Lenovo Global Technology

ThinkSystem ST50
(3.80 GHz, Intel Xeon E-2276G)

| Specspeed®2017_fp_base = 33.1 | Specspeed®2017_fp_peak = 33.5 |

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

<table>
<thead>
<tr>
<th>Threads</th>
<th>SPECspeed®2017_fp_base (33.1)</th>
<th>SPECspeed®2017_fp_peak (33.5)</th>
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<tbody>
<tr>
<td>603.bwaves_s</td>
<td>6</td>
<td>79.1</td>
</tr>
<tr>
<td>607.cactuBSSN_s</td>
<td>6</td>
<td>56.7</td>
</tr>
<tr>
<td>619.lbm_s</td>
<td>6</td>
<td>16.1</td>
</tr>
<tr>
<td>621.wrf_s</td>
<td>6</td>
<td>40.0</td>
</tr>
<tr>
<td>627.cam4_s</td>
<td>6</td>
<td>43.6</td>
</tr>
<tr>
<td>628.pop2_s</td>
<td>6</td>
<td>37.5</td>
</tr>
<tr>
<td>638.imagick_s</td>
<td>6</td>
<td>31.0</td>
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<tr>
<td>644.nab_s</td>
<td>6</td>
<td>60.1</td>
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<tr>
<td>649.fotonik3d_s</td>
<td>6</td>
<td>62.7</td>
</tr>
<tr>
<td>654.roms_s</td>
<td>6</td>
<td>17.0</td>
</tr>
</tbody>
</table>

**Hardware**

- **CPU Name:** Intel Xeon E-2276G
- **Max MHz:** 4900
- **Nominal:** 3800
- **Enabled:** 6 cores, 1 chip
- **Orderable:** 1 chip
- **Cache L1:** 32 KB I + 32 KB D on chip per core
- **L2:** 256 KB I+D on chip per core
- **L3:** 12 MB I+D on chip per chip
- **Memory:** 64 GB (4 x 16 GB 2Rx8 PC4-2666V-E)
- **Storage:** 1 x 960 GB SATA SSD
- **Other:** None

**Software**

- **OS:** Red Hat Enterprise Linux 8.1 (Ootpa)
  Kernel 4.18.0-147.el8.x86_64
- **Compiler:** C/C++: Version 19.1.1.217 of Intel
  Compiler for Linux;
  Fortran: Version 19.1.1.217 of Intel Fortran
  Compiler for Linux
- **Parallel:** Yes
- **Firmware:** Lenovo BIOS Version ITE109B released Apr-2020
- **File System:** xfs
- **System State:** Run level 3 (multi-user)
- **Base Pointers:** 64-bit
- **Peak Pointers:** 64-bit
- **Other:** jemalloc memory allocator V5.0.1
- **Power Management:** BIOS set to prefer performance at the cost of additional power usage
Lenovo Global Technology
ThinkSystem ST50
(3.80 GHz, Intel Xeon E-2276G)

CPU2017 License: 9017
Test Sponsor: Lenovo Global Technology
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SPECspeed®2017_fp_base = 33.1
SPECspeed®2017_fp_peak = 33.5

Results Table

| Benchmark      | Threads | Seconds | Ratio | Seconds | Ratio | Seconds | Ratio | Threads | Seconds | Ratio | Seconds | Ratio | Seconds | Ratio | Seconds | Ratio | Seconds | Ratio |
|----------------|---------|---------|-------|---------|-------|---------|-------|---------|---------|-------|---------|-------|---------|-------|---------|-------|
| 603.bwaves_s   | 6       | 745     | 79.2  | 746     | 79.1  | 747     | 79.0  | 6       | 746     | 79.1  | 745     | 79.1  | 746     | 79.1  |
| 607.cactuBSSN_s| 6       | 294     | 56.7  | 294     | 56.7  | 293     | 56.9  | 6       | 294     | 56.7  | 294     | 56.7  | 293     | 56.9  |
| 619.lbm_s      | 6       | 324     | 16.1  | 325     | 16.1  | 324     | 16.2  | 6       | 324     | 16.1  | 325     | 16.1  | 324     | 16.2  |
| 621.wrf_s      | 6       | 336     | 39.4  | 326     | 40.6  | 330     | 40.0  | 6       | 303     | 43.7  | 304     | 43.6  | 308     | 42.9  |
| 628.pop2_s     | 6       | 317     | 37.5  | 316     | 37.5  | 317     | 37.5  | 6       | 317     | 37.5  | 316     | 37.5  | 317     | 37.5  |
| 638.imagick_s  | 6       | 465     | 31.0  | 465     | 31.0  | 465     | 31.0  | 6       | 465     | 31.0  | 465     | 31.0  | 465     | 31.0  |
| 644.nab_s      | 6       | 291     | 60.1  | 291     | 60.1  | 291     | 60.1  | 6       | 278     | 62.8  | 278     | 62.7  | 278     | 62.7  |
| 649.fotonik3d_s| 6       | 523     | 17.4  | 522     | 17.4  | 523     | 17.4  | 6       | 524     | 17.4  | 523     | 17.4  | 523     | 17.4  |
| 654.roms_s     | 6       | 935     | 16.8  | 928     | 17.0  | 927     | 17.0  | 6       | 935     | 16.8  | 928     | 17.0  | 927     | 17.0  |

SPECspeed®2017_fp_base = 33.1
SPECspeed®2017_fp_peak = 33.5

Results appear in the order in which they were run. Bold underlined text indicates a median measurement.

Operating System Notes
Stack size set to unlimited using "ulimit -s unlimited"

Environment Variables Notes
Environment variables set by runcpu before the start of the run:
KMP_AFFINITY = "granularity=fine,compact"
LD_LIBRARY_PATH = 
"/home/cpu2017-1.1.0-ic19.1.1/lib/intel64:/home/cpu2017-1.1.0-ic19.1.1/j
e5.0.1-64"
MALLOC_CONF = "retain:true"
OMP_STACKSIZE = "192M"

General Notes
Binaries compiled on a system with 1x Intel Core i9-7980XE CPU + 64GB RAM
memory using Redhat Enterprise Linux 8.0
Transparent Huge Pages enabled by default
Prior to runcpu invocation
Filesystem page cache synced and cleared with:
sync; echo 3> /proc/sys/vm/drop_caches
Yes: 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)

(Continued on next page)
General Notes (Continued)

is mitigated in the system as tested and documented.
Yes: The test sponsor attests, as of date of publication, that CVE-2018-3640 (Spectre variant 3a)
is mitigated in the system as tested and documented.
Yes: The test sponsor attests, as of date of publication, that CVE-2018-3639 (Spectre variant 4)
is mitigated in the system as tested and documented.
jemalloc, a general purpose malloc implementation
built with the RedHat Enterprise 7.5, and the system compiler gcc 4.8.5

Platform Notes

BIOS configuration:
Hyper-Threading set to Disable

Sysinfo program /home/cpu2017-1.1.0-ic19.1.1/bin/sysinfo
Rev: r6365 of 2019-08-21 295195f888a3d7ed8e6e46a485a0011
running on localhost.localdomain Thu May 28 19:10:51 2020

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 : Intel(R) Xeon(R) E-2276G CPU @ 3.80GHz
  1 "physical id"s (chips)
  6 "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 : 6
siblings : 6
physical 0: cores 0 1 2 3 4 5

From lscpu:
Architecture: x86_64
CPU op-mode(s): 32-bit, 64-bit
Byte Order: Little Endian
CPU(s): 6
On-line CPU(s) list: 0-5
Thread(s) per core: 1
Core(s) per socket: 6
Socket(s): 1
NUMA node(s): 1
Vendor ID: GenuineIntel
CPU family: 6
Model: 158
Model name: Intel(R) Xeon(R) E-2276G CPU @ 3.80GHz

(Continued on next page)
## Lenovo Global Technology

### ThinkSystem ST50
**(3.80 GHz, Intel Xeon E-2276G)**

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**CPU2017 License:** 9017  
**Test Date:** May-2020

**Test Sponsor:** Lenovo Global Technology  
**Hardware Availability:** Mar-2020

**Tested by:** Lenovo Global Technology  
**Software Availability:** Apr-2020

### Platform Notes (Continued)

- **Stepping:** 10
- **CPU MHz:** 4647.685
- **CPU max MHz:** 4900.0000
- **CPU min MHz:** 800.0000
- **BogoMIPS:** 7584.00

**Virtualization:** VT-x

**L1d cache:** 32K  
**L1i cache:** 32K

**L2 cache:** 256K  
**L3 cache:** 12288K

**NUMA node0 CPU(s):** 0-5

**Flags:** fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflush dts acpi mmx fxsr sse sse2 ss ht tm pbe syscall nx pdpe1gb rdtscp lm constant_tsc art arch_perfmon pebs bts rep_good nopl xtopology nonstop_tsc cpuid aperfmperf tsc_known_freq pni pclmulqdq dtes64 monitor ds_cpl vmx smx est tm2 ssse3 sdbg fma cx16 xtpr pdcm pcid sse4_1 sse4_2 x2apic movbe popcnt tsc_deadline_timer aes xsave avx f16c rdrand lahf_lm abm 3dnowprefetch cpuid_fault epb invpcid_single pti ssbd ibrs ibpb stibp tpr_shadow vnmi flexpriority ept vpid fsgsbase tsc_adjust bmi1 hle avx2 smep bmi2 erms invpcid rtm mpx rdseed adx smap clflushopt intel_pt xsaveopt xsavec xgetbv1 xsaves dtherm ida arat pln pts hwp hwp_notify hwp_act_window hwp_epp md_clear flush_lld

/proc/cpuinfo cache data

- **cache size:** 12288 KB

From numactl --hardware

- **available:** 1 nodes (0)
- **node 0 cpus:** 0 1 2 3 4 5
- **node 0 size:** 64254 MB
- **node 0 free:** 63585 MB
- **node distances: node 0:**
  - 0: 10

From /proc/meminfo

- **MemTotal:** 65796896 kB
- **HugePages_Total:** 0
- **Hugepagesize:** 2048 kB

From /etc/*release* /etc/*version*

- **os-release:
  - NAME="Red Hat Enterprise Linux"
  - VERSION="8.1 (Ootpa)"
  - ID="rhel"
  - ID_LIKE="fedora"
  - VERSION_ID="8.1"

(Continued on next page)
## Lenovo Global Technology

**ThinkSystem ST50**  
(3.80 GHz, Intel Xeon E-2276G)

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**Test Sponsor:** Lenovo Global Technology  
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**Hardware Availability:** Mar-2020  
**Tested by:** Lenovo Global Technology  
**Software Availability:** Apr-2020

---

### Platform Notes (Continued)

```plaintext
PLATFORM_ID="platform:el8"
PRETTY_NAME="Red Hat Enterprise Linux 8.1 (Ootpa)"
ANSI_COLOR="0;31"
redhat-release: Red Hat Enterprise Linux release 8.1 (Ootpa)
system-release: Red Hat Enterprise Linux release 8.1 (Ootpa)
system-release-cpe: cpe:/o:redhat:enterprise_linux:8.1:ga
```

```plaintext
uname -a:
Linux localhost.localdomain 4.18.0-147.el8.x86_64 #1 SMP Thu Sep 26 15:52:44 UTC 2019
x86_64 x86_64 x86_64 GNU/Linux
```

Kernel self-reported vulnerability status:

- **CVE-2018-3620 (L1 Terminal Fault):** Mitigation: PTE Inversion; VMX: conditional cache flushes, SMT disabled
- **Microarchitectural Data Sampling:** Mitigation: Clear CPU buffers; SMT disabled
- **CVE-2017-5754 (Meltdown):** Mitigation: PTI
- **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 generic retpoline, IBPB: conditional, IBRS_FW, RSB filling

```plaintext
run-level 3 May 28 19:06
```

```
run-level 3 May 28 19:06
```

### 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.

```plaintext
Memory:
4x SK Hynix HMA82GU7CJR8N-VK 16 GB 2 rank 2666
```

(End of data from sysinfo program)
## Lenovo Global Technology

**ThinkSystem ST50**  
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<td>Apr-2020</td>
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</tbody>
</table>

### SPEC CPU 2017 Floating Point Speed Result

**SPECspeed®2017_fp_base = 33.1**  
**SPECspeed®2017_fp_peak = 33.5**

### Compiler Version Notes

<table>
<thead>
<tr>
<th>Language</th>
<th>Benchmark</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>lbm_s(base, peak)</td>
<td>619.lbm_s(base, peak)</td>
</tr>
<tr>
<td>C</td>
<td>imagick_s(base, peak)</td>
<td>638.imagick_s(base, peak)</td>
</tr>
<tr>
<td>C</td>
<td>nab_s(base, peak)</td>
<td>644.nab_s(base, peak)</td>
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</tbody>
</table>

Intel(R) C Intel(R) 64 Compiler for applications running on Intel(R) 64,  
Version 19.1.1.217 Build 20200306  
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

<table>
<thead>
<tr>
<th>Language</th>
<th>Benchmark</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>C++</td>
<td>cactuBSSN_s(base, peak)</td>
<td>607.cactuBSSN_s(base, peak)</td>
</tr>
</tbody>
</table>

Intel(R) C++ Intel(R) 64 Compiler for applications running on Intel(R) 64,  
Version 19.1.1.217 Build 20200306  
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

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<tr>
<td>Fortran</td>
<td>bwaves_s(base, peak)</td>
<td>603.bwaves_s(base, peak)</td>
</tr>
<tr>
<td>Fortran</td>
<td>fotonik3d_s(base, peak)</td>
<td>649.fotonik3d_s(base, peak)</td>
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<tr>
<td>Fortran</td>
<td>roms_s(base, peak)</td>
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Intel(R) Fortran Intel(R) 64 Compiler for applications running on Intel(R) 64,  
Version 19.1.1.217 Build 20200306  
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<td>wrf_s(base, peak)</td>
<td>621.wrf_s(base, peak)</td>
</tr>
<tr>
<td>Fortran</td>
<td>cam4_s(base, peak)</td>
<td>627.cam4_s(base, peak)</td>
</tr>
<tr>
<td>Fortran</td>
<td>pop2_s(base, peak)</td>
<td>628.pop2_s(base, peak)</td>
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Intel(R) Fortran Intel(R) 64 Compiler for applications running on Intel(R) 64,  
Version 19.1.1.217 Build 20200306  
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.
## Base Compiler Invocation

C benchmarks:
```
icc
```

Fortran benchmarks:
```
ifort
```

Benchmarks using both Fortran and C:
```
ifort icc
```

Benchmarks using Fortran, C, and C++:
```
icpc icc ifort
```

## Base Portability Flags

<table>
<thead>
<tr>
<th>Benchmark</th>
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<tbody>
<tr>
<td>603.bwaves_s</td>
<td>-DSPEC_LP64</td>
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<tr>
<td>607.cactuBSSN_s</td>
<td>-DSPEC_LP64</td>
</tr>
<tr>
<td>619.lbm_s</td>
<td>-DSPEC_LP64</td>
</tr>
<tr>
<td>621.wrf_s</td>
<td>-DSPEC_LP64 -DSPEC_CASE_FLAG -convert big_endian</td>
</tr>
<tr>
<td>627.cam4_s</td>
<td>-DSPEC_LP64 -DSPEC_CASE_FLAG</td>
</tr>
<tr>
<td>628.pop2_s</td>
<td>-DSPEC_LP64 -DSPEC_CASE_FLAG -convert big_endian -assume byterecl</td>
</tr>
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<td>-DSPEC_LP64</td>
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<td>-DSPEC_LP64</td>
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</table>

## Base Optimization Flags

### C benchmarks:
```
-m64 -std=c11 -xCORE-AVX2 -ipo -O3 -no-prec-div -qopt-prefetch
-ffinite-math-only -qopt-mem-layout-trans=4 -qopenmp -DSPEC_OPENMP
-mbranches-within-32B-boundaries
```

### Fortran benchmarks:
```
-m64 -Wl,-z,muldefs -DSPEC_OPENMP -xCORE-AVX2 -ipo -O3 -no-prec-div
-qopt-prefetch -ffinite-math-only -qopt-mem-layout-trans=4 -qopenmp
-nostandard-realloc-lhs -mbranches-within-32B-boundaries
-L/usr/local/jemalloc64-5.0.1/lib -ljemalloc
```

### Benchmarks using both Fortran and C:
```
-m64 -std=c11 -Wl,-z,muldefs -xCORE-AVX2 -ipo -O3 -no-prec-div
-qopt-prefetch -ffinite-math-only -qopt-mem-layout-trans=4 -qopenmp
```
**Lenovo Global Technology**  
ThinkSystem ST50  
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| SPECspeed®2017_fp_base = 33.1 |  |
| SPECspeed®2017_fp_peak = 33.5 |  |

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**Hardware Availability:** Mar-2020  
**Software Availability:** Apr-2020

---

**Base Optimization Flags (Continued)**

Benchmarks using both Fortran and C (continued):
- `-DSPEC_OPENMP`  
- `mbranches-within-32B-boundaries`  
- `nostandard-realloc-lhs`  
- `-L/usr/local/jemalloc64-5.0.1/lib -ljemalloc`

Benchmarks using Fortran, C, and C++:
- `-m64`  
- `-std=c11`  
- `-Wl,-z,muldefs`  
- `-xCORE-AVX2`  
- `-ipo`  
- `-O3`  
- `-no-prec-div`  
- `-qopt-prefetch`  
- `-ffinite-math-only`  
- `-qopt-mem-layout-trans=4`  
- `-qopenmp`  
- `-DSPEC_OPENMP`  
- `mbranches-within-32B-boundaries`  
- `nostandard-realloc-lhs`  
- `-L/usr/local/jemalloc64-5.0.1/lib -ljemalloc`

---

**Peak Compiler Invocation**

C benchmarks:
- `icc`

Fortran benchmarks:
- `ifort`

Benchmarks using both Fortran and C:
- `ifort icc`

Benchmarks using Fortran, C, and C++:
- `icpc icc ifort`

---

**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`: `-m64`  
- `-std=c11`  
- `-Wl,-z,muldefs`  
- `-xCORE-AVX2`  
- `-ipo`  
- `-O3`  
- `-no-prec-div`  
- `-qopt-prefetch`  
- `-ffinite-math-only`  
- `-qopt-mem-layout-trans=4`  
- `-qopenmp`  
- `-DSPEC_OPENMP`  
- `-mbranches-within-32B-boundaries`
Lenovo Global Technology
ThinkSystem ST50
(3.80 GHz, Intel Xeon E-2276G)

Peak Optimization Flags (Continued)

644.nab_s (continued):
-L/usr/local/jemalloc64-5.0.1/lib -ljemalloc

Fortran benchmarks:

603.bwaves_s: -m64 -W1,-z,muldefs -prof-gen(pass 1) -prof-use(pass 2)
-DSPEC_SUPPRESS_OPENMP -DSPEC_OPENMP -ipo -xCORE-AVX2
-O3 -no-prec-div -qopt-prefetch -ffinite-math-only
-qopt-mem-layout-trans=4 -qopenmp -nostandard-realloc-lhs
-mbranches-within-32B-boundaries
-L/usr/local/jemalloc64-5.0.1/lib -ljemalloc

649.fotonik3d_s: Same as 603.bwaves_s

654.roms_s: basepeak = yes

Benchmarks using both Fortran and C:

621.wrf_s: -m64 -std=c11 -W1,-z,muldefs -prof-gen(pass 1)
-no-prec-div -ipo -xCORE-AVX2 -O3 -qopt-prefetch
-qopt-mem-layout-trans=4 -qopenmp -DSPEC_OPENMP
-mbranches-within-32B-boundaries -nostandard-realloc-lhs
-L/usr/local/jemalloc64-5.0.1/lib -ljemalloc

627.cam4_s: basepeak = yes

628.pop2_s: basepeak = yes

Benchmarks using Fortran, C, and C++:

607.cactuBSSN_s: basepeak = yes
## Lenovo Global Technology

**ThinkSystem ST50**  
(3.80 GHz, Intel Xeon E-2276G)

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<td>Apr-2020</td>
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</tbody>
</table>

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