Intel Contributions to a Faster Cassandra

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- Performance varies by use, configuration and other factors. Learn more at www.Intel.com/PerformanceIndex
  Performance results are based on testing as of dates shown in configurations and may not reflect all publicly available updates. See backup for configuration details. No product or component can be absolutely secure.

- See backup for configuration details. For more complete information about performance and benchmark results, visit www.intel.com/benchmarks

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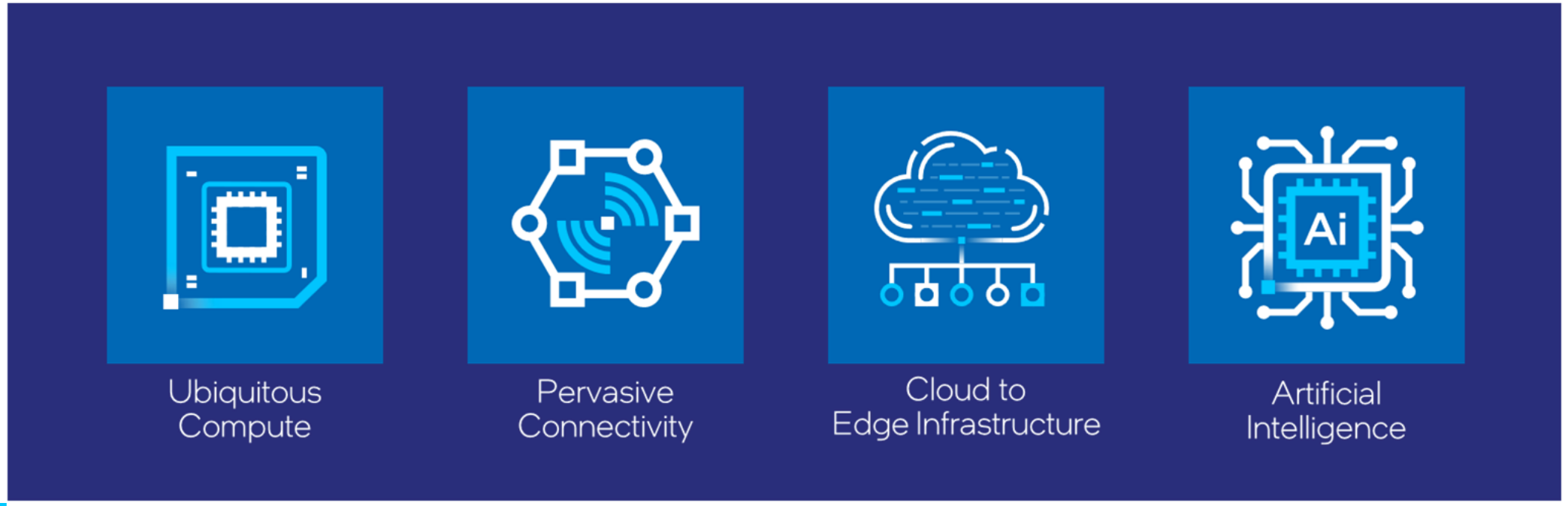
Agenda

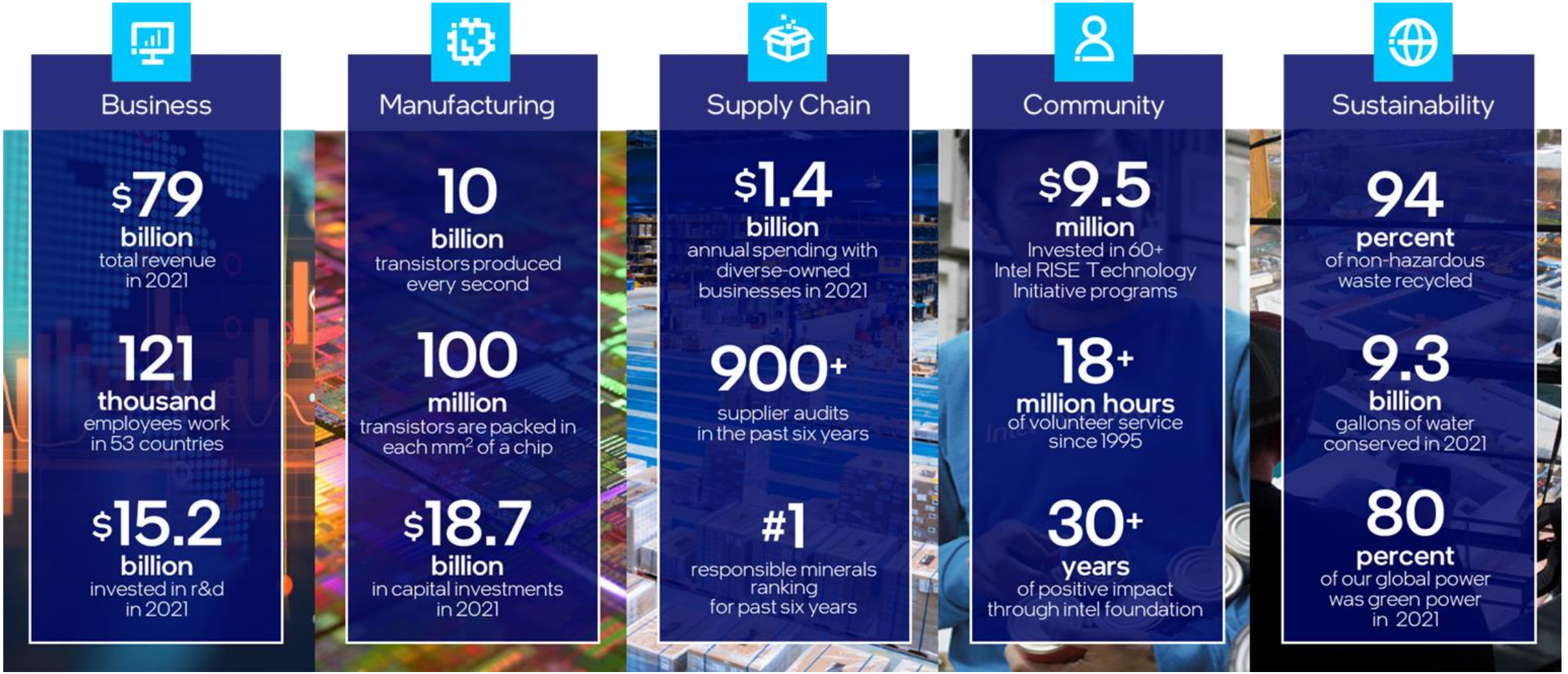
- Intel and the Open-Source Ecosystem
- Java optimizations
- Contributions to Cassandra

The Entire World is Becoming **Digital**



Semiconductors are the underlying technology empowering developers and powering our customers' innovations

Who is Intel?


Business
$79 billion total revenue in 2021
121 thousand employees work in 53 countries
$15.2 billion invested in r&d in 2021
Manufacturing
10 billion transistors produced every second
100 million transistors are packed in each mm² of a chip
$18.7 billion in capital investments in 2021
Supply Chain
$1.4 billion annual spending with diverse-owned businesses in 2021
900+ supplier audits in the past six years
#1 responsible minerals ranking for past six years
Community
$9.5 million Invested in 60+ Intel RISE Technology Initiative programs
18+ million hours of volunteer service since 1995
30+ years of positive impact through intel foundation
Sustainability
94 percent of non-hazardous waste recycled
9.3 billion gallons of water conserved in 2021
80 percent of our global power was green power in 2021

We Are Committed to a Vibrant Open Ecosystem For Developers

Open.

Choice.

Trust.

Focus on making our ecosystem successful:

1. **Enable developer productivity on high performance open platforms**
2. **Foster choice and interoperability of software platforms and ecosystems for our industry**
3. **Built on a confidential computing platform you can trust**

20 Years of Investment
Across hundreds of independent projects

#1 Linux Kernel
Corporate Contributor since 2007[1]

Creator of Countless Industry Leading Projects

120+ Intel Employed Maintainers

6 Architectures Supported in oneAPI

700+ GitHub Projects

CHROME OS Leading Contributor

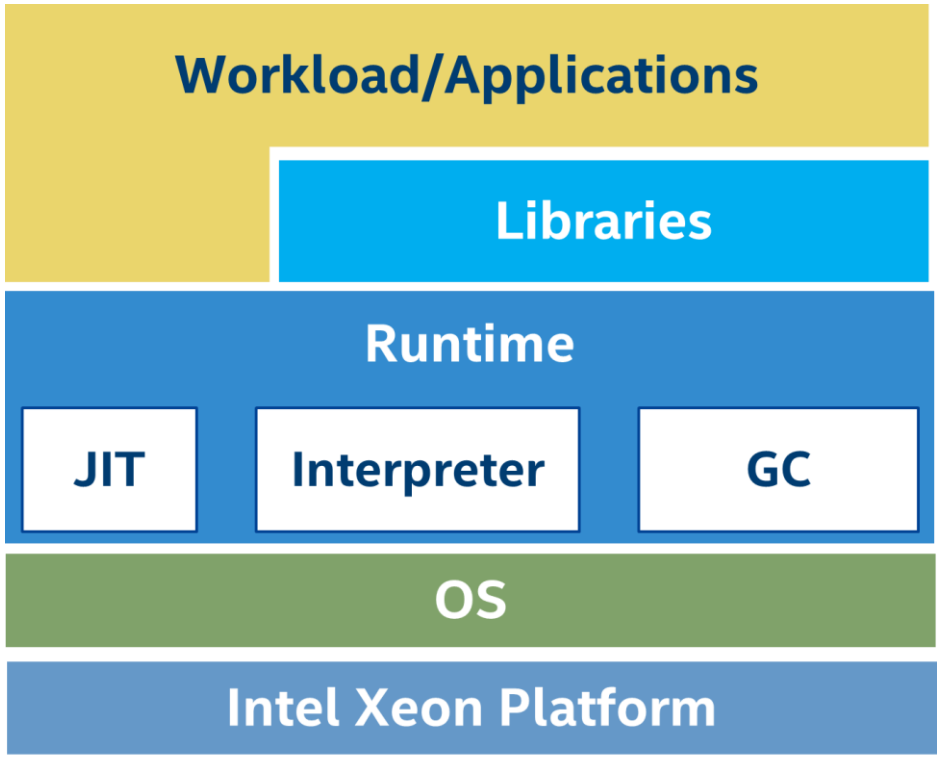
[1]source: https://www.linuxfoundation.org/wp-content/uploads/2020_kernel_history_report_082720.pdf

Additional Resources: Intel.com/SoftwareFirst

Performance Features in OpenJDK

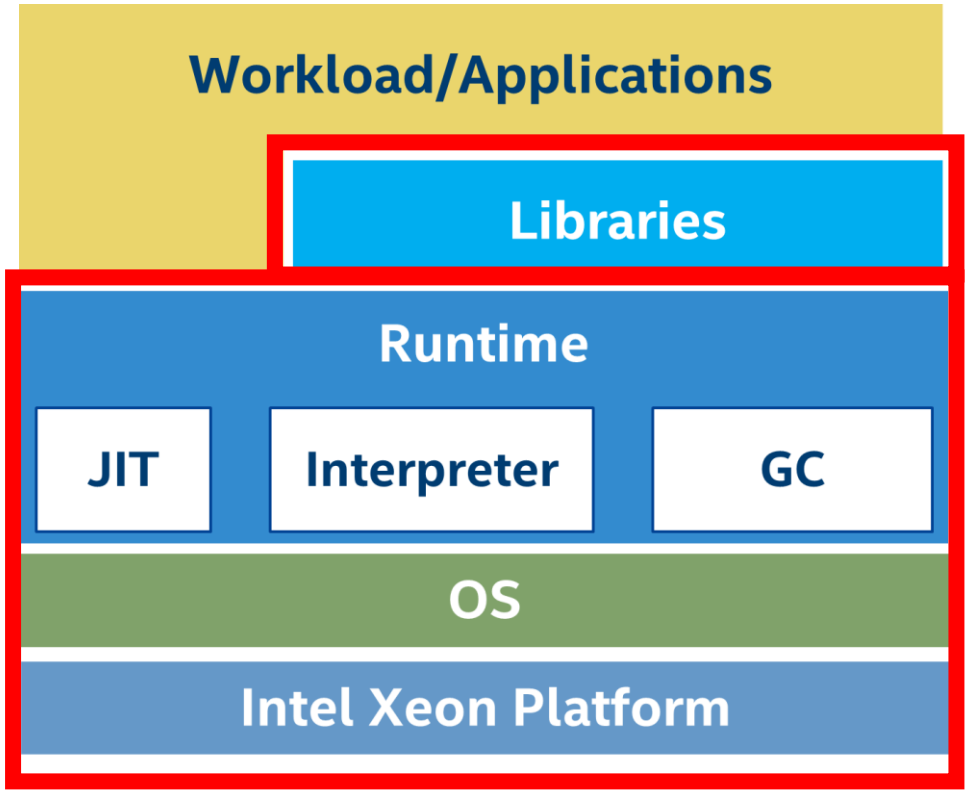
How the Java runtime works

- "Write once, run anywhere"
- Java app code compiles to bytecode, then interpreted "just in time" in a runtime layer
- Memory management is configurable but automatic
- Compilation and optimization abstracted away from developer



Where Optimizations Are Made

- When OpenJDK is compiled, targets are made for Intel platforms
- Specific instruction sets and “accelerators” are added to OpenJDK binaries
- Accelerators are added at the CPU level to support different operations



Intel contributions to OpenJDK

Performance optimizations

- **Just-in-time compiler**
- **Core class libraries**
- **Runtime and garbage collection**

Participate in Java standard

- **Java for data parallel programming**
- **Foreign-function interface for efficient access to accelerators and heterogeneous memory**

OpenJDK Optimizations

Java Optimizations for Cassandra

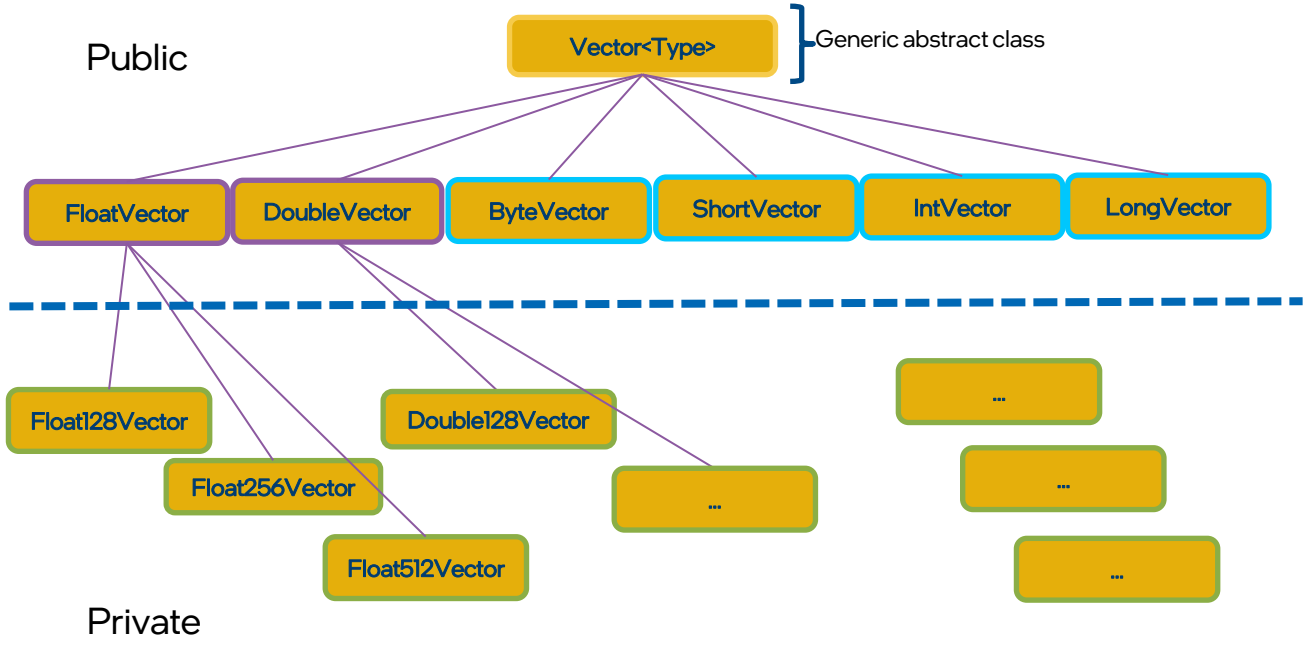
Vectorization	Runtime and GC	New JDK APIs Vector API, Direct IO	Crypto Crypto (AES-GCM) - JDK11 & later Crypto (CRC32) - JDK15 & later
Checksum	Compression	String/Array	Math Libraries

New JDK APIs

Vector API, Direct IO

Vector API

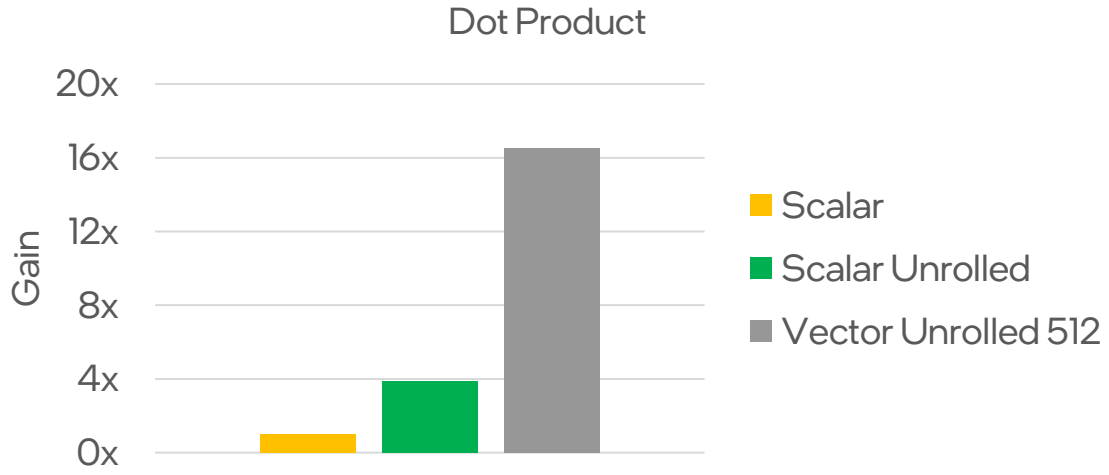
- Enables data parallel algorithm development in Java
- Allows programmers to benefit from Intel AVX technology
- JEP: http://openjdk.java.net/jeps/338
- Support for fixed size vectors
- Available since JDK 16
- API:
  - Arithmetic
  - Shift, Rotate
  - Trigonometric
  - Comparison, Blend, Mask
  - Casts, Reinterpret
  - Reduction, Extraction, Insertion
  - Rearrange

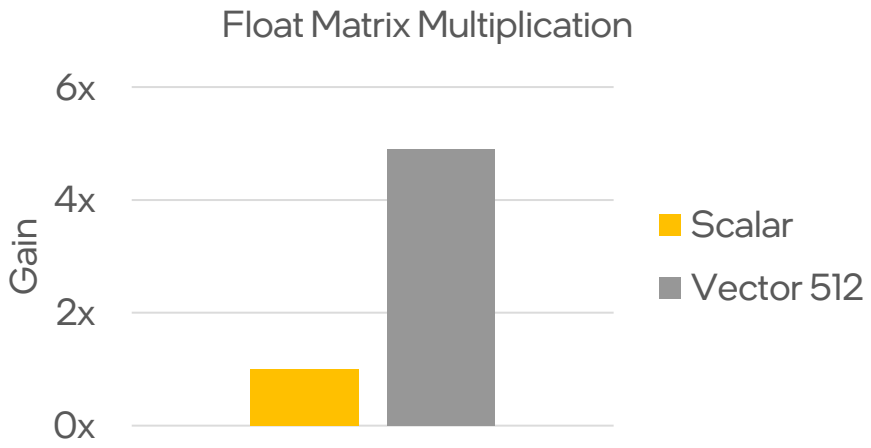


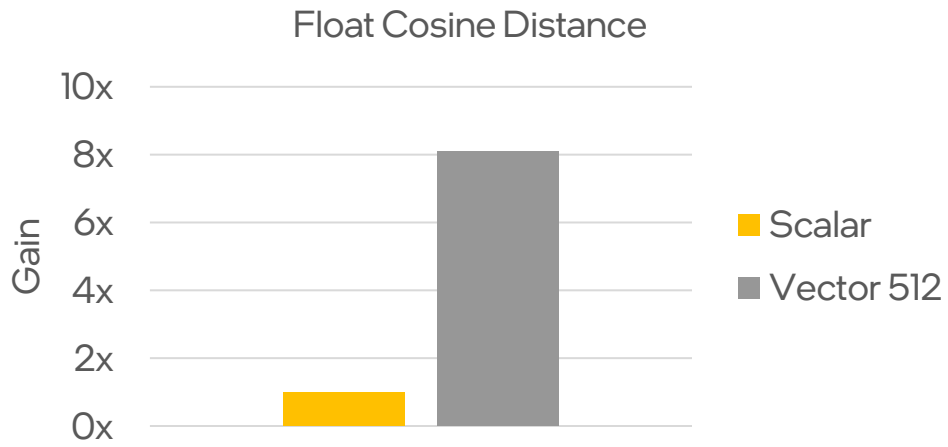
New JDK APIs

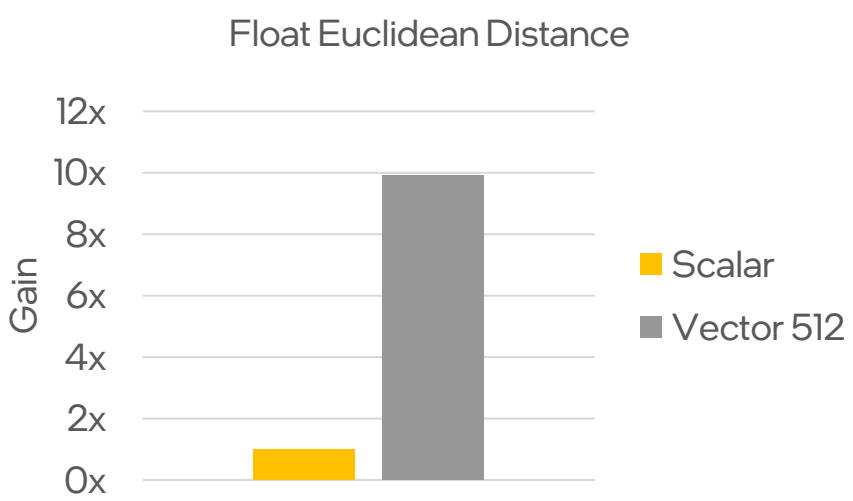
Vector API, Direct IO

Vector API – Performance (JDK 17)







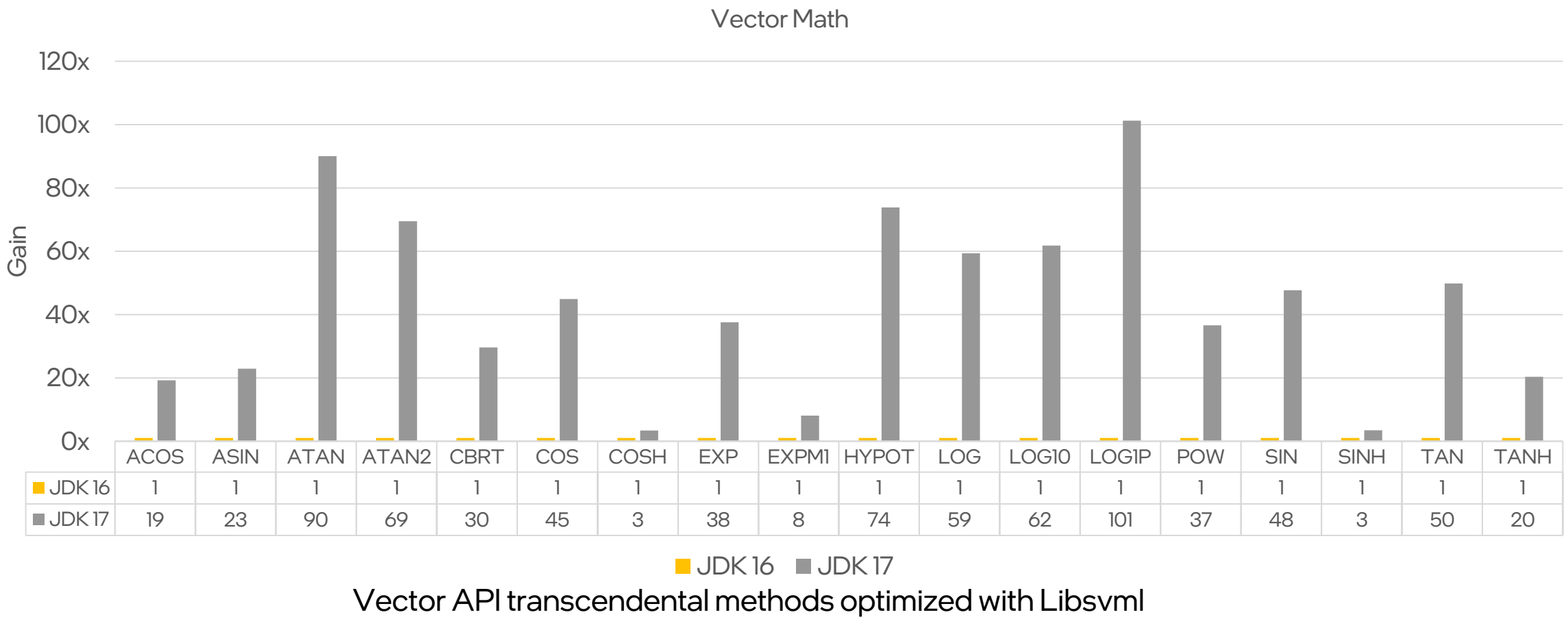


See backup slides for workloads and configurations. Results may vary.

New JDK APIs

Vector API, Direct IO

Vector API – Vector Math Performance



	ACOS	ASIN	ATAN	ATAN2	CBRT	COS	COSH	EXP	EXPM1	HYPOT	LOG	LOG10	LOG1P	POW	SIN	SINH	TAN	TANH
JDK 16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
JDK 17	19	23	90	69	30	45	3	38	8	74	59	62	101	37	48	3	50	20

Vector API transcendental methods optimized with Libsvml

See backup slides for workloads and configurations. Results may vary.

Greater Apache Cassandra Database Performance on 3rd Gen Intel® Xeon® Scalable Processors

Get up to 1.12x the Apache Cassandra Database Performance with 8vCPU Lsv3 Virtual Machines

vs. Lasv3 VMs

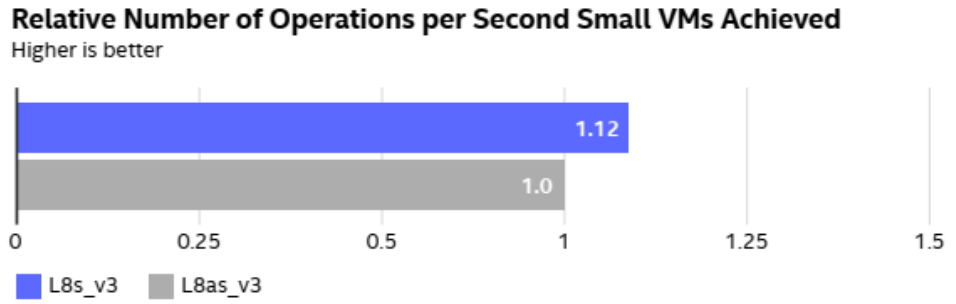


Figure 1. Relative Apache Cassandra performance in OPS of the 8vCPU Azure Lsv3 and Lasv3 virtual machines. Higher is better.

Get up to 1.085x the Apache Cassandra Database Performance with 16vCPU Lsv3 VMs

vs. Lasv3 VMs

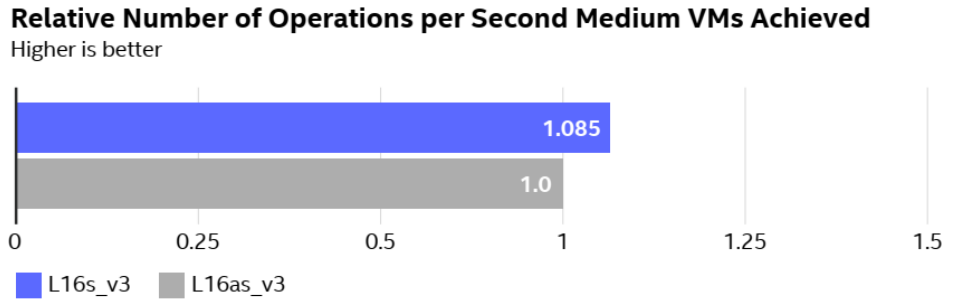


Figure 2. Relative Apache Cassandra performance in OPS of the 16vCPU Azure Lsv3 and Lasv3 virtual machines. Higher is better.

For complete test details and results, read the report at https://facts.pt/OJpQ8Gc

Generation & JDK Matching

Cascade Lake

JDK 11 LTS

- Whole heap on Intel DCPMM
- Intel optimizations for concurrent ZGC
- Base 64 encoding optimizations
- Bit-count optimizations

JDK 12

- Partial heap on Intel DCPMM
- VNNI support through vectorization
- AES-GCM crypto optimizations

JDK 13

- Floating-point Math.min/max intrinsics
- Garbage-collection pause-time improvements

Cascade Lake/Ice Lake

JDK 14

- AES-ECB, AES-CTR , AES-GCM optimizations
- Math.ceil, floor, rint optimization and vectorization
- Support for Persistent Mapped Byte Buffers

JDK 15

- CRC32
- AVX-512 ternary logic optimizations
- ADQ/NAPI-ID support for Intel NIC

JDK 16

- Java vector API (JEP-338)
- AVX-512 optimizations for string/array intrinsics; optimized rotate

Cascade Lake/Ice Lake

JDK 17 LTS

- Adler-32 optimization
- Math.signum, I2L optimization
- Hybrid large-page support
- Vector-API 2nd incubation; optimized math functions through SVML
- RSA Crypto scaling optimization
- AVX-512 optimizations: partial inlining, clearMemory, code-gen

JDK 18

- BASE-64 encode/decode for AVX512 + ICX
- Interleaved AES-GCM
- CRC32C for ICX
- Vector API 3rd Incubation; masked optimizations

More Resources

Read about tuning and accelerating Java and JDK applications by downloading our guides:

- Accelerating performance for server-side Java* applications
- Java Tuning Guide on 3rd Generation Intel Xeon Scalable Processors Based Platform
- Boosting Java* Performance in Big Data Applications


intel

Benchmarking Configurations

Platform:

“Bare metal” on-premise machine tested July 10, 2022

ICX: Intel(R) Xeon(R) Platinum 8380 CPU @ 2.30GHz

Red Hat Enterprise Linux release 8.4 (Ootpa)

JDK:

JDK 8: openjdk version "1.8.0_282“

JDK 11: openjdk version "11.0.10" 2021-01-19 LTS

JDK 16: openjdk version "16.0.2" 2021-07-20

JDK 17: openjdk version "17.0.2" 2022-01-18 LTS

JDK 18: openjdk version "18.0.1" 2022-04-19

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