SOLUTIONS BRIEF:

Driving transformation in the Financial Services Industry with the Intel® Xeon® Scalable Processor

ABSTRACT: Today's Financial Services Industry (FSI) companies support thousands of transactions per second with seamless scalability for low-latency market trading, risk modeling, and real-time analytics. With IT spending projected to reach over $500B by 2020, FSI companies are actively positioning technology at the core of their strategies as they look to leverage the growth of processing power, data storage, and networking speeds.

Intel plays a key role with the new Intel® Xeon® Scalable processor, our biggest platform advancement in a decade[2], optimized for a wide array of workloads including Deep Learning training and inference, yet highly scalable for a multi-cloud environment.

> *There shouldn't be a technology strategy [at big banks]. There should only be a strategy with technology at its core. There's a huge difference.*
>
> *~ Anthony Jenkins, former CEO of Barclay's[1]*

Benefits of Upgrading to the Intel® Xeon® Scalable Processor

Intel® Xeon® Scalable processors pack performance, security, and agility within a new scalable architecture optimized for a wide array of workloads. Each core is re-engineered with Intel® Mesh Architecture, an improved layout of interconnects that deliver low latency and high bandwidth among cores, memory, and I/O controllers[3]. Intel® Xeon® Scalable processors also serve as a platform to expand your storage and networking to eliminate bottlenecks across the data center.

UP TO
2X BETTER PEAK PERFORMANCE
with Intel® AVX-512
(compared to previous generation)[4]

PERFORMANCE
Drive faster transactions and quicker time to insight in financial models
- More, faster Cores (up to 28 with Intel® Xeon® Platinum processors)
- 50% more memory channels over last generation
- Intel® Advanced Vector Extensions 512 feature enables up to 2x flops per cycle[4]

NEW MESH ARCHITECTURE
New Intel® Mesh Architecture with Intel® Ultra Path interconnect Links

AGILITY
Scalable options to drive better overall TCO
- Intel® Mesh Architecture, new on-chip interconnect layout designed for efficiency and scalability
- 2, 4 and 8-socket configurations to meet a wide variety of workloads and TCO requirements
- 4x10GbE Integrated Intel® Ethernet connectivity for fast data transmission

Designed for
99.999% SERVER UPTIME

SECURITY
Built-in hardware security and reliability features to protect sensitive transactions and user data
- 72 RAS (reliability, availability, serviceability) features, including advanced Intel® Run Sure technology, to ensure data and platform security and to achieve 99.999% up time for mission critical workloads
- Intel® Key Protection Technology (KPT) with Integrated Intel® QuickAssist Technology and Intel® Platform Trust Technology (Intel® PTT): Delivers hardware-enhanced platform security by providing efficient key and data protection, at rest, in use and in flight.

Platform Adjacencies optimized for the Intel® Xeon® Scalable Processor

In today's software defined infrastructure, bottlenecks can often occur beyond the processor in storage or networking. The Intel® Xeon® Scalable Processor supports a variety of options, such as Intel® Optane SSDs, Intel® Ethernet Network Adapters, and Intel® Omni-path Fabric to expand performance and eliminate bottlenecks.

Intel® Optane SSDs provide high performance, low latency storage. Paired with the Intel® Xeon® Platinum Processor, Intel® Optane SSDs produced a 2x performance boost with SAS on an analytics workload[5] Intel® Ethernet Network Adapters and Intel® Omni-path Fabric can speed systems for fast performance in I/O intensive workloads and complex financial modeling.

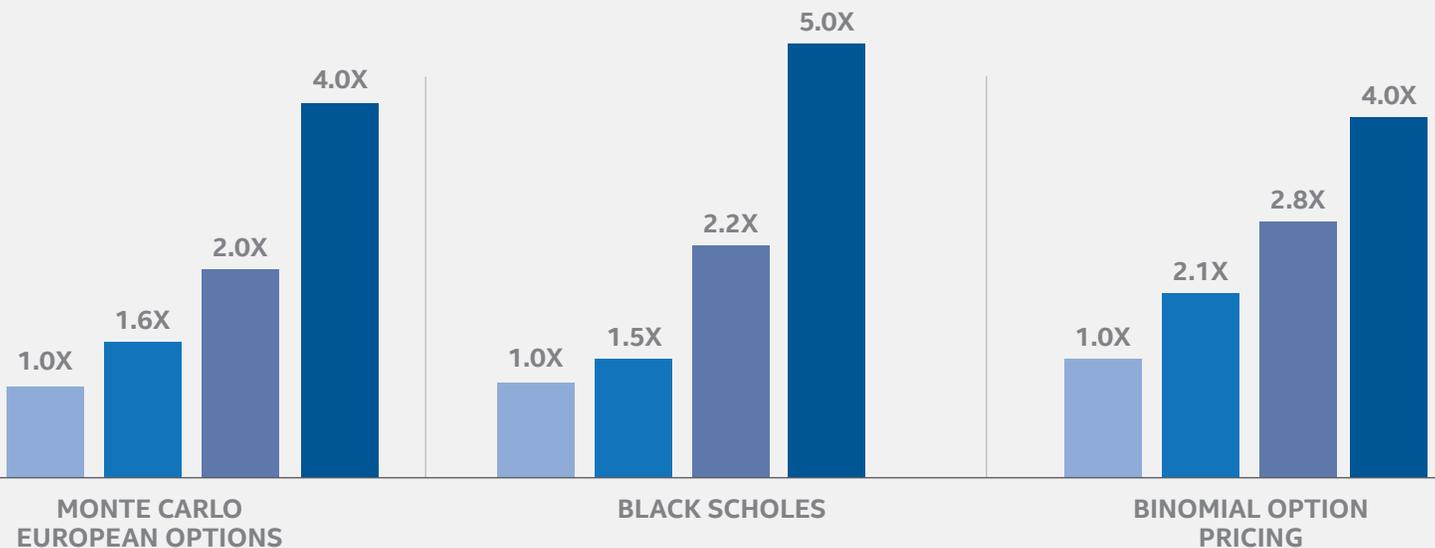**2X** PERFORMANCE BOOST FOR SAS ANALYTICS WORKLOAD[5]

PERFORMANCE IN ADVANCED ANALYTICS AND FINANCIAL MODELING

Comparing performance across a typical three year old install base, the Intel® Xeon® Gold 6148 processor yields a **4x performance boost** in Monte Carlo European option simulations[10]. Other workloads such as Black Sholes, a commonly used double-precision mathematical model for financial valuation, resulted in a **5x gain over prior generation[11].** Binomial option pricing, a lattice-based approach using a discrete-time model which varies price over time of financial instrument, resulted in up to a **4x performance gain[12].** Pervasive performance, that delivers faster time to insight or the capability to run more simulations[17] for better accuracy.

PERFORMANCE IN FSI WORKLOADS ACROSS GENERATIONS

THREE GENERATION OLD XEON® E5 · TWO GENERATION OLD XEON® E5 · LAST GENERATION XEON® E5 · INTEL® XEON® GOLD 6148 PROCESSOR

MONTE CARLO EUROPEAN OPTIONS: 1.0X, 1.6X, 2.0X, 4.0X
BLACK SCHOLES: 1.0X, 1.5X, 2.2X, 5.0X
BINOMIAL OPTION PRICING: 1.0X, 2.1X, 2.8X, 4.0X

> *[AI] is really exciting for the financial industry because it will open up the potential to help people with their financial lives in ways that we can't even imagine today.*
>
> ~ Ken Dodelin, Vice President of Digital Product Management at Capital One[15].

ARTIFICIAL INTELLIGENCE WITH THE INTEL® XEON® SCALABLE PROCESSOR

Driven by the deluge of data, faster processing, and surge in applicable frameworks, Artificial Intelligence (AI) and its subset Deep Learning, is an undeniable trend with massive potential for financial services.

FOR THE FINANCIAL SERVICES INDUSTRY, ARTIFICIAL INTELLIGENCE READILY APPLIES IN THREE USE CASES:

- 360 degree view of customers that drive personalized service tools and interactive chat robots

- Real-time and predictive measures for fraud detection and anti-money laundering

- Process optimizations that reduce bottlenecks and identify operational savings

Intel already powers over 90% of the datacenters that are poised to support Deep Learning[16]. As FSIs look to harness Artificial Intelligence, Intel® Xeon® Scalable processors provide flexibility and great TCO, allowing customers to leverage software optimized to their existing Intel infrastructure while providing up to **2.2x Deep learning performance**[17] over prior generations.

> *AI will become the most defining technology of the new banking and financial services of the future.*
>
> ~ Roberto Ferrari, Managing Director, CheBanca![14]

Furthermore, Intel works with developers and partners to optimize across widely used Deep Learning frameworks such as **TensorFlow**, **Caffe**, and **Theano** in addition to Intel's own analytics software, Intel® Data Analytics **Acceleration Library (DAAL), Intel® Math Kernel Library.**

One partner on the forefront of AI is already seeing dramatic performance improvement in Deep Learning with the Intel® Xeon® Scalable processor.

> *Together with Intel, we've optimized deep learning engines with the latest version of the Intel® Math Kernel Library and the Intel® Xeon® Scalable processors to increase Deep Learning inference performance by over 100x.*
>
> ~ Dr. Matt Wood, GM, Artificial Intelligence, AWS[18]

BANKING IN A HYBRID CLOUD ENVIRONMENT

While artificial intelligence represents the wave of the future, a key technology delivering agility today is Hybrid Cloud infrastructure. An estimated 40% of enterprises today are taking advantage of the hybrid cloud environment[19] , with a growing rate into 2020. As FSIs look to better service customers while meeting dynamic compliance and regulatory requirements, hybrid cloud provides a more holistic way to manage security and deliver performance. The Intel® Xeon® Scalable processor is designed with this agility in mind, providing hardware enabled security features and more virtual machine capacity for cloud on and off-premises.

The ideal hybrid cloud strategy involves a balance between business, technical, and ecosystem considerations. Understanding how technology can best meet a company's requirements for agility, performance, and security is critical to defining a financial institution's cloud strategy. The new Intel® Xeon® Scalable processor delivers several features to meet those requirements, enabling financial institutions to upgrade their systems and migrate their operations to a hybrid cloud environment.

FOR THE FINANCIAL SERVICES INDUSTRY, A MULTI-CLOUD STRATEGY ENABLES THE FOLLOWING:

Tremendous agility to allow financial institutions to quickly modify their portfolio of services to meet dynamic customer demands

Increased real-time scalability to rapidly accelerate the time-to-market for new applications and services built and optimized by third-party developers. In fact, IDC data suggests outdated infrastructures result in a 6x slower rate of product innovation and time to market[20].

Ubiquitous network access with 99.999% uptime to allow customers and banks to access financial data from any device anywhere in the world at any time of the day, driving customer engagement and enabling banks to create a 360 view of their customers

> " *Cloud is an inevitability. Therefore, the faster DBS moves to cloud, the more advantages we gain from being an early mover and creating cool tech.* "
>
> *~ David Gledhill, group chief information officer and head of group technology and operations at DBS.[21]*

In addition to worldwide economic volatility, financial organizations face tremendous compliance and regulatory pressures, increasing competition, and dynamic customer expectations. Furthermore, concerns over security lie at the forefront of every financial services company and are carefully considered with each technological upgrade. A hybrid cloud strategy centering on the Intel® Xeon® Scalable processor addresses both regulatory concerns and data privacy through built-in security features and tiered data compartmentalization, while still delivering on performance.

TIME IS MONEY, GET THE MOST OUT OF YOUR DATACENTER

The Financial Service Industry requires the very best performance, throughput, and compute to compete in a rapidly transforming sector. The Intel® Xeon® Scalable processor provides an agile solution for multi-cloud environments, newly designed for performance in a wide array of workloads including Deep Learning. For more information on how Intel® Xeon® Scalable processors can speed your financial institution **visit: www.intel.com/xeonscalable or www.intel.com/fsi to learn more about Intel in Financial Services**

WANT TO FIND MORE INFO ON INTEL® XEON SCALABLE PROCESSORS AND PLATFORM ADJACENCIES?

Take a look at these helpful links:

TCO Estimator Tool – Helpful tools to select and calculate TCO savings with the Intel® Xeon® Scalable Processor

Common Wealth Bank of Australia (CBA) & Hybrid Cloud – Hear first-hand how the CBA is employing a hybrid cloud for banking

Intel® Omni-path Architecture – Learn more about Intel® Omni-path products to speed your data center

Explore Intel® SSDs – Specifics on Intel® SSDs, to help speed your data center

Hybrid Cloud & Workload placement strategies - Considerations for transforming to a Hybrid Cloud model

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 Configurations: Tested by Intel as of Jun 2017; test versus out of box 4x NVMe SSD. 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. Check with your system manufacturer or retailer or learn more at intel.com.

[1] http://www.businessinsider.com/ex-barclays-boss-anthony-jenkins-on-fintech-and-bankings-uber-moment-2015-11?r=UK&IR=T

[2] https://newsroom.intel.com/newsroom/wp-content/uploads/sites/11/2017/07/intel-xeon-scalable-processors-overview.pdf

[3] "Intel's new Mesh Architecture: The superhighway of the datacenter", https://itpeernetwork.intel.com/intel-mesh-architecture-data-center/

[4] Up to 2X flops per cycle: when compared with Intel® AVX2 available on previous E5/E7 v3, v4 families

[5] 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.

[10] Monte Carlo European Options. OS: Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327. Testing by Intel March 2017. 'montecarlo' compiled with compile.sh file. Used Intel® Compiler of Intel® Parallel Studio XE Professional Edition 2017 update 2. Runs performed with all the threads available on the server and KMP_AFFINITY=compact,granularity=fine. Tests performed on March 2017.THREE GEN: 2S Intel® Xeon® processor CPU E5-2697 v2 @ 2.70GHz, 24 cores, turbot and HT on, 64GB total memory, 8x8GB 1867 MHz DDR3, Red Hat Enterprise Linux Server release 7.1 kernel 3.10.0-229.el7.x86_64 TWO GEN: 2S Intel® Xeon® processor E7-2697 v3, 2.6GHz, 28 cores, turbo and HT on, BIOS 86B.0036.R05, 64GB total memory, 8x8GB 2133 MHz DDR4, Fedora release 20 kernel 3.15.10-200 . LAST GEN: 2S Intel® Xeon® processor CPU E5-2697 v4 , 2.3GHz, 36 cores, turbo and HT on, BIOS 86B0271.R00, 128GB total memory, 8 slots / 16GB / 2400 MT/s / DDR4 RDIMM, 1 x 1TB SATA, Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327. NEW: Intel® Xeon® Gold processor 6148, 2.4GHz, 40 cores, turbo and HT on, BIOS 86B.01.00.0412, 192GB total memory, 12 slots / 16 GB / 2666 MT/s / DDR4 RDIMM, 1 x 800GB INTEL SSD SC2BA80, Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327.

[11] Black Scholes Workload. OS: Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327. Testing by Intel March 2017. 'blackscholes' compiled with compile.sh file. Used Intel® Compiler of Intel® Parallel Studio XE Professional Edition 2017 update 2. Runs performed with all the threads available on the server and KMP_AFFINITY=compact,granularity=fine. Tests performed on March 2017.THREE GEN: 2S Intel® Xeon® processor CPU E5-2697 v2 @ 2.70GHz, 24 cores, turbot and HT on, 64GB total memory, 8x8GB 1867 MHz DDR3, Red Hat Enterprise Linux Server release 7.1 kernel 3.10.0-229.el7.x86_64. TWO GEN: 2S Intel® Xeon® processor E7-2697 v3, 2.6GHz, 28 cores, turbo and HT on, BIOS 86B.0036.R05, 64GB total memory, 8x8GB 2133 MHz DDR4, Fedora release 20 kernel 3.15.10-200 . LAST GEN: 2S Intel® Xeon® processor CPU E5-2697 v4 , 2.3GHz, 36 cores, turbo and HT on, BIOS 86B0271.R00, 128GB total memory, 8 slots / 16GB / 2400 MT/s / DDR4 RDIMM, 1 x 1TB SATA, Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327. NEW: Intel® Xeon® Gold processor 6148, 2.4GHz, 40 cores, turbo and HT on, BIOS 86B.01.00.0412, 192GB total memory, 12 slots / 16 GB / 2666 MT/s / DDR4 RDIMM, 1 x 800GB INTEL SSD SC2BA80, Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327.

[12] FSI Binomial workload. OS: Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327. Testing by Intel March 2017. 'binomial' compiled with compile.sh file. Used Intel® Compiler of Intel® Parallel Studio XE Professional Edition 2017 update 2. Runs performed with all the threads available on the server and KMP_AFFINITY=compact,granularity=fine. Tests performed on March 2017.

THREE GEN: 2S Intel® Xeon® processor CPU E5-2697 v2 @ 2.70GHz, 24 cores, turbot and HT on, 64GB total memory, 8x8GB 1867 MHz DDR3, Red Hat Enterprise Linux Server release 7.1 kernel 3.10.0-229.el7.x86_64. TWO GEN: 2S Intel® Xeon® processor E7-2697 v3, 2.6GHz, 28 cores, turbo and HT on, BIOS 86B.0036.R05, 64GB total memory, 8x8GB 2133 MHz DDR4, Fedora release 20 kernel 3.15.10-200 . LAST GEN: 2S Intel® Xeon® processor CPU E5-2697 v4 , 2.3GHz, 36 cores, turbo and HT on, BIOS 86B0271.R00, 128GB total memory, 8 slots / 16GB / 2400 MT/s / DDR4 RDIMM, 1 x 1TB SATA, Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327. NEW: Intel® Xeon® Gold processor 6148, 2.4GHz, 40 cores, turbo and HT on, BIOS 86B.01.00.0412, 192GB total memory, 12 slots / 16 GB / 2666 MT/s / DDR4 RDIMM, 1 x 800GB INTEL SSD SC2BA80, Red Hat Enterprise Linux* 7.2 kernel 3.10.0-327.

[14] "The Next Big Wave: How Financial Institutions can stay ahead of the AI revolution", Finextra research firm in association with Intel, May 2017

[15] Ibid.,

[16] Intel Internal Estimate, https://newsroom.intel.com/newsroom/wp-content/uploads/sites/11/2016/08/machine-learning-fact-sheet.pdf

[17] 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. Platform: 2S Intel® Xeon® CPU E5-2697 v2 @ 2.70GHz (12 cores), HT enabled, turbo enabled, scaling governor set to "performance" via intel_pstate driver, 256GB DDR3-1600 ECC RAM. CentOS Linux release 7.3.1611 (Core), Linux kernel 3.10.0-514.21.1.el7.x86_64. SSD: Intel® SSD 520 Series 240GB, 2.5in SATA 6Gb/s, 25nm, MLC.

Performance measured with: Environment variables: KMP_AFFINITY='granularity=fine, compact,1,0', OMP_NUM_THREADS=24, CPU Freq set with cpupower frequency-set -d 2.7G -u 3.5G -g performance

[18] "Fast Forward to your <NEXT>" Public Launch Presentation Keynote, July 11th, 2017

[19] Forrester commissioned research 2017

[20] The Enterprise Strategy Group, 2017

[21] http://www.thebanker.com/Transactions-Technology/Banks-join-the-steady-march-to-the-cloud