Lenovo Global Technology
ThinkSystem ST50
(3.50 GHz, Intel Xeon E-2224G)

SPECrate®2017_int_base = 31.5
SPECrate®2017_int_peak = 32.5

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

Hardware
CPU Name: Intel Xeon E-2224G
Max MHz: 4700
Nominal: 3500
Enabled: 4 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: 8 MB I+D on chip per chip
Other: None
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
C/C++: Compiler for Linux;
Fortran: Version 19.1.1.217 of Intel Fortran
Compiler for Linux
Parallel: No
Firmware: Lenovo BIOS Version ITE109B released Apr-2020
File System: xfs
System State: Run level 3 (multi-user)
Base Pointers: 64-bit
Peak Pointers: 32/64-bit
Other: jemalloc memory allocator V5.0.1
Power Management: BIOS set to prefer performance at the cost of additional power usage
SPEC CPU®2017 Integer Rate Result

Lenovo Global Technology
ThinkSystem ST50
(3.50 GHz, Intel Xeon E-2224G)

SPECrate®2017_int_base = 31.5
SPECrate®2017_int_peak = 32.5

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<th>Ratio</th>
<th>Seconds</th>
<th>Ratio</th>
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<td>4</td>
<td>272</td>
<td>23.4</td>
<td>274</td>
<td>23.3</td>
<td>272</td>
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<td>199</td>
<td><strong>28.5</strong></td>
<td>199</td>
<td>28.5</td>
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<td>28.4</td>
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<tr>
<td>505.mcf_r</td>
<td>4</td>
<td>127</td>
<td>51.1</td>
<td>127</td>
<td>50.7</td>
<td>127</td>
<td><strong>51.0</strong></td>
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<tr>
<td>520.omnetpp_r</td>
<td>4</td>
<td>289</td>
<td>18.2</td>
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</tr>
<tr>
<td>523.xalanbmkm_r</td>
<td>4</td>
<td>101</td>
<td>41.9</td>
<td><strong>101</strong></td>
<td><strong>41.8</strong></td>
<td>102</td>
<td>41.3</td>
</tr>
<tr>
<td>525.x264_r</td>
<td>4</td>
<td>98.3</td>
<td>71.3</td>
<td>97.0</td>
<td>72.2</td>
<td><strong>97.6</strong></td>
<td><strong>71.7</strong></td>
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<tr>
<td>531.deepsjeng_r</td>
<td>4</td>
<td>183</td>
<td>25.0</td>
<td>182</td>
<td>25.2</td>
<td><strong>182</strong></td>
<td><strong>25.1</strong></td>
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<td>541.leela_r</td>
<td>4</td>
<td><strong>318</strong></td>
<td><strong>20.8</strong></td>
<td>317</td>
<td>20.9</td>
<td>319</td>
<td>20.8</td>
</tr>
<tr>
<td>548.exchange2_r</td>
<td>4</td>
<td>156</td>
<td><strong>67.3</strong></td>
<td>156</td>
<td>67.1</td>
<td>155</td>
<td>67.8</td>
</tr>
<tr>
<td>557.xz_r</td>
<td>4</td>
<td>290</td>
<td>14.9</td>
<td>291</td>
<td>14.9</td>
<td><strong>290</strong></td>
<td><strong>14.9</strong></td>
</tr>
</tbody>
</table>

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

Compiler Notes
The inconsistent Compiler version information under Compiler Version section is due to a discrepancy in Intel Compiler. The correct version of C/C++ compiler is: Version 19.1.1.217 Build 20200306 Compiler for Linux
The correct version of Fortran compiler is: Version 19.1.1.217 Build 20200306 Compiler for Linux

Submit Notes
The taskset mechanism was used to bind copies to processors. The config file option 'submit' was used to generate taskset commands to bind each copy to a specific processor. For details, please see the config file.

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:
LD_LIBRARY_PATH = "/home/cpu2017-1.1.0-ic19.1.1/lib/intel64:/home/cpu2017-1.1.0-ic19.1.1/lib/ia32:/home/cpu2017-1.1.0-ic19.1.1/je5.0.1-32"
MALLOC_CONF = "retain:true"
Lenovo Global Technology
ThinkSystem ST50
(3.50 GHz, Intel Xeon E-2224G)
SPECrate®2017_int_base = 31.5
SPECrate®2017_int_peak = 32.5

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

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) 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:
ICE Performance Mode set to 4HD Cooling Mode

Sysinfo program /home/cpu2017-1.1.0-ic19.1.1/bin/sysinfo
Rev: r6365 of 2019-08-21 295195f888a3d7ed16e6e46a485a0011
running on localhost.localdomain Sun Jun  7 14:38:05 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-2224G CPU @ 3.50GHz
        1 "physical id"s (chips)
        4 "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 : 4
   siblings : 4
   physical 0: cores 0 1 2 3

From lscpu:
   Architecture: x86_64
   CPU op-mode(s): 32-bit, 64-bit
   Byte Order: Little Endian
   CPU(s): 4
   On-line CPU(s) list: 0-3
   Thread(s) per core: 1
Platform Notes (Continued)

Core(s) per socket:  4
Socket(s):  1
NUMA node(s):  1
Vendor ID:  GenuineIntel
CPU family:  6
Model:  158
Model name:  Intel(R) Xeon(R) E-2224G CPU @ 3.50GHz
Stepping:  10
CPU MHz:  4575.541
CPU max MHz:  4700.0000
CPU min MHz:  800.0000
BogoMIPS:  7008.00
Virtualization:  VT-x
L1d cache:  32K
L1i cache:  32K
L2 cache:  256K
L3 cache:  8192K
NUMA node0 CPU(s):  0-3
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 rdscpl
lm constant_tsc arch_perfmon pebs bts rep_good nopl xtopology nonstop_tsc cpuid
aperfperf tsc_known_freq pni pclmulqdq dtes64 monitor ds_cpl vmx smx est tm2 ssse3
sdmb fma cx16 xtrr pdcm pclid sse4_1 sse4_2 x2apic movbe popcnt tsc_deadline_timer
aes xsave avx f16c rdrand lahf_lm abml 3nowprefetch cpuid_fault epb invpcid_single
pti ssbd ibrs ibpb stibp tpr_shadow vmmi flexpriority ept vpid fsgsbase tsc_adjust
bmi1 hle avx2 smep bmi2 erms invpcid rtm mpx rdseed adx smap clflushopt intel_pt
xsavesopt x saves xgetbv1 xsavec xgetbv1 xsavee opt xsave xgetbv1 xsaves dtherm ida arat pln pts hwp hwp_notify hwp_act_window
hwp_epp md_clear flush_lld

From /proc/cpuinfo cache data
    cache size : 8192 KB

From numactl --hardware  WARNING: a numactl 'node' might or might not correspond to a
    physical chip.
    available: 1 nodes (0)
    node 0 cpus: 0 1 2 3
    node 0 size: 64256 MB
    node 0 free: 63583 MB
    node distances:
        node 0
    0: 10

From /proc/meminfo
    MemTotal:  65798296 kB
    HugePages_Total: 0
    Hugepagesize: 2048 kB

(Continued on next page)
SPEC CPU®2017 Integer Rate Result

Lenovo Global Technology
ThinkSystem ST50
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CPU2017 License: 9017
Test Sponsor: Lenovo Global Technology
Tested by: Lenovo Global Technology

Platform Notes (Continued)

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

```
NAME="Red Hat Enterprise Linux"
VERSION="8.1 (Ootpa)"
ID="rhel"
ID_LIKE="fedora"
VERSION_ID="8.1"
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

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, STIBP: disabled, RSB
```

run-level 3 Jun 7 14:37

SPEC is set to: /home/cpu2017-1.1.0-ic19.1.1
```
Filesystem Type Size Used Avail Use% Mounted on
/dev/sda3 xfs 812G 66G 747G 9% /home
```

From /sys/devices/virtual/dmi/id
BIOS: LENOVO ITE109B 04/24/2020
Vendor: LENOVO
Product: INVALID
Product Family: Lenovo Product
Serial: INVALID

Additional information from dmidecode follows. WARNING: Use caution when you interpret
this section. The 'dmidecode' program reads system data which is "intended to allow

(Continued on next page)
Lenovo Global Technology
ThinkSystem ST50
(3.50 GHz, Intel Xeon E-2224G)

SPEC CPU®2017 Integer Rate Result

Copyright 2017-2020 Standard Performance Evaluation Corporation

Lenovo Global Technology

SPECrate®2017_int_base = 31.5

SPECrate®2017_int_peak = 32.5

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

Test Date: Jun-2020
Hardware Availability: Mar-2020
Software Availability: Apr-2020

Platform Notes (Continued)

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

(End of data from sysinfo program)

Compiler Version Notes

==============================================================================
C       | 502.gcc_r(peak)
------------------------------------------------------------------------------
Intel(R) C Compiler for applications running on IA-32, Version 2021.1 NextGen Build 20200304
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

==============================================================================
C       | 500.perlbench_r(base) 502.gcc_r(base) 505.mcf_r(base, peak)
         | 525.x264_r(base, peak) 557.xz_r(base)
Intel(R) C Compiler for applications running on Intel(R) 64, Version 2021.1 NextGen Build 20200304
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

==============================================================================
C       | 500.perlbench_r(peak) 557.xz_r(peak)
------------------------------------------------------------------------------
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.

==============================================================================
C       | 502.gcc_r(peak)
------------------------------------------------------------------------------
Intel(R) C Compiler for applications running on IA-32, Version 2021.1 NextGen Build 20200304
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

==============================================================================
C       | 500.perlbench_r(base) 502.gcc_r(base) 505.mcf_r(base, peak)
         | 525.x264_r(base, peak) 557.xz_r(base)
(Continued on next page)
## Lenovo Global Technology

ThinkSystem ST50
(3.50 GHz, Intel Xeon E-2224G)

| SPECrate®2017_int_base = 31.5 |
| SPECrate®2017_int_peak = 32.5 |

**CPU2017 License:** 9017  
**Test Sponsor:** Lenovo Global Technology  
**Test Date:** Jun-2020  
**Tested by:** Lenovo Global Technology  
**Hardware Availability:** Mar-2020  
**Software Availability:** Apr-2020

### Compiler Version Notes (Continued)

Intel(R) C Compiler for applications running on Intel(R) 64, Version 2021.1  
NextGen Build 20200304  
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

```
C       | 500.perlbench_r(peak) 557.xz_r(peak)
```

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

```
C       | 502.gcc_r(peak)
```

Intel(R) C Compiler for applications running on IA-32, Version 2021.1 NextGen Build 20200304  
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

```
C       | 500.perlbench_r(base) 502.gcc_r(base) 505.mcf_r(base, peak) 525.x264_r(base, peak) 557.xz_r(base)
```

Intel(R) C Compiler for applications running on Intel(R) 64, Version 2021.1  
NextGen Build 20200304  
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

```
C       | 500.perlbench_r(peak) 557.xz_r(peak)
```

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

```
C++     | 520.omnetpp_r(base, peak) 523.xalancbmk_r(base, peak) 531.deepsjeng_r(base, peak) 541.leela_r(base, peak)
```

Intel(R) C++ Compiler for applications running on Intel(R) 64, Version 2021.1  
NextGen Build 20200304  
Copyright (C) 1985-2020 Intel Corporation. All rights reserved.

(Continued on next page)
**Compiler Version Notes (Continued)**

Fortran | 548.exchange2_r(base, peak)

---

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

C++ benchmarks:
- icpc

Fortran benchmarks:
- ifort

**Base Portability Flags**

500.perlbench_r: -DSPEC_LP64 -DSPEC_LINUX_X64
502.gcc_r: -DSPEC_LP64
505.mcf_r: -DSPEC_LP64
520.omnetpp_r: -DSPEC_LP64
523.xalancbmk_r: -DSPEC_LP64 -DSPEC_LINUX
525.x264_r: -DSPEC_LP64
531.deepsjeng_r: -DSPEC_LP64
541.leela_r: -DSPEC_LP64
548.exchange2_r: -DSPEC_LP64
557.xz_r: -DSPEC_LP64

**Base Optimization Flags**

C benchmarks:
- m64 -qnextgen -std=c11
- W1,-plugin-opt=-x86-branches-within-32B-boundaries -W1,-z,muldefs
- xCORE-AVX2 -O3 -ffast-math -flto -mfpmath=sse -funroll-loops
- fuse=ld=gold -qopt-mem-layout-trans=4
- L/usr/local/IntelCompiler19/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin
  -lqkmalloc

(Continued on next page)
## Lenovo Global Technology

### SPEC CPU®2017 Integer Rate Result

**ThinkSystem ST50**
(3.50 GHz, Intel Xeon E-2224G)

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>SPECrate 2017_int_base</th>
<th>SPECrate 2017_int_peak</th>
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<tr>
<td></td>
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<td>32.5</td>
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**CPU2017 License:** 9017  
**Test Date:** Jun-2020  
**Test Sponsor:** Lenovo Global Technology  
**Tested by:** Lenovo Global Technology  
**Hardware Availability:** Mar-2020  
**Software Availability:** Apr-2020  

### Base Optimization Flags (Continued)

#### C++ benchmarks:
- `-m64`  
- `-qnextgen`  
- `-Wl,-plugin-opt=-x86-branches-within-32B-boundaries`  
- `-Wl,-z,muldefs`  
- `-xCORE-AVX2`  
- `-O3`  
- `-ffast-math`  
- `-flto`  
- `-mfpmath=sse`  
- `-funroll-loops`  
- `-fuse-ld=gold`  
- `-qopt-mem-layout-trans=4`  
- `-L/usr/local/IntelCompiler19/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin`  
- `-lqkmalloc`  

#### Fortran benchmarks:
- `-m64`  
- `-Wl,-plugin-opt=-x86-branches-within-32B-boundaries`  
- `-Wl,-z,muldefs`  
- `-xCORE-AVX2`  
- `-O3`  
- `-ipo`  
- `-no-prec-div`  
- `-qopt-mem-layout-trans=4`  
- `-nostandard-realloc-lhs`  
- `-align array32byte`  
- `-auto`  
- `-mbranches-within-32B-boundaries`  
- `-L/usr/local/IntelCompiler19/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin`  
- `-lqkmalloc`  

### Peak Compiler Invocation

#### C benchmarks:
- `icc`

#### C++ benchmarks:
- `icpc`

#### Fortran benchmarks:
- `ifort`

### Peak Portability Flags

500.perlbench_r: `-DSPEC_LP64`  
502.gcc_r: `-D_FILE_OFFSET_BITS=64`  
505.mcf_r: `-DSPEC_LP64`  
520.omnetpp_r: `-DSPEC_LP64`  
523.xalancbmk_r: `-DSPEC_LP64`  
525.x264_r: `-DSPEC_LP64`  
531.deepsjeng_r: `-DSPEC_LP64`  
541.leela_r: `-DSPEC_LP64`  
548.exchange2_r: `-DSPEC_LP64`  
557.xz_r: `-DSPEC_LP64`
Lenovo Global Technology
ThinkSystem ST50
(3.50 GHz, Intel Xeon E-2224G)

SPECrater®2017_int_base = 31.5
SPECrater®2017_int_peak = 32.5

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

Test Date: Jun-2020
Hardware Availability: Mar-2020
Software Availability: Apr-2020

Peak Optimization Flags

C benchmarks:

500.perlbuch_r: -Wl,-z,muldefs -prof-gen(pass 1) -prof-use(pass 2)
-xCORE-AVX2 -ipo -O3 -no-prec-div
-qopt-mem-layout-trans=4 -fno-strict-overflow
-mbranches-within-32B-boundaries
-L/usr/local/IntelCompiler19/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin
-lqkmalloc

502.gcc_r: -m32
-L/usr/local/IntelCompiler19/compilers_and_libraries_2020.1.217/linux/compiler/lib/ia32_lin
-std=gnu89
-Wl,-plugin-opt=-x86-branches-within-32B-boundaries
-Wl,-z,muldefs -fprofile-generate(pass 1)
-fprofile-use=default.profdata(pass 2) -xCORE-AVX2 -flto
-Ofast(pass 1) -O3 -ffast-math -qnextgen -fuse-ld=gold
-qopt-mem-layout-trans=4 -L/usr/local/jemalloc32-5.0.1/lib
-ljemalloc

505.mcf_r: basepeak = yes

525.x264_r: -m64 -qnextgen -std=c11
-Wl,-plugin-opt=-x86-branches-within-32B-boundaries
-Wl,-z,muldefs -xCORE-AVX2 -flto -O3 -ffast-math
-fuse-ld=gold -qopt-mem-layout-trans=4 -fno-alias
-L/usr/local/IntelCompiler19/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin
-lqkmalloc

557.xz_r: -Wl,-z,muldefs -xCORE-AVX2 -ipo -O3 -no-prec-div
-qopt-mem-layout-trans=4 -mbranches-within-32B-boundaries
-L/usr/local/IntelCompiler19/compilers_and_libraries_2020.1.217/linux/compiler/lib/intel64_lin
-lqkmalloc

C++ benchmarks:

520.omnetpp_r: basepeak = yes

523.xalancbmk_r: basepeak = yes

531.deepsjeng_r: basepeak = yes

541.leela_r: basepeak = yes

Fortran benchmarks:

(Continued on next page)
Lenovo Global Technology
ThinkSystem ST50
(3.50 GHz, Intel Xeon E-2224G)

SPECrate®2017_int_base = 31.5
SPECrate®2017_int_peak = 32.5

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

Test Date: Jun-2020
Hardware Availability: Mar-2020
Software Availability: Apr-2020

Peak Optimization Flags (Continued)

548.exchange2_r: basepeak = yes

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-CFL-B.html

You can also download the XML flags sources by saving the following links:
http://www.spec.org/cpu2017/flags/Intel-ic19.1u1-official-linux64_revA.xml
http://www.spec.org/cpu2017/flags/Lenovo-Platform-SPECcpu2017-Flags-V1.2-CFL-B.xml

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For questions about this result, please contact the tester. For other inquiries, please contact info@spec.org.

Tested with SPEC CPU®2017 v1.1.0 on 2020-06-07 02:38:05-0400.
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