automotive SDK
- Movidius Fathom

**TOOLKITS**
- Intel® Nervana™
- Intel® MKL
- Intel® DAAL
- Intel® Nervana™ Graph*
- Intel® GO™
- Intel® DL Training & Deployment
- Intel® Nervana™ DL Software & Cloud
- Intel® Computer Vision SDK
- Intel® GO™ Automotive SDK
- Movidius Fathom

**FRAMEWORKS**
- Spark
- MLlib
- BIGDL
- TensorFlow
- mxnet
- theano
- torch
- Caffe
- Chainer

**LIBRARIES**
- Python
- Intel Distribution
- Intel® DAAL
- Intel® Nervana™ Graph*
- Intel® MKL
- MKL-DNN
- Intel® MLSL
- Intel® DAAL
- Intel Distribution
- Intel® Nervana™ Graph*
- Intel® MKL
- MKL-DNN
- Intel® MLSL

**HARDWARE**
- Compute
- Memory/Storage
- Networking
- Computer Vision

*Future

AI ON INTEL: UNLEASHING THE NEXT WAVE
WE KNOW THE FUTURE
BECAUSE WE’RE BUILDING IT
LET’S COLLABORATE

Software.intel.com/BigDL
Software.intel.com/Al
MEET US TODAY AND TOMORROW
Intel, the Intel logo, Xeon, Xeon phi, Atom, Core, Nervana, Iris, RealSense, GO, etc. are trademarks of Intel Corporation in the U.S. and/or other countries.
*Other names and brands may be claimed as the property of others.
© 2017 Intel Corporation
### Configurations:

- **2.7X performance for big data decision support workload (MKL)**

<table>
<thead>
<tr>
<th>SUT</th>
<th>1 -- BDX (E5-2699v4) + old S/W Stack A</th>
<th>2 -- SKX (Platinum 8160) + old S/W Stack A</th>
<th>3 -- BDX (E5-2699v4) + new, optimized S/W Stack B</th>
<th>4 -- SKX (Platinum 8160) + new, optimized S/W Stack B</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Nodes</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td># of Master Nodes</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td># of Worker Nodes</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CPU</td>
<td>Xeon E5-2699v4</td>
<td>Xeon Platinum 8160</td>
<td>Xeon E5-2699v4</td>
<td>Xeon Platinum 8160</td>
</tr>
<tr>
<td># of CPU vCores</td>
<td>88</td>
<td>96</td>
<td>88</td>
<td>96</td>
</tr>
<tr>
<td># of Cores per CPU</td>
<td>22</td>
<td>24</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td># of Sockets</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Hyperthread</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Clock</td>
<td>2.2 GHz (3.60 GHz Max)</td>
<td>2.1 GHz (3.70 GHz Max)</td>
<td>2.2 GHz (3.60 GHz Max)</td>
<td>2.1 GHz (3.70 GHz Max)</td>
</tr>
<tr>
<td>Cache</td>
<td>55MB Smart Cache</td>
<td>33 MB L3 Cache</td>
<td>55MB Smart Cache</td>
<td>33 MB L3 Cache</td>
</tr>
<tr>
<td>Memory</td>
<td>384GB DDR4 (12 x 32GB, 2666 MT/s)</td>
<td>384GB DDR4 (24 x 16GB, 2133 MT/s)</td>
<td>384GB DDR4 (12 x 32GB, 2666 MT/s)</td>
<td>384GB DDR4 (24 x 16GB, 2133 MT/s)</td>
</tr>
<tr>
<td>Data Storage</td>
<td>800GB * 8 SATA SSD</td>
<td>800GB * 8 SATA SSD</td>
<td>800GB * 8 SATA SSD</td>
<td>800GB * 8 SATA SSD</td>
</tr>
<tr>
<td>Network</td>
<td>10GbE</td>
<td>10GbE</td>
<td>10GbE</td>
<td>10GbE</td>
</tr>
<tr>
<td>BIOS</td>
<td>SE5C610.86B.01.01.0018.0720.20161249</td>
<td>SE5C620.86B.01.00.0470.0407.20170855</td>
<td>SE5C610.86B.01.01.0018.0720.20161249</td>
<td>SE5C620.86B.01.00.0470.0407.20170855</td>
</tr>
<tr>
<td>Hive</td>
<td>Apache Hive 2.0.0</td>
<td>Apache Hive 2.0.0</td>
<td>Apache Spark 2.0.2</td>
<td>Apache Spark 2.0.2</td>
</tr>
<tr>
<td>Spark</td>
<td>Apache Spark 1.6.3</td>
<td>Apache Spark 1.6.3</td>
<td>Apache Hadoop 2.7.3</td>
<td>Apache Hadoop 2.7.3</td>
</tr>
<tr>
<td>Hadoop</td>
<td>Apache Hadoop 2.7.3</td>
<td>Apache Hadoop 2.7.3</td>
<td>Apache Hadoop 2.7.3</td>
<td>Apache Hadoop 2.7.3</td>
</tr>
<tr>
<td>OS Version</td>
<td>CentOS 7.3</td>
<td>CentOS 7.3</td>
<td>CentOS 7.3</td>
<td>CentOS 7.3</td>
</tr>
<tr>
<td>JDK</td>
<td>Oracle JDK 1.8.0_121</td>
<td>Oracle JDK 1.8.0_121</td>
<td>Oracle JDK 1.8.0_121</td>
<td>Oracle JDK 1.8.0_121</td>
</tr>
</tbody>
</table>
**LEGAL DISCLAIMERS**

- Intel technologies’ features and benefits depend on system configuration and may require enabled hardware, software or service activation. Learn more at intel.com, or from the OEM or retailer.

- No computer system can be absolutely secure.

- Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase. For more complete information about performance and benchmark results, visit [http://www.intel.com/performance](http://www.intel.com/performance).

**Configurations:**

- **4.3X for Spark MLLib thru Intel Math Kernel Library (MKL)**
  - Spark-Perf (same for before and after): 9 nodes each with Intel® Xeon® processor E5-2697A v4 @ 2.60GHz * 2 (16 cores, 32 threads); 256 GB; 10x SSDs; 10Gbps NIC
  - 19x for HDFS Erasure Coding in micro workload (RawErasureCoderBenchmark) and 1.25x in Terasort, plus 50+% storage capacity saving and higher failure tolerance level.
    - RawErasureCoderBenchmark (same for before and after): single node with Intel® Xeon® processor E5-2699 v4 @ 2.20GHz * 2 (22 cores, 44 threads); 256GB; 8x HDDs; 10Gbps NIC
  - Terasort (same for before and after): 10 nodes each with Intel® Xeon® processor E5-2699 v4 @ 2.20GHz * 2 (22 cores, 44 threads); 256GB; 8x HDDs; 10Gbps NIC
  - 5.6x for HBase off heaping read in micro workload (PE) and 1.3x in real Alibaba production workload
    - PE (same for before and after): Intel® Xeon® Processor X5670 @ 2.93Hz * 2 (6 cores, 12 threads); RAM: 150 GB; 1Gbps NIC
    - Alibaba (same for before and after): 400 nodes cluster with Intel® Xeon® processors
  - 1.22x Spark Shuffle File Encryption performance for TeraSort and 1.28x for BigBench
    - Terasort (same for before and after): Single node with Intel® Xeon® Processor E5-2699 v3 @ 2.30GHz * 2 (18 cores, 36 threads); 128GB; 4x SSD; 10Gbps NIC
    - BigBench (same for before and after): 6 nodes each with Intel® Xeon® Processor E5-2699 v3 @ 2.30GHz * 2 (18 cores, 36 threads); 256GB; 1x SSD; 8x SATA HDD 3TB, 10Gbps NIC
  - 1.35X Spark Shuffle RPC encryption performance for TeraSort and 1.18x for BigBench
    - Terasort (same for before and after): 3 nodes each with Intel® Xeon® Processor E5-2699 v3 @ 2.30GHz * 2 (18 cores, 36 threads); 128GB; 4x SSD; 10Gbps NIC
    - BigBench (same for before and after): 5 nodes. 1x head node: Intel® Xeon® Processor E5-2699 v3 @ 2.30GHz * 2 (18 cores, 36 threads); 384GB; 1x SSD; 8x SATA HDD 3TB, 10Gbps NIC. 4x worker nodes: each with Intel® Xeon® processor E5-2699 v4 @ 2.20GHz * 2 (22 cores, 44 threads); 384GB; 1x SSD; 8x SATA HDD 3TB, 10Gbps NIC.

Intel, the Intel logo, Xeon, Xeon phi, Lake Crest, etc. are trademarks of Intel Corporation in the U.S. and/or other countries.

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

© 2017 Intel Corporation
## Decision Support Workload Configuration Summary

*The brief query descriptions are derived from TPC-DS specification*

<table>
<thead>
<tr>
<th>Query Number</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q19</td>
<td>Select the top revenue generating products bought by out of zip code customers for a given year, month and manager.</td>
</tr>
<tr>
<td>Q42</td>
<td>For each item and a specific year and month calculate the sum of the extended sales price of store transactions.</td>
</tr>
<tr>
<td>Q43</td>
<td>Report the sum of all sales from Sunday to Saturday for stores in a given data range by stores.</td>
</tr>
<tr>
<td>Q52</td>
<td>Report the total of extended sales price for all items of a specific brand in a specific year and month.</td>
</tr>
<tr>
<td>Q55</td>
<td>For a given year, month and store manager calculate the total store sales of any combination of all brands.</td>
</tr>
<tr>
<td>Q63</td>
<td>For a given year calculate the monthly sales of items of specific categories, classes and brands that were sold in stores and group the results by store manager. Additionally, for every month and manager print the yearly average sales of those items.</td>
</tr>
<tr>
<td>Q68</td>
<td>Compute the per customer extended sales price, extended list price and extended tax for &quot;out of town&quot; shoppers buying from stores located in two cities in the first two days of each month of three consecutive years. Only consider customers with specific dependent and vehicle counts.</td>
</tr>
<tr>
<td>Q73</td>
<td>Count the number of customers with specific buy potentials and whose dependent count to vehicle count ratio is larger than 1 and who in three consecutive years bought in stores located in 4 counties between 1 and 5 items in one purchase. Only purchases in the first 2 days of the months are considered.</td>
</tr>
<tr>
<td>Q98</td>
<td>Report on items sold in a given 30 day period, belonging to the specified category.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parallel Stream Number</th>
<th>Executed Queries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream #1</td>
<td>Q19, Q19, Q19, Q19, Q19</td>
</tr>
<tr>
<td>Stream #2</td>
<td>Q42, Q42, Q42, Q42, Q42</td>
</tr>
<tr>
<td>Stream #3</td>
<td>Q43, Q43, Q43, Q43, Q43</td>
</tr>
<tr>
<td>Stream #4</td>
<td>Q52, Q52, Q52, Q52, Q52</td>
</tr>
<tr>
<td>Stream #5</td>
<td>Q55, Q55, Q55, Q55, Q55</td>
</tr>
<tr>
<td>Stream #6</td>
<td>Q63, Q63, Q63, Q63, Q63</td>
</tr>
<tr>
<td>Stream #7</td>
<td>Q68, Q68, Q68, Q68, Q68</td>
</tr>
<tr>
<td>Stream #8</td>
<td>Q73, Q73, Q73, Q73, Q73</td>
</tr>
<tr>
<td>Stream #9</td>
<td>Q98, Q98, Q98, Q98, Q98</td>
</tr>
</tbody>
</table>
Спасибо!
nikolay.mester@intel.com