## Lenovo Global Technology

**ThinkSystem SR645**  
**2.85 GHz, AMD EPYC 7443**

### SPEC CPU®2017 Floating Point Speed Result

<table>
<thead>
<tr>
<th>SPECspeed®2017_fp_base</th>
<th>SPECspeed®2017_fp_peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>199</td>
<td>203</td>
</tr>
</tbody>
</table>

**CPU2017 License:** 9017  
**Test Sponsor:** Lenovo Global Technology  
**Tested by:** Lenovo Global Technology  
**Test Date:** Apr-2021  
**Hardware Availability:** Apr-2021  
**Software Availability:** Mar-2021

<table>
<thead>
<tr>
<th>Thread</th>
<th>SPECspeed®2017_fp_base</th>
<th>SPECspeed®2017_fp_peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>603.bwaves_s</td>
<td>48</td>
<td>315</td>
</tr>
<tr>
<td>607.cactuBSSN_s</td>
<td>48</td>
<td>115</td>
</tr>
<tr>
<td>619.ibm_s</td>
<td>48</td>
<td>179</td>
</tr>
<tr>
<td>621.wrf_s</td>
<td>48</td>
<td>152</td>
</tr>
<tr>
<td>627.cam4_s</td>
<td>48</td>
<td>73.3</td>
</tr>
<tr>
<td>628.pop2_s</td>
<td>48</td>
<td>251</td>
</tr>
<tr>
<td>638.imagick_s</td>
<td>48</td>
<td>209</td>
</tr>
<tr>
<td>644.nab_s</td>
<td>48</td>
<td>364</td>
</tr>
<tr>
<td>649.fotonik3d_s</td>
<td>48</td>
<td>112</td>
</tr>
<tr>
<td>654.roms_s</td>
<td>48</td>
<td>264</td>
</tr>
</tbody>
</table>

### Hardware

- **CPU Name:** AMD EPYC 7443  
- **Max MHz:** 4000  
- **Nominal:** 2850  
- **Enabled:** 48 cores, 2 chips  
- **Orderable:** 1.2 chips  
- **Cache L1:** 32 KB I + 32 KB D on chip per core  
- **L2:** 512 KB I+D on chip per core  
- **L3:** 128 MB I+D on chip per core, 32 MB shared / 6 cores  
- **Other:** None  
- **Memory:** 512 GB (16 x 32 GB 2Rx4 PC4-3200AA-R)  
- **Storage:** 1 x 960 GB SATA SSD  
- **Other:** None

### Software

- **OS:** SUSE Linux Enterprise Server 15 SP2 (x86_64)  
- **Kernel:** 5.3.18-22-default  
- **Compiler:** C/C++/Fortran: Version 3.0.0 of AOCC  
- **Parallel:** Yes  
- **Firmware:** Lenovo BIOS Version D8E115E 2.01 released Mar-2021  
- **File System:** xfs  
- **System State:** Run level 3 (multi-user)  
- **Base Pointers:** 64-bit  
- **Peak Pointers:** 64-bit  
- **Other:** jemalloc: jemalloc memory allocator library v5.1.0  
- **Power Management:** BIOS set to prefer performance at the cost of additional power usage
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SPECspeed®2017_fp_base = 199
SPECspeed®2017_fp_peak = 203

Results Table

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Threads</th>
<th>Seconds</th>
<th>Ratio</th>
<th>Threads</th>
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<th>Threads</th>
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<th>Ratio</th>
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<tr>
<td>603.bwaves_s</td>
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<td>617</td>
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<td>607.cactuBSSN_s</td>
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<td>315</td>
<td>52.9</td>
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<td>52.6</td>
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<tr>
<td>628.pop2_s</td>
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Results appear in the order in which they were run. Bold underlined text indicates a median measurement.

Compiler Notes

The AMD64 AOCC Compiler Suite is available at http://developer.amd.com/amd-aocc/

Submit Notes

The config file option 'submit' was used. 'numactl' was used to bind copies to the cores. See the configuration file for details.

Operating System Notes

'ulimit -s unlimited' was used to set environment stack size
'ulimit -l 2097152' was used to set environment locked pages in memory limit
runcpu command invoked through numactl i.e.: numactl --interleave=all runcpu <etc>
'echo 8 > /proc/sys/vm/dirty_ratio' run as root to limit dirty cache to 8% of memory.
'echo 1 > /proc/sys/vm/swappiness' run as root to limit swap usage to minimum necessary.
'echo 1 > /proc/sys/vm/zone_reclaim_mode' run as root to free node-local memory and avoid remote memory usage.
'sync; echo 3 > /proc/sys/vm/drop_caches' run as root to reset filesystem caches.
'sysctl -w kernel.randomize_va_space=0' run as root to disable address space layout randomization (ASLR) to reduce run-to-run variability.
To enable Transparent Hugepages (THP) for all allocations, 'echo always > /sys/kernel/mm/transparent_hugepage/enabled' and

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Operating System Notes (Continued)
'echo always > /sys/kernel/mm/transparent_hugepage/defrag' run as root.
To enable THP only on request for peak runs of 628.pop2_s, and 638.imagick_s,
'echo madvise > /sys/kernel/mm/transparent_hugepage/enabled' run as root.
To disable THP for peak runs of 627.cam4_s, 644.nab_s, 649.fotonik3d_s, and 654.roms_s,
'echo never > /sys/kernel/mm/transparent_hugepage/enabled' run as root.

Environment Variables Notes
Environment variables set by runcpu before the start of the run:
GOMP_CPU_AFFINITY = "0-47"
LD_LIBRARY_PATH =
   "/home/cpu2017-1.1.5-amd-aocc300-milan-B1/amd_speed_aocc300_milan_B_lib/
   64;/home/cpu2017-1.1.5-amd-aocc300-milan-B1/amd_speed_aocc300_milan_B_lib/
   32;"
MALLOCONF = "retain:true"
OMP_DYNAMIC = "false"
OMP_SCHEDULE = "static"
OMP_STACKSIZE = "128M"
OMP_THREAD_LIMIT = "48"

Environment variables set by runcpu during the 654.roms_s peak run:
GOMP_CPU_AFFINITY = "0-47"

General Notes
Binaries were compiled on a system with 2x AMD EPYC 7742 CPU + 1TiB Memory using openSUSE 15.2

NA: The test sponsor attests, as of date of publication, that CVE-2017-5754 (Meltdown)
is mitigated in the system as tested and documented.
Yes: The test sponsor attests, as of date of publication, that CVE-2017-5753 (Spectre variant 1)
is mitigated in the system as tested and documented.
Yes: The test sponsor attests, as of date of publication, that CVE-2017-5715 (Spectre variant 2)
is mitigated in the system as tested and documented.
jemalloc: configured and built with GCC v4.8.2 in RHEL 7.4 (No options specified)
jemalloc 5.1.0 is available here:
https://github.com/jemalloc/jemalloc/releases/download/5.1.0/jemalloc-5.1.0.tar.bz2

Platform Notes
BIOS configuration:
Operating Mode set to Maximum Performance and then set it to Custom Mode
4-Link xGMI Max Speed set to 16Gbps
SOC P-States set to P0
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**Platform Notes (Continued)**

SMT Mode set to Disable  
DLWM Support set to Disabled

Sysinfo program /home/cpu2017-1.1.5-amd-aocc300-milan-B1/bin/sysinfo  
Rev: r6538 of 2020-09-24 e8664e66d2d7080afeaa89d4b38e2f1c  
running on localhost Thu Apr 1 18:28:48 2021

SUT (System Under Test) info as seen by some common utilities.  
For more information on this section, see  
https://www.spec.org/cpu2017/Docs/config.html#sysinfo

From /proc/cpuinfo:

- model name: AMD EPYC 7443 24-Core Processor
  - 2 "physical id"'s (chips)
  - 48 "processors"

  cores, siblings (Caution: counting these is hw and system dependent. The following excerpts from /proc/cpuinfo might not be reliable. Use with caution.)
  - cpu cores : 24
  - siblings : 24
  - physical 0: cores 0 1 2 3 4 5 8 9 10 11 12 13 16 17 18 19 20 21 24 25 26 27 28 29
  - physical 1: cores 0 1 2 3 4 5 8 9 10 11 12 13 16 17 18 19 20 21 24 25 26 27 28 29

From lscpu:

- Architecture: x86_64
- CPU op-mode(s): 32-bit, 64-bit
- Byte Order: Little Endian
- Address sizes: 48 bits physical, 48 bits virtual
- CPU(s): 48
- On-line CPU(s) list: 0-47
- Thread(s) per core: 1
- Core(s) per socket: 24
- Socket(s): 2
- NUMA node(s): 2
- Vendor ID: AuthenticAMD
- CPU family: 25
- Model: 1
- Model name: AMD EPYC 7443 24-Core Processor
- Stepping: 1
- CPU MHz: 1795.652
- CPU max MHz: 2850.0000
- CPU min MHz: 1500.0000
- BogoMIPS: 5688.92
- Virtualization: AMD-V
- L1d cache: 32K
- L1i cache: 32K
- L2 cache: 512K
- L3 cache: 32768K

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Platform Notes (Continued)

NUMA node0 CPU(s):   0-23
NUMA node1 CPU(s):   24-47
Flags:               fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov
                     pat pse36 clflush mmx fxsr sse sse2 ht syscall nx mmxext fxsr_opt pdpe1gb rdtscp lm
                     constant_tsc rep_good nopl nonstop_tsc cpuid extd_apicid aperfmperf pni pclmulqdq
                     monitor ssse3 fma cx16 pdcd sse4_1 sse4_2 movbe popcnt avx f16c rdrand
                     lahf_lm cmp_legacy svm extapid cr8_legacy abm sse4a misalignsse 3nowprefetch osvw
                     ibs skinit wdt tce topoext perfctr_core perfctr_nb bext perfctr_llc mwaitx cpb
                     cat_l3 cdp_l3 invpcid_single hw_pstate ssbd mba ibrs ibpb stibp vmcall fsgsbase
                     bmi1 avx2 smep bmi2 erms invpcid cmtd rdt_a rdseed adx smap clflushopt clwb sha_ni
                     xsaveopt xsaveerptr wbnoinvd arat npt lbrv svm_lock nrip_save tsc_scale
                     vmcb_clean flushbyasid decodeassist pausefilter pfthreshold v_vmsave_vmload vgif
                     umip pku ospe vaes vpclmulqdq rdpid overflow_recov succor smca

From /proc/cpuinfo cache data
  cache size: 512 KB

From numactl --hardware WARNING: a numactl 'node' might or might not correspond to a physical chip.
  available: 2 nodes (0-1)
    node 0 cpus: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
    node 0 size: 257806 MB
    node 0 free: 257351 MB
    node 1 cpus: 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
    node 1 size: 258039 MB
    node 1 free: 257507 MB
    node distances:
      node 0 1
      0: 10 32
      1: 32 10

From /proc/meminfo
  MemTotal: 528226048 kB
  HugePages_Total: 0
  Hugepagesize: 2048 kB

From /sys/devices/system/cpu/cpu*/cpufreq/scaling_governor has performance

From /etc/*release* /etc/*version*
  os-release:
    NAME="SLES"
    VERSION="15-SP2"
    VERSION_ID="15.2"
    PRETTY_NAME="SUSE Linux Enterprise Server 15 SP2"
    ID="sles"

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Platform Notes (Continued)

ID_LIKE="suse"
ANSI_COLOR="0;32"
CPE_NAME="cpe:/o:suse:sles:15:sp2"

uname -a:
   Linux localhost 5.3.18-22-default #1 SMP Wed Jun 3 12:16:43 UTC 2020 (720aeba) x86_64
   x86_64 x86_64 GNU/Linux

Kernel self-reported vulnerability status:

CVE-2018-12207 (iTLB Multihit): Not affected
CVE-2018-3620 (L1 Terminal Fault): Not affected
Microarchitectural Data Sampling: Not affected
CVE-2017-5754 (Meltdown): Not affected
CVE-2018-3639 (Speculative Store Bypass): Mitigation: Speculative Store Bypass disabled via prctl and seccomp
CVE-2017-5753 (Spectre variant 1): Mitigation: usercopy/swapgs barriers and __user pointer sanitization
CVE-2017-5715 (Spectre variant 2): Mitigation: Full AMD retpoline, IBPB: conditional, IBRS_FW, STIBP: disabled, RSB filling
CVE-2020-0543 (Special Register Buffer Data Sampling): Not affected
CVE-2019-11135 (TSX Asynchronous Abort): Not affected

run-level 3 Apr 1 18:26
SPEC is set to: /home/cpu2017-1.1.5-amd-aocc300-milan-B1

From /sys/devices/virtual/dmi/id
Vendor: Lenovo
Product: ThinkSystem SR645 MB
Product Family: ThinkSystem
Serial: 1234567890

Additional information from dmidecode follows. WARNING: Use caution when you interpret this section. The 'dmidecode' program reads system data which is "intended to allow hardware to be accurately determined", but the intent may not be met, as there are frequent changes to hardware, firmware, and the "DMTF SMBIOS" standard.
Memory:
   16x Samsung M393A4K40DB3-CWE 32 GB 2 rank 3200
   16x Unknown Unknown

BIOS:

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Platform Notes (Continued)

BIOS Vendor: Lenovo
BIOS Version: D8E115E-2.01
BIOS Date: 03/04/2021
BIOS Revision: 2.1
Firmware Revision: 3.1

(End of data from sysinfo program)

Compiler Version Notes

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C

| 619.lbm_s(base, peak) 638.imagick_s(base, peak) 644.nab_s(base, peak) |

AMD clang version 12.0.0 (CLANG: AOCC_3.0.0-Build#78 2020_12_10) (based on LLVM Mirror.Version.12.0.0)
Target: x86_64-unknown-linux-gnu
Thread model: posix
InstalledDir: /opt/AMD/aocc-compiler-3.0.0/bin

---

C++, C, Fortran

| 607.cactuBSSN_s(base, peak) |

AMD clang version 12.0.0 (CLANG: AOCC_3.0.0-Build#78 2020_12_10) (based on LLVM Mirror.Version.12.0.0)
Target: x86_64-unknown-linux-gnu
Thread model: posix
InstalledDir: /opt/AMD/aocc-compiler-3.0.0/bin

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Fortran

| 603.bwaves_s(base, peak) 649.fotonik3d_s(base, peak) 654.roms_s(base, peak) |

AMD clang version 12.0.0 (CLANG: AOCC_3.0.0-Build#78 2020_12_10) (based on LLVM Mirror.Version.12.0.0)
Target: x86_64-unknown-linux-gnu
Thread model: posix
InstalledDir: /opt/AMD/aocc-compiler-3.0.0/bin

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Compiler Version Notes (Continued)

LLVM Mirror.\textsuperscript{Version.12.0.0}
Target: x86\_64-unknown-linux-gnu
Thread model: posix
InstalledDir: /opt/AMD/aocc-compiler-3.0.0/bin

-----------------------------------------------

Fortran, C      | 621.wrf\_s(base, peak) 627.cam4\_s(base, peak)
| 628.pop2\_s(base, peak)
-----------------------------------------------

AMD clang version 12.0.0 (CLANG: AOCC\_3.0.0-Build\#78 2020\_12\_10) (based on
LLVM Mirror.\textsuperscript{Version.12.0.0}
Target: x86\_64-unknown-linux-gnu
Thread model: posix
InstalledDir: /opt/AMD/aocc-compiler-3.0.0/bin

Base Compiler Invocation

C benchmarks:
clang

Fortran benchmarks:
flang

Benchmarks using both Fortran and C:
flang clang

Benchmarks using Fortran, C, and C++:
clang++ clang flang

Base Portability Flags

603.bwaves\_s: -DSPEC\_LP64
607.cactuBSSN\_s: -DSPEC\_LP64
619.lbm\_s: -DSPEC\_LP64
621.wrf\_s: -DSPEC\_CASE\_FLAG -Mbyteswapio -DSPEC\_LP64
627.cam4\_s: -DSPEC\_CASE\_FLAG -DSPEC\_LP64

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Base Portability Flags (Continued)

628.pop2_s: -DSPEC_CASE_FLAG -Mbyteswapio -DSPEC_LP64
638.imagick_s: -DSPEC_LP64
644.nab_s: -DSPEC_LP64
649.fotonik3d_s: -DSPEC_LP64
654.roms_s: -DSPEC_LP64

Base Optimization Flags

C benchmarks:
- m64 -mno-adx -mno-sse4a -Wl,-mllvm -Wl,-region-vectorize
- Wl,-mllvm -Wl,-function-specialize
- Wl,-mllvm -Wl,-align-all-nofallthru-blocks=6
- Wl,-mllvm -Wl,-reduce-array-computations=3 -O3 -march=znver3
- fveclib=AMDLIBM -ffast-math -flto -fstruct-layout=5
- mllvm -unroll-threshold=50 -mllvm -inline-threshold=1000
- fremap-arrays -mllvm -function-specialize -flv-function-specialization
- mllvm -enable-gvn-hoist -mllvm -global-vectorize-slp=true
- mllvm -enable-licm-vrp -mllvm -reduce-array-computations=3 -z muldefs
- DSPEC_OPENMP -fopenmp -fopenmp=libomp -lomp -lamdlibm -ljemalloc
- lflang -lflangrti

Fortran benchmarks:
- m64 -mno-adx -mno-sse4a -Wl,-mllvm -Wl,-enable-X86-prefetching
- Wl,-mllvm -Wl,-enable-licm-vrp -Wl,-mllvm -Wl,-region-vectorize
- Wl,-mllvm -Wl,-function-specialize
- Wl,-mllvm -Wl,-align-all-nofallthru-blocks=6
- Wl,-mllvm -Wl,-reduce-array-computations=3 -Hz,1,0x1 -O3
- march=znver3 -fveclib=AMDLIBM -ffast-math -Mrecursive
- mllvm -fuse-tile-inner-loop -funroll-loops
- mllvm -extra-vectorizer-passes -mllvm -lsr-in-nested-loop
- mllvm -enable-licm-vrp -mllvm -reduce-array-computations=3
- mllvm -global-vectorize-slp=true -z muldefs -DSPEC_OPENMP -fopenmp
- fopenmp=libomp -lomp -lamdlibm -ljemalloc -lflang -lflangrti

Benchmarks using both Fortran and C:
- m64 -mno-adx -mno-sse4a -Wl,-mllvm -Wl,-enable-X86-prefetching
- Wl,-mllvm -Wl,-enable-licm-vrp -Wl,-mllvm -Wl,-region-vectorize
- Wl,-mllvm -Wl,-function-specialize
- Wl,-mllvm -Wl,-align-all-nofallthru-blocks=6
- Wl,-mllvm -Wl,-reduce-array-computations=3 -O3 -march=znver3
- fveclib=AMDLIBM -ffast-math -flto -fstruct-layout=5
- mllvm -unroll-threshold=50 -mllvm -inline-threshold=1000
- fremap-arrays -mllvm -function-specialize -flv-function-specialization
- mllvm -enable-gvn-hoist -mllvm -global-vectorize-slp=true

(Continued on next page)
**Base Optimization Flags (Continued)**

Benchmarks using both Fortran and C (continued):
- `-mllvm -enable-licm-vrp` `-mllvm -reduce-array-computations=3` `-Hz,1,0x1`
- `-Mrecursive` `-mllvm -fuse-tile-inner-loop -funroll-loops`
- `-mllvm -extra-vectorizer-passes` `-mllvm -lsl-in-nested-loop` `-z muldefs`
- `-DSPEC_OPENMP` `-fopenmp` `-fopenmp=libomp` `-lomp` `-lamdlibm` `-ljemalloc` `-lflang` `-lflangrti`

Benchmarks using Fortran, C, and C++:
- `-m64` `-mno-adx` `-mno-sse4a` `-std=c++98`
- `-Wl,-mllvm -Wl,-x86-use-vzeroupper=false`
- `-Wl,-mllvm -Wl,-region-vectorize` `-Wl,-mllvm -Wl,-function-specialize`
- `-Wl,-mllvm -Wl,-align-all-nofallthru-blocks=6`
- `-Wl,-mllvm -Wl,-reduce-array-computations=3` `-O3` `-march=znver3`
- `-fveclib=AMDLIBM` `-ffast-math` `-flto` `-fstruct-layout=5`
- `-mllvm -unroll-threshold=50` `-mllvm -inline-threshold=1000`
- `-fremap-arrays` `-mllvm -function-specialize` `-fiv-function-specialization`
- `-mllvm -enable-gvn-hoist` `-mllvm -global-vectorize-slp=true`
- `-mllvm -enable-licm-vrp` `-mllvm -reduce-array-computations=3`
- `-mllvm -enable-partial-unswitch` `-mllvm -unroll-threshold=100`
- `-mllvm -convert-pow-exp-to-int=false`
- `-Hz,1,0x1` `-Mrecursive` `-mllvm -fuse-tile-inner-loop -funroll-loops`
- `-mllvm -lsl-in-nested-loop` `-z muldefs` `-DSPEC_OPENMP` `-fopenmp`
- `-fopenmp=libomp` `-lomp` `-lamdlibm` `-ljemalloc` `-lflang` `-lflangrti`

**Base Other Flags**

C benchmarks:
- `-Wno-unused-command-line-argument` `-Wno-return-type`

Fortran benchmarks:
- `-Wno-unused-command-line-argument` `-Wno-return-type`

Benchmarks using both Fortran and C:
- `-Wno-unused-command-line-argument` `-Wno-return-type`

Benchmarks using Fortran, C, and C++:
- `-Wno-unused-command-line-argument` `-Wno-return-type`
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**CPU2017 License:** 9017  
**Test Sponsor:** Lenovo Global Technology  
**Tested by:** Lenovo Global Technology

### Peak Compiler Invocation

C benchmarks:  
`clang`

Fortran benchmarks:  
`flang`

Benchmarks using both Fortran and C:  
`flang clang`

Benchmarks using Fortran, C, and C++:  
`clang++ clang flang`

### Peak Portability Flags

Same as Base Portability Flags

### Peak Optimization Flags

C benchmarks:

- 619.lbm_s: `basepeak = yes`
- 638.imagick_s: `basepeak = yes`
- 644.nab_s: `basepeak = yes`

Fortran benchmarks:

- 603.bwaves_s: `basepeak = yes`
- 649.fotonik3d_s: `basepeak = yes`

*(Continued on next page)*
Lenovo Global Technology
ThinkSystem SR645
2.85 GHz, AMD EPYC 7443

SPECspeed®2017_fp_base = 199
SPECspeed®2017_fp_peak = 203

CPU2017 License: 9017
Test Sponsor: Lenovo Global Technology
Tested by: Lenovo Global Technology

Test Date: Apr-2021
Hardware Availability: Apr-2021
Software Availability: Mar-2021

Peak Optimization Flags (Continued)

654.roms_s (continued):
   -ljemalloc -lflang

Benchmarks using both Fortran and C:
621.wrf_s: basepeak = yes
627.cam4_s: basepeak = yes
628.pop2_s: basepeak = yes

Benchmarks using Fortran, C, and C++:
607.cactuBSSN_s: basepeak = yes

Peak Other Flags

C benchmarks:
   -Wno-unused-command-line-argument -Wno-return-type

Fortran benchmarks:
   -Wno-unused-command-line-argument -Wno-return-type

Benchmarks using both Fortran and C:
   -Wno-unused-command-line-argument -Wno-return-type

Benchmarks using Fortran, C, and C++:
   -Wno-unused-command-line-argument -Wno-return-type

The flags files that were used to format this result can be browsed at
http://www.spec.org/cpu2017/flags/Lenovo-Platform-SPECcpu2017-Flags-V1.2-Milan-D.html

You can also download the XML flags sources by saving the following links:
http://www.spec.org/cpu2017/flags/Lenovo-Platform-SPECcpu2017-Flags-V1.2-Milan-D.xml