STAC Update: Big Workloads

Peter Nabicht
President, STAC

peter.nabicht@STACresearch.com

Overview

- STAC-A2 (derivatives risk computation)
- STAC-M3 (tick history / timeseries analysis)

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STAC-A2: Risk computation

- Non-trivial Monte Carlo calculations
  - Heston-based Greeks for multi-asset, path-dependent options with early exercise
  - Metrics: Speed, capacity, quality, efficiency
- Numerous reports
  - Some public, some in the STAC Vault
- Premium STAC members get:
  - Reports in STAC Vault
  - Detailed config info on public and private reports
  - Code from vendor implementations of the benchmarks

www.STACresearch.com/a2

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A few points on STAC-A2 for the uninitiated

- Some tests measure **response time** for a single option of given problem size
- **Throughput** measures time to handle a portfolio of options
- **Efficiency** relates throughput to power and space
- Each response-time workload is tested 5 times, back-to-back:
  - First run is the **COLD** run
  - Subsequent 4 are **WARM** runs
- COLD relates to real-world systems that must respond to heterogeneous problem classes
  - COLD time includes building memory structures, loading kernels, etc.
- WARM relates to real-world systems configured to handle numerous requests for the same problem class

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STAC-A2 / Dell PowerEdge XE8545 / 4 x A100 SXM4 40GB

- First STAC-A2 from Dell Technologies
- STAC-A2 Pack for CUDA (Rev G)
- Stack:
  - NVIDIA CUDA 11.6
  - Dell PowerEdge XE8545
    - 2 x AMD EPYC 7713 64-core processor @ 2.0GHz
    - 4 x NVIDIA A100 SXM4 40GiB GPU
    - 32 x 16GiB Dual Rank ECC DDR4 @ 2933Mhz
  - Red Hat Enterprise Linux 8.3

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Compared to all publicly reported solutions to date

- Set 3 records:
  - The highest space efficiency
    - STAC-A2.β2.HPORTFOLIO.SPACE_EFF
  - The fastest cold times in the baseline Greeks benchmark
    - STAC-A2.β2.GREEKS.TIME.COLD
  - The fastest cold times in the large Greek benchmark
    - STAC-A2.β2.GREEKS.10-100k-1260TIME.COLD

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Vs. a solution with 8 x GPUs*

- Had 1.2x the space efficiency
  - STAC-A2.β2.HPORTFOLIO.SPACE_EFF
- Was 2.9x the speed in the cold runs of the baseline Greeks benchmark
  - STAC-A2.β2.GREEKS.TIME.COLD
- Was 1.1x the speed in the cold runs of the Greeks benchmark
  - STAC-A2.β2.GREEKS.10-100k-1260.TIME.COLD
- Was 67% of the speed in the warm runs of the baseline Greeks benchmark
  - STAC-A2.β2.GREEKS.TIME.WARM

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* SUT ID NVDA210914

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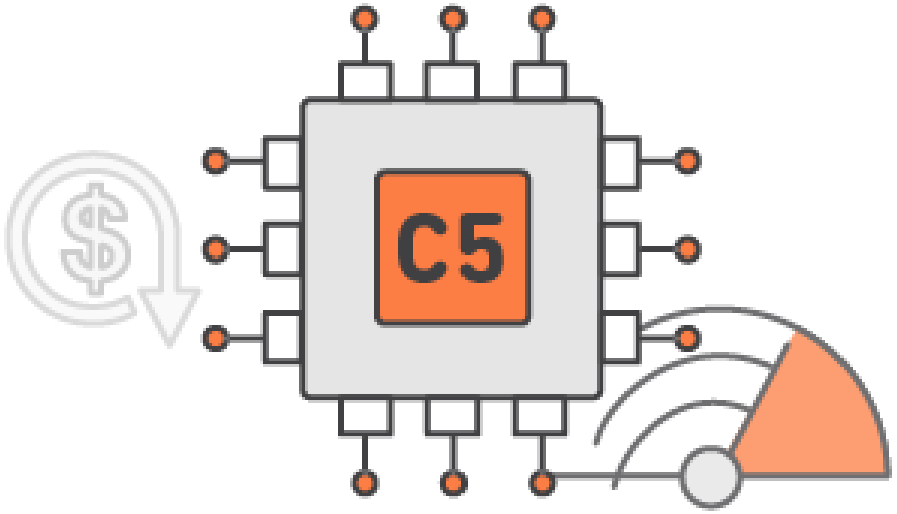
STAC-A2 / AWS c5.metal / 2 x Intel® Xeon® Platinum 8275CL

- First AWS-based solution with publicly released STAC-A2 results
- Cloud server with no hypervisor
- STAC-A2 Pack for Intel® oneAPI (Rev N)
- Stack:
  - Intel® oneAPI Base Toolkit 2022.3
  - Intel® oneAPI HPC Toolkit 2022.3
  - c5.metal Amazon Web Services Instance
    - 2 x Intel® Xeon® Platinum 8275CL (Cascade Lake) CPU @ 3.00GHz
    - 96 logical cores
    - 192 GiB of DRAM
  - Amazon Linux release 2 (Karoo)



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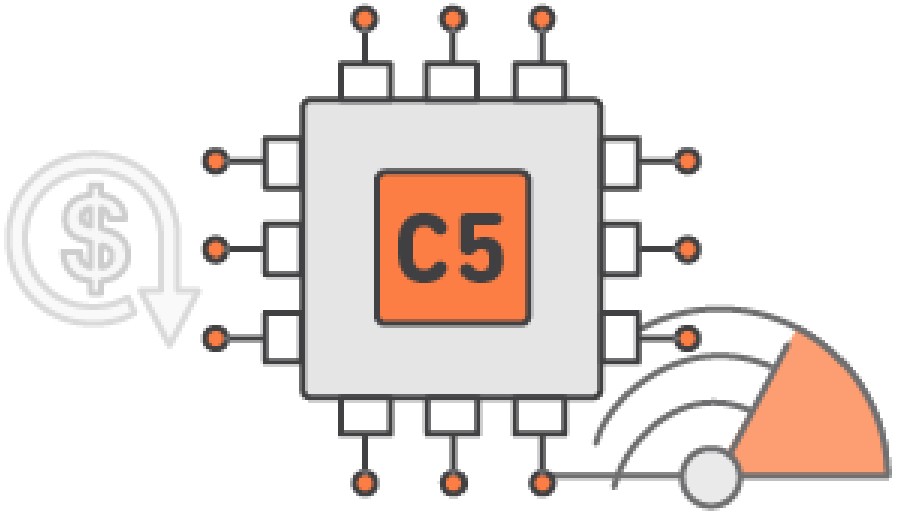
Vs. cloud-based SUT with 10 instances and Cascade Lake CPUs*

- Completed 1.1x the options per dollar over a 1 hour burst and a 3-day period
  - STAC-A2.β2.HPORTFOLIO.PRICE_PERF .BURST and .PERIODIC
- Completed 1.2x the options per dollar (reflecting reserve instance pricing discounts) over a 1-year period
  - STAC-A2.β2.HPORTFOLIO.PRICE_PERF .CONTINUOUS



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* SUT ID INTC210331

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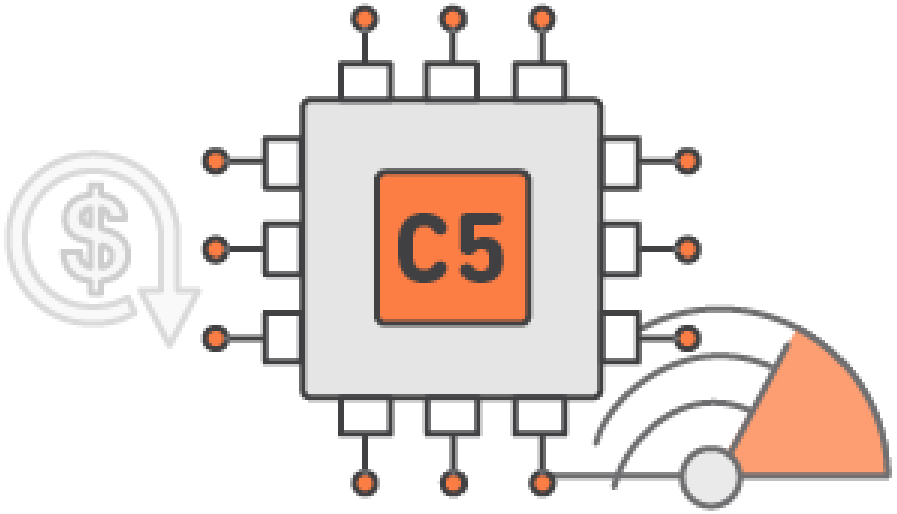
Vs. on-prem solution with 2 x Sky Lake CPUs*

- Had 2x the throughput
  - STAC-A2.β2.HPORTFOLIO.SPEED
- In the baseline problem size
  - Was 2.4x the speed in cold runs STAC-A2.β2.GREEKS.TIME.COLD
  - Was 1.74x faster in warm runs STAC-A2.β2.GREEKS.TIME. WARM
- Was 2.3x the speed in the cold and warm runs of the large problem size
  - STAC-A2.β2.GREEKS.10-100k-1260TIME.COLD
  - STAC-A2.β2.GREEKS.10-100k-1260TIME.WARM



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* SUT ID INTC190401

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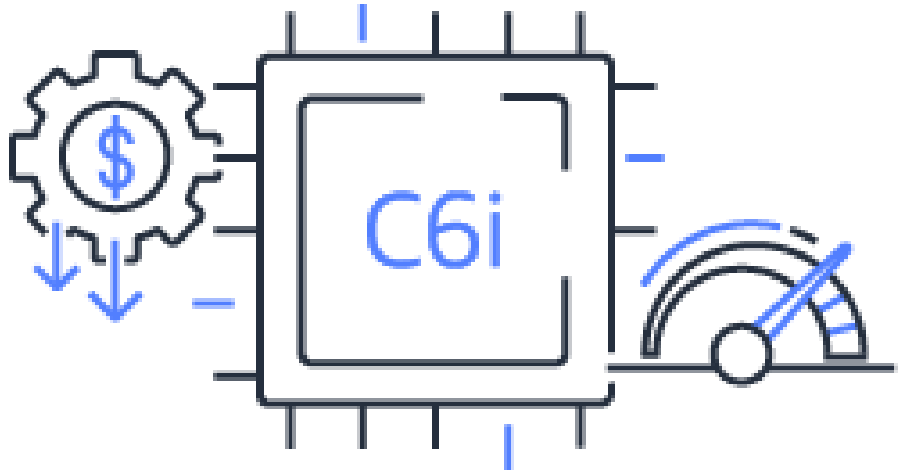
STAC-A2 / AWS c6i.metal / 2 x Intel® Xeon® Platinum 8375C

- Also, cloud server with no hypervisor but with new generation CPU (Ice Lake)
- STAC-A2 Pack for Intel® oneAPI (Rev N)
- Stack:
  - Intel® oneAPI Base Toolkit 2022.3
  - Intel® oneAPI HPC Toolkit 2022.3
  - c6i.metal Amazon Web Services Instance
    - 2 x Intel® Xeon® Platinum 8375C CPU @ 2.90GHz
    - 128 logical cores
    - 256 GiB of DRAM
  - Amazon Linux release 2 (Karoo)



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Vs. all publicly reported cloud-based solutions

- The highest options per dollar over a 1 hour burst and a 3-day period
  - STAC-A2.β2.HPORTFOLIO.PRICE_PERF.BURST
  - STAC-A2.β2.HPORTFOLIO.PRICE_PERF.PERIODIC
- The highest options per dollar (reflecting reserve instance pricing discounts) over a 1-year period
  - STAC-A2.β2.HPORTFOLIO.PRICE_PERF.CONTINUOUS

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Vs. on-prem solution with 2 x Cascade Lake CPUs*

- Had 1.5x the throughput
  - STAC-A2.β2.HPORTFOLIO.SPEED
- In the baseline problem size
  - Was 1.3x the speed in cold runs STAC-A2.β2.GREEKS.TIME.COLD
  - Was 1.4x the speed in warm runs STAC-A2.β2.GREEKS.TIME.WARM
- In the large problem size
  - Was 1.8x the speed in cold runs STAC-A2.β2.GREEKS.10-100k-1260TIME.COLD
  - Was 1.4x the speed in warm runs STAC-A2.β2.GREEKS.10-100k-1260TIME.WARM
- Handled 2 x the paths in the max paths test
  - (STAC-A2.β2.GREEKS.MAX_ASSETS)

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* SUT ID INTC190402

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STAC-M3

- Performance benchmarks for enterprise tick analytics
  - Language/DBMS neutral
  - Developed by banks and hedge funds
- Workload:
  - Synthetic data modeled on NYSE TAQ
  - Simulates concurrent access with varying number of users
  - Mix of I/O- and compute-intensive operations
- Many years of comparison points on diverse architectures

www.STACresearch.com/m3

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STAC Packs

- Wide range of implementations
  - Databases: kdb+, shakti, eXtremeDB
  - Clustered file systems, parallel file systems, NFS, flash arrays, NVME over Fabric, direct-attached SSD, NAND and post-NAND Flash (e.g. Optane)
  - Single database server, database cluster (bare metal and cloud)
- Analytics STAC Track subscribers can access STAC Pack source code
  - Understand how to develop for a given database
  - Run tests: Mark your own stacks to market
  - Discover code optimizations

council@*STACresearch*.com

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STAC-M3 / kdb+ / Dell PowerScale F900 All-Flash NAS, 3-node cluster

- Ran baseline (Antuco) and scale (Kanaga) benchmarks
- Demonstrates F900 handling larger data sets
- A follow-on to Antuco-only on PowerScale F900 (KDB210929)
- STAC-M3 Pack for kdb+: Compatibility Rev H

www.STACresearch.com/KDB220506

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STAC-M3 / kdb+ / Dell PowerScale F900 All-Flash NAS, 3-node cluster

- Stack:
  - kdb+ 4.0 in distributed mode
  - 8 x Dell PowerEdge R7525 servers, each with:
    - 2 x AMD EPYC 7H12 64-core CPU
    - 512GiB DRAM
    - Ubuntu 20.04.03 LTS
    - NFS v3
  - 3 node Dell PowerScale F900 All-Flash Scale-Out NAS
    - Dell OneFS 9.2 storage cluster operating system
    - 251 TiB total physical capacity

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Vs. previous generation of Dell EMC flash storage appliance*

- Outperformed in 14 of 17 STAC-M3 Antuco mean response-time benchmarks, including:
  - 16.9x the speed in the 10-user market snapshot (STAC-M3.β1.10T.MKTSNAP.TIME)
  - 4.1x the speed in the 100-user unpredictable interval stats (STAC-M3.ß1.100T.STATS-UI.TIME)
  - 3.4x the speed in the 50-user unpredictable interval stats (STAC-M3.ß1.50T.STATS-UI.TIME)
- Comparison SUT used kdb+ 3.6 and STAC Pack Compatibility Rev E

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* SUT ID KDB190430

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Vs. cloud-based solution with 12 DB servers and local storage*

- Outperformed in 4 of 17 STAC-M3 Antuco mean response-time benchmarks, including:
  - 2.9x the speed in NBBO (STAC-M3.β1.1T.NBBO.TIME)
  - 2.4x the speed in 1-user unpredictable interval stats (STAC-M3.ß1.1T.STATS-UI.TIME)
- In STAC-M3 Kanaga mean response-time benchmarks:
  - Faster in all 5 involving 100 users (STAC-M3.β1.100T.YR{1,2,3,4,5}VWAB-12D-HO.TIME)
  - Faster in 3 of 5 involving 50 users (STAC-M3.β1.50T.YR{3,4,5}VWAB-12D-HO.TIME)
- Comparison SUT was kdb+ in sharded mode

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* SUT ID KDB211210

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STAC-M3 / kdb+ / 2 x DDN AI400X2 All-Flash / 16x DB servers

- Ran baseline (Antuco) and scale (Kanaga) benchmarks
- Demonstrates scaling with DDN AI400X2 and EXAScaler software
- STAC-M3 Pack for kdb+: Compatibility Rev H

www.STACresearch.com/KDB221014

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STAC-M3 / kdb+ / 2 x DDN AI400X2 All-Flash / 16x DB servers

- Stack:
  - kdb+ 4.0 Cloud Edition in distributed mode
  - 2 x DDN AI400X2 All-Flash appliances, each with:
    - DDN EXAScaler Parallel Filesystem version 6.1.0
    - 24 x 3.8TB NVMe SSD
  - 16 x GIGABYTE H262-Z62, each with:
    - DDN EXAScaler 6.1.0 software
    - Centos 8.3.2011
    - 2 x AMD EPYC 7763 64-core CPUs @ 2.45 GHz
    - 512GiB memory

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Compared to all publicly disclosed mean-response time results

- Outperformed in 4 of 7 100-user benchmarks:
  - 100-user intervalized statistics (STAC-M3.β1.100T.STATS-UI.TIME)
  - 1-, 2-, and 3-year 100-user 12-day VWAB (STAC-M3.β1.100T.YR{1,2,3}VWAB-12D-HO.TIME)

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* SUT ID KDB190430

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Vs. stack w/ network-attached flash storage and 9 DB servers*

- Faster in 13 of 17 Antuco mean-response time benchmarks, including:
  - 6x speedup in 50-user intervalized stats (STAC-M3.β1.50T.STATS-UI.TIME)
  - 5x speedup in 10-user aggregate stats (STAC-M3.β1.10T.STATS-AGG.TIME)
  - 4.9x speedup in single-user intervalized stats (STAC-M3.β1.1T.STATS-UI.TIME)
- Faster in 21 of 24 Kanaga mean-response time benchmarks, including:
  - 2.1 – 4.4x speedup in single-user high-bid (STAC-M3.β1.1T.{2,3,4,5}YRHIBID.TIME)

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* SUT ID KDB220506

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Vs. public cloud stack with 15 DB & 40 storage servers*

- Faster in 13 of 17 Antuco mean-response time benchmarks, including:
  - 6.5x speedup in 10-user volume curve (STAC-M3.β1.10T.VOLCURV.TIME)
- Faster n 16 of 24 Kanaga mean-response time benchmarks, including:
  - 15.5 – 19.3x speedup in 10-user market snapshots (STAC-M3.β1.10T.YR{2,3,4,5}-MKTSNAP.TIME)
- Comparison SUT used previous version of the STAC Packs.

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* SUT ID KDB210507

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