What’s New & Performance

Dr. Stefan Reimbold

19. Juni 2020

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Notes:

Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.
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Agenda

- Distributions
- IBM z15 and LinuxONE III
- Performance
- Kernel News

Distributions

What is available today

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Support Matrix

● **Certified by Linux partner**

For detailed version levels see the information below.

Overview shows Linux distributions in service.

Extended support is available for Linux distributions that are out of service.

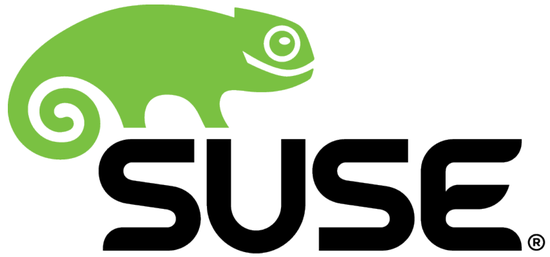
	z15	z14 M0x	z14 ZR1	z13	z13s	zEnterprise – zEC12, zBC12	zEnterprise – z196, z114	System z10, System z9
	LinuxONE III	Emperor II	Rockhopper II	Emperor	Rockhopper			
RHEL 8	●	●	●	●	●			
RHEL 7	●	●	●	●	●	●	●	
RHEL 6	●	●	●	●	●	●	●	●
RHEL 5				●		●	●	●
SLES 15	●	●	●	●	●	●		
SLES 12	●	●	●	●	●	●	●	
SLES 11		●	●	●	●	●	●	●
Ubuntu 18.04	●	●	●	●	●	●		
Ubuntu 16.04	●	●	●	●	●	●		

Last update 11/26/2019

See www.ibm.com/systems/z/os/linux/resources/testedplatforms.html for latest updates and details.

SUSE Linux Enterprise Server

- **SUSE Linux Enterprise Server 11**
  - 03/2009 SLES11 GA - Kernel 2.6.27, GCC 4.3.3
  - 07/2015 SLES11 SP4 - Kernel 3.0, GCC 4.3.4
  - End of Service 31 Mar 2019 (LTSS 31 Mar 2022)
- **SUSE Linux Enterprise Server 12**
  - 10/2014 SLES12 GA - Kernel 3.12, GCC 4.8
  - 12/2019 SLES12 SP5 - Kernel 4.12, GCC 4.8
  - End of Service 31 Oct 2024 (LTSS 31 Oct 2027)
- **SUSE Linux Enterprise Server 15**
  - 07/2018 SLES15 GA - Kernel 4.12, GCC 7.1 & 7.3
  - 06/2019 SLES15 SP1 - Kernel 4.12, GCC 7.3 & 8.2
  - End of Service 31 Oct 2028 (LTSS: 31 Oct 2031)



Red Hat Enterprise Linux

- **Red Hat Enterprise Linux 6**
  - 11/2010 RHEL6 GA - Kernel 2.6.32, GCC 4.4.0
  - 06/2018 RHEL6 Update 10
  - EOS 30 Nov. 2020 (ELS 30 June 2024)

- **Red Hat Enterprise Linux 7**
  - 06/2014 RHEL7 GA - Kernel 3.10, GCC 4.8
  - 08/2019 RHEL7 Update 7
  - EOS 30 Jun. 2024 (ELS tbd)

- **Red Hat Enterprise Linux 8**
  - 05/2019 RHEL8 GA - Kernel 4.18, GCC 8.2.1
  - 11/2019 RHEL 8 Update 1
  - EOS May 2029 (ELS tbd)

Ubuntu

- Ubuntu 16.04 (Xenial Xerus)
  - 04/2016 Ubuntu 16.04 GA: Kernel 4.4, GCC 5.3.0+ LTS-Release
  - 02/2019 Ubuntu 16.04.06 LTS
  - End of Service 04/2021
- Ubuntu 18.04 (Bionic Beaver)
  - 04/2018 Ubuntu 18.04 GA: Kernel 4.15, GCC 7.2.0 LTS-Release
  - 08/2019 Ubuntu 18.04.03
  - End of Service 04/2023
- Lifecycle
  - Regular releases every 6 months and supported for 9 months
  - LTS releases every 2 years and supported for 5 years
  - LTS enablement stack will provide newer kernels within LTS releases
  - http://www.ubuntu.com/info/release-end-of-life

IBM z15 and LinuxOne III

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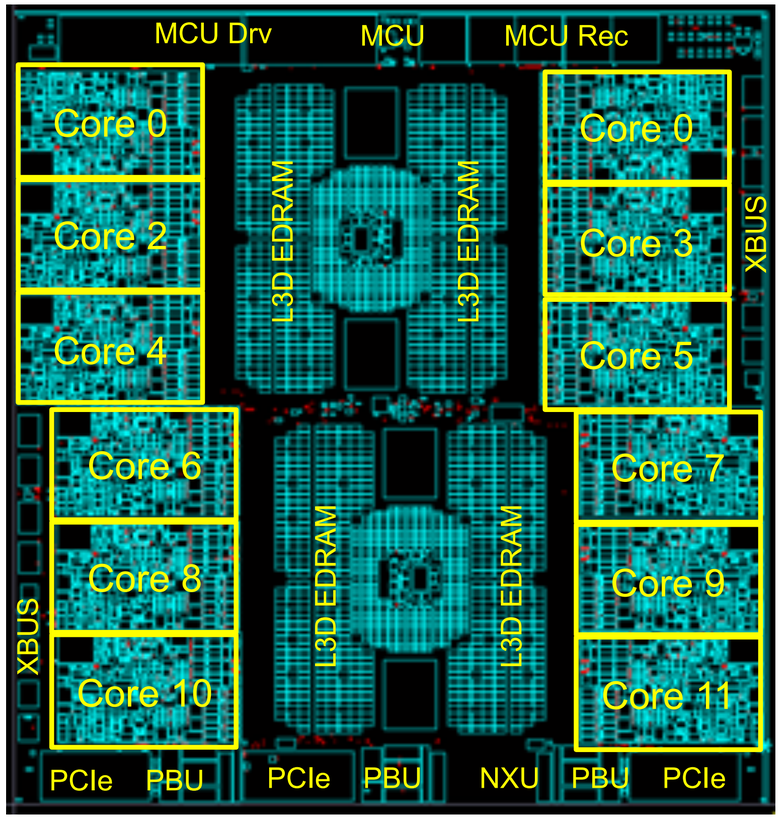
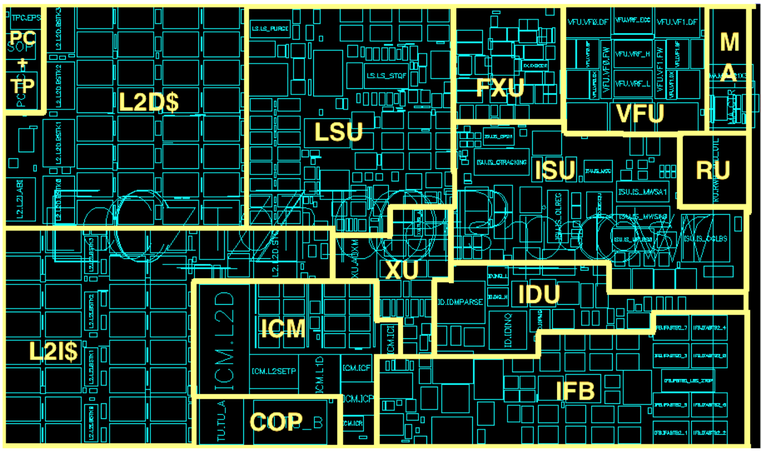
Overview

- **19“** industry standard form factor
- New on-chip compression acceleration





- 14nm SOI technology
- 17 layers of metal
- 5.2 GHz

- 12 cores per CP-chip
- Increased cache sizes:
  - 2x L2 on-chip
  - 1.4x L4
- **14%** single thread performance improvement
- **40 TB** max memory
- **190** usable cores

Toleration Support

- Linux distributions
  - Red Hat RHEL 7.6
  - Red Hat RHEL 6.10
  - SUSE SLES 12 SP4 maintweb
  - SUSE SLES 11 SP4 maintweb
  - Ubuntu 18.04 LTS
  - Red Hat RHEL 8.0 z stream if needed
  - SUSE SLES 15 SP1 maintweb if needed
  - Ubuntu 16.04 LTS

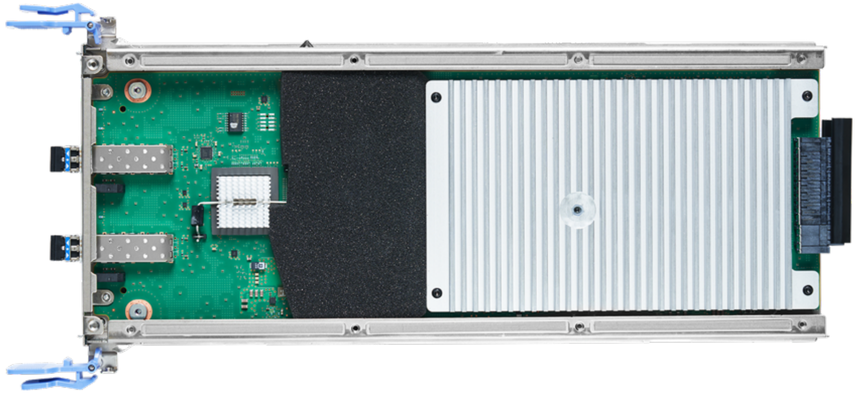
- z/VM Hypervisor
  - z/VM 7.1
  - z/VM 6.4

- KVM Hypervisor
  - Red Hat RHEL 7.6 alt
  - SUSE SLES 12 SP4
  - Ubuntu 18.04 LTS

  - Red Hat RHEL 8.0 z stream if needed
  - SUSE SLES 15 SP1 maintweb if needed

IBM FICON Express16SA

- Same performance as FICON Express16S+
- Increased performance compared to FICON Express 16S
- Exploited transparently, no distro support required



IBM OSA-Express7S

- 25 GbE networking adapter
- Strictly requires 25GbE optics and switches – no dynamic switching to 10GbE
- The IBM Z specific `qeth` Linux driver is used for IBM OSA-Express7S
  - Existing driver works without changes
  - kernel patch required to report correct link speed
  - Likewise `qethqoat` (part of s390-tools) to report correct model generation

IBM RoCE Express2.1

- 25 GbE networking adapter
- Strictly requires 25GbE optics and switches – no dynamic switching to 10GbE
- Vendor-provided mlx5 Linux driver required

IBM Crypto Express7S

- Toleration - treated as CEX6S
- Supported by latest release of RHEL 7, RHEL 8, SLES 12, SLES 15, Ubuntu 18.04

I/O Features

- (**New**) Crypto Express7S (CEX7S)
  - Toleration: Treated as a CEX6S
  - Supported by latest releases of RHEL 7, RHEL 8, SLES 12, SLES 15, Ubuntu 18.04
- FICON Express16SA
  - Same performance as FICON Express16S+
  - Exploited transparently, no distro support required
- New RoCE Express2.1 10 and 25 GbE
  - (**New**) Now up to 16 features per system
- OSA-Express7S 25 GbE SR1.1
  - (**New**) 10 and 1 GbE features in addition to 25 GbE now available

New Vector Instructions

- Reported with new feature flags in `/proc/cpuinfo`
  - `vxp`
  - `vxe2`
- Examples for use of new vector instructions
  - Vector alignment hints
  - Vector Byte and element swaps
  - Vector substring search in `strstr()` and `memmem()`
- Exploited (among others) in
  - GCC 9.1
  - glibc 2.30
  - LLVM 9.0.0

Secure Boot for SCSI IPL

- Part of the **Pervasive Encryption** effort
- Ensure that only code is loaded during IPL that is
  - signed by a trusted distribution vendor (currently: Red Hat, SUSE or Canonical)
  - unmodified
- Kernel image and `zipl` boot record must be signed
- `zipl` tool creates signature entries for SCSI IPL
- New switch on HMC enables secure boot
- Firmware checks signatures and stops IPL on mismatch
- `/sys/firmware/ipl/has_secure` indicates support
- `/sys/firmware/ipl/secure` indicates IPL using secure boot
- zipl option `secure="auto/0/1"`
  0 - disable secure boot
  1 - enforce secure boot
  auto - enable secure boot if system supports it and image/stage3 signed
- Support available in Kernel 5.3

Performance

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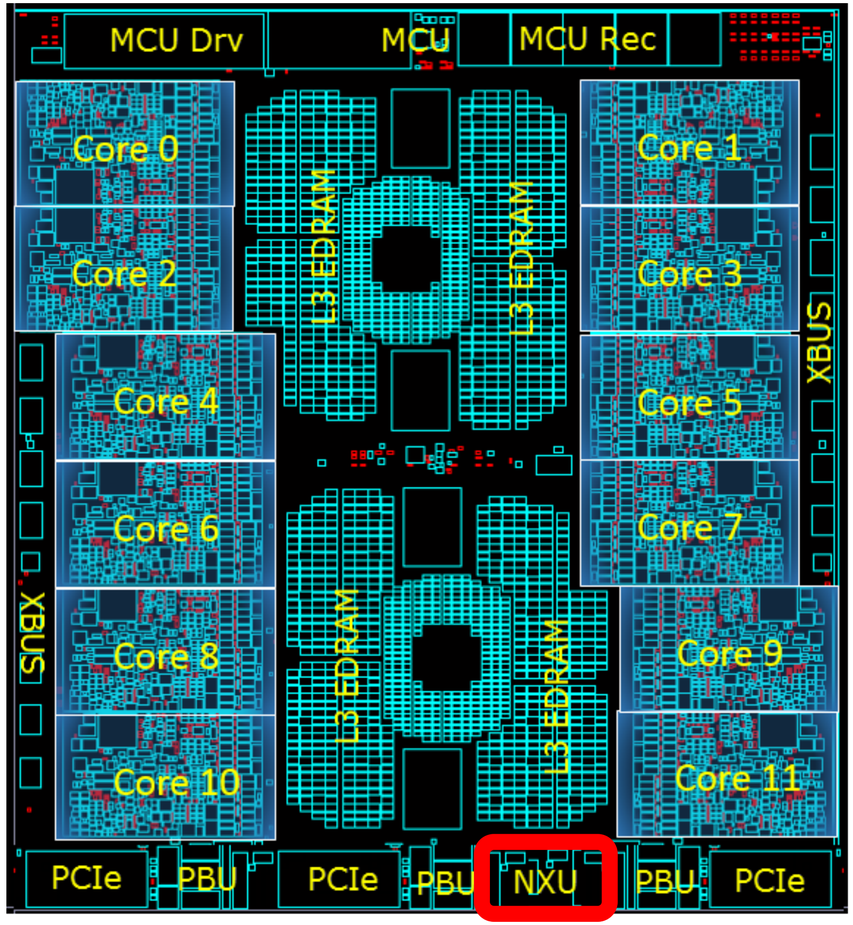
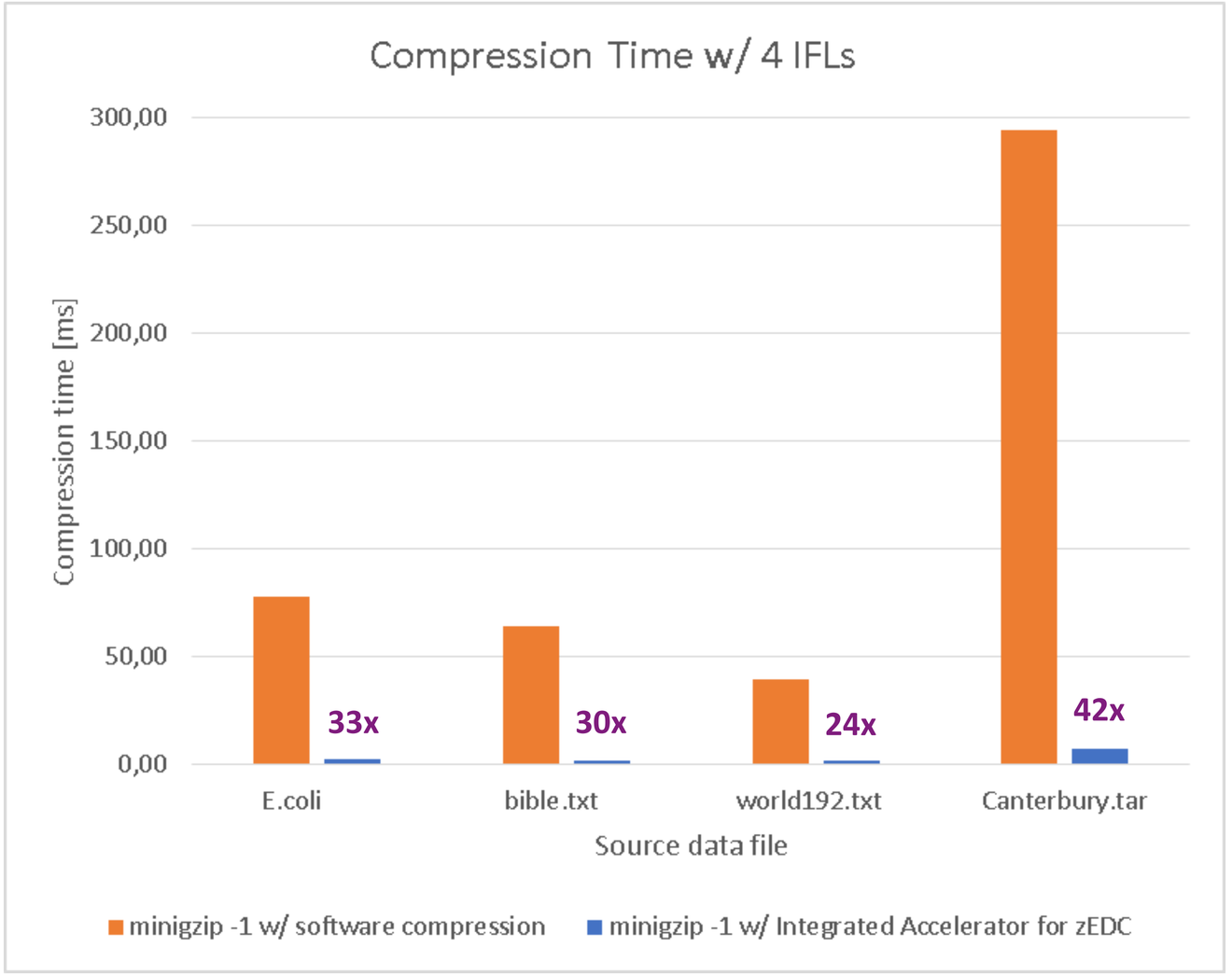
Integrated Accelerator for zEDC



12.5 8.1 19.10

Compression Time with Integrated Accelerator for zEDC versus Software Compression on z15

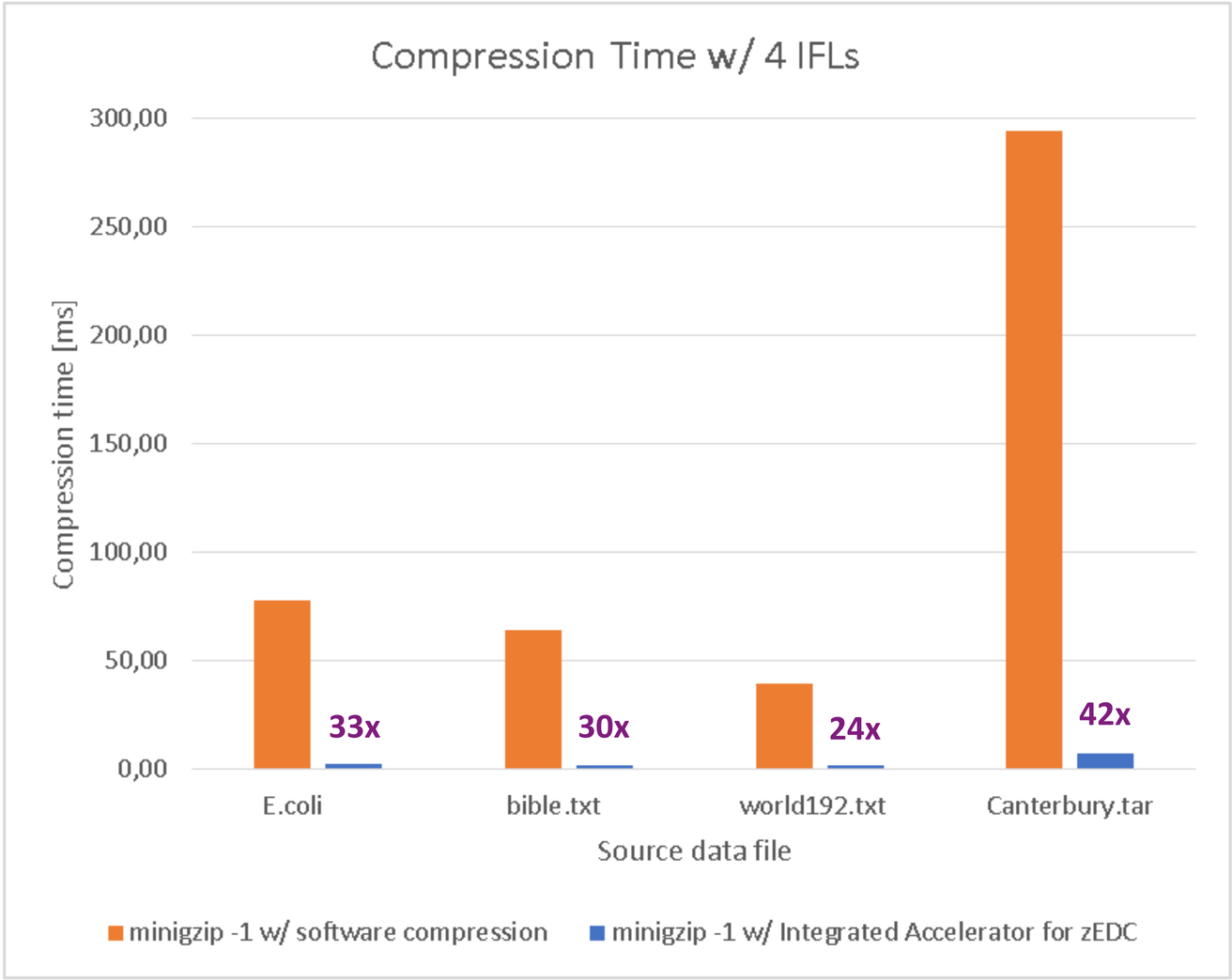
Compress data with zlib on z15 with 4 IFLs up to 42x faster with Integrated Accelerator for zEDC compared to using software compression



DISCLAIMER: Performance results based on IBM internal tests running the minigzip benchmark with compression level -1 from the dfl tcc branch of zlib (downloaded from https://github.com/iii-i/zlib/tree/dfltcc-20190708). Source data files were taken from the Large Corpus (downloaded from http://corpus.canterbury.ac.nz/descriptions). Canterbury.tar contained all files from all corpora. Results may vary. z15 configuration: LPAR with 4 dedicated IFLs, 64 GB memory, 40 GB DASD storage, SLES 12 SP4 (SMT mode).

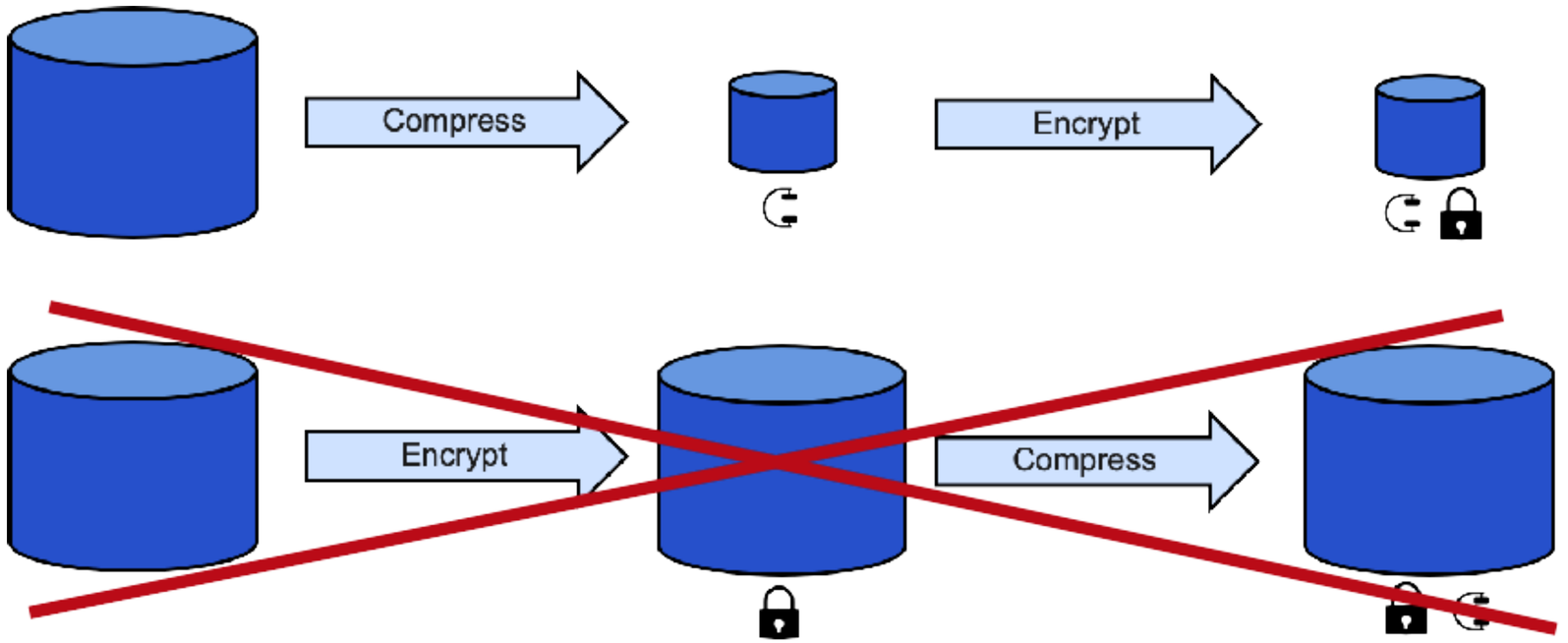
Integrated Accelerator for zEDC

- Data compress and uncompress using new hardware instruction
- Reported with new feature flag in `/proc/cpuinfo: dflt`
- Compression equivalent to **gzip -1**
  - -1 is fastest
  - -9 slowest
  - default is -6
- Can be exploited e.g. by **zlib**
- Compress data with zlib on IBM z15 up to **42x faster** compared to software compression



Integrated Accelerator for zEDC

- **Note:** Sequence of compression and encryption is essential



Integrated Accelerator for zEDC

Filename	Filesize	HW Speedup Factor X
Canterbury Corpus		
alice29.txt	152089	3,7
ptt5	513216	5,0
fields.c	11150	1,2
kennedy.xls	1029744	9,3
sum	38240	1,7
lcet10.txt	426754	7,7
plrabn12.txt	481861	9,4
cp.html	24603	1,4
grammar.lsp	3721	1,1
xargs.1	4227	1,0
asyoulik.txt	125179	3,2
Artificial Corpus		
a.txt	1	1,0
aaa.txt	100000	1,3
alphabet.txt	100000	1,3
random.txt	100000	4,6
Large Corpus		
E.coli	4638690	33,9
bible.txt	4047392	30,3
world192.txt	2473400	24,0

Filename	Filesize	HW Speedup Factor X
Miscellaneous Corpus		
pi.txt	1000000	13,3
Calgary Corpus		
bib	111261	2,8
book1	768771	13,6
book2	610856	10,1
geo	102400	4,1
news	377109	7,3
obj1	21504	1,5
obj2	246814	5,5
paper1	53161	1,8
paper2	82199	2,4
pic	513216	5,0
progc	39611	1,6
progl	71646	1,9
progp	49379	1,5
trans	93695	1,9
Canterbury Corpus Complete		
Canterbury.tar	18606080	42,0

tar Archives

- Software compression (default -6)

```
# time tar cvfz linux-5.0.20.tar.gz linux-5.0.20 > /dev/null
real    0m22.237s
user    0m22.138s
sys     0m0.572s
```

- Software Compression (fastest)

```
# time DFLTCC=0 GZIP=-1 tar cvfz linux-5.0.20.tar.gz linux-5.0.20 > /dev/null
real    0m13.019s
user    0m12.898s
sys     0m0.566s
```

19x faster

- Hardware Compression

```
# time DFLTCC=1 GZIP=-1 tar cvfz linux-5.0.20.tar.gz linux-5.0.20 > /dev/null
real    0m0.668s
user    0m0.172s
sys     0m0.666s
```

tar Archives

- Hardware compression

```
-rw-r--r--  1 root root 208482011 Feb 21 11:29 linux-5.0.20.tar.gz
```

- Software compression (default -6)

```
-rw-r--r--  1 root root 168411813 Feb 21 11:34 linux-5.0.20.tar.gz
```

-19%

- Software compression (fastest)

```
-rw-r--r--  1 root root 210084697 Feb 21 11:33 linux-5.0.20.tar.gz
```

tar Archives

- No compression

```
# time tar cvf linux-5.0.20.tar linux-5.0.20 > /dev/null
real    0m0.704s
```

- Hardware Compression

```
# time GZIP=-1 tar cvfz linux-5.0.20.tar.gz linux-5.0.20 > /dev/null
real    0m0.668s
```

faster

gzip

- Software compression (default -6)

```
# time gzip linux-5.0.20.tar
real    0m22.738s
```

- Software Compression (fastest)

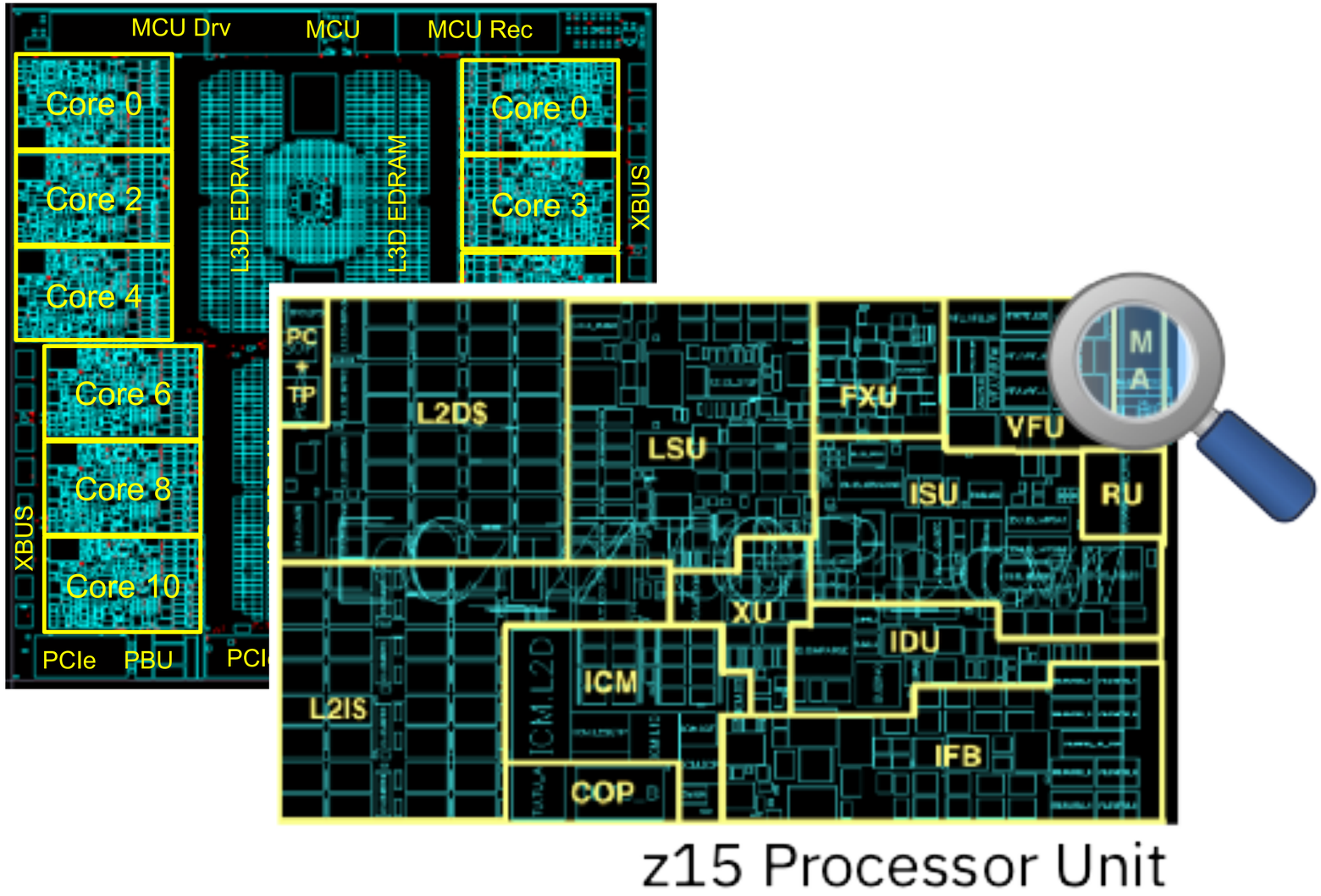
```
# time DFLTCC=0 gzip -1 linux-5.0.20.tar
real    0m13.177s
```

- Hardware Compression

24x faster

```
# time gzip -1 linux-5.0.20.tar
real    0m0.544s
```

CPACF



z15 Processor Unit

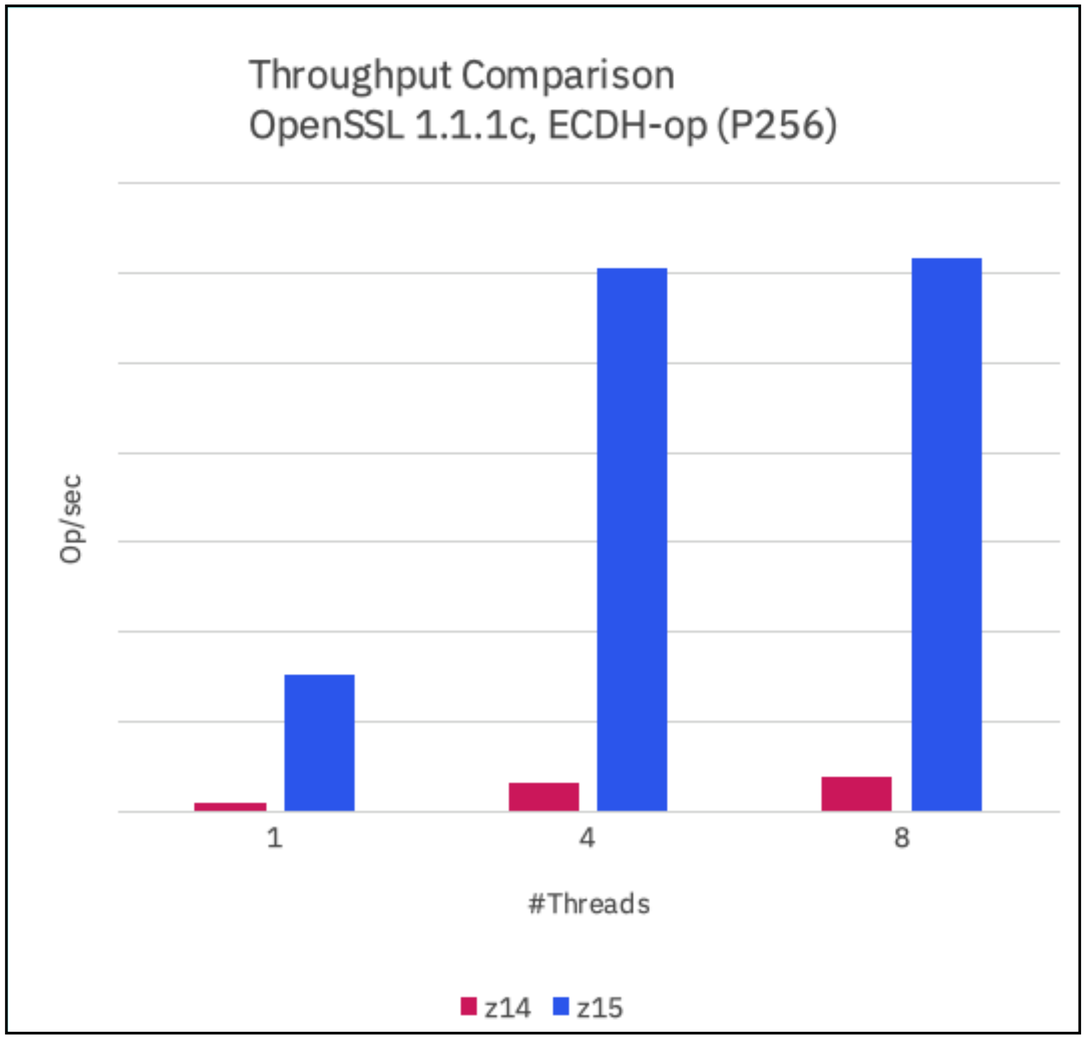
CPACF

- New Message Security Assist MSA9 for Elliptic Curve Cryptography (ECC)
- Supports
  - message authentication
  - generation of elliptic curve keys
  - scalar multiplication
- Used with SSL/TLS protocol
  - securing client-server network connection
  - handshake establishes the secure connection
- TLS v1.3 supports ECDH (key exchange) and ECDSA (signature)
- Supported curves:
  - ECDSA (sign/verify) P256, P384, P521 Ed 25519, Ed448
  - ECDH (key exchange) P256, P384, P521, X25519, X448
- ECC support available also with Crypto Express (CEX) CCA co-processor

z15 Processor Unit

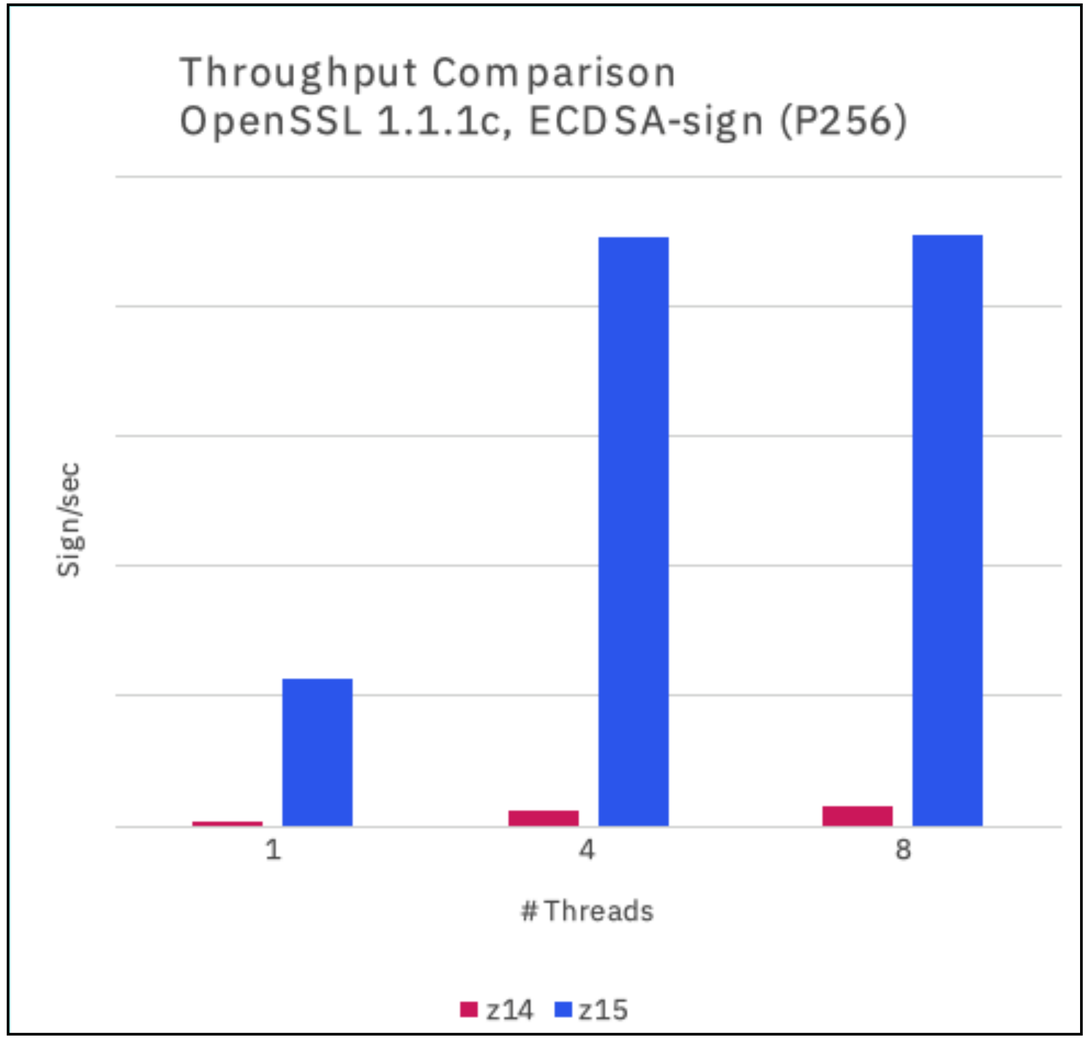
CPACF

- OpenSSL speed test for ECHD-ECDSA
- Up to **20x more key exchange** operations
- On a z15 with PU hardware support for ECC



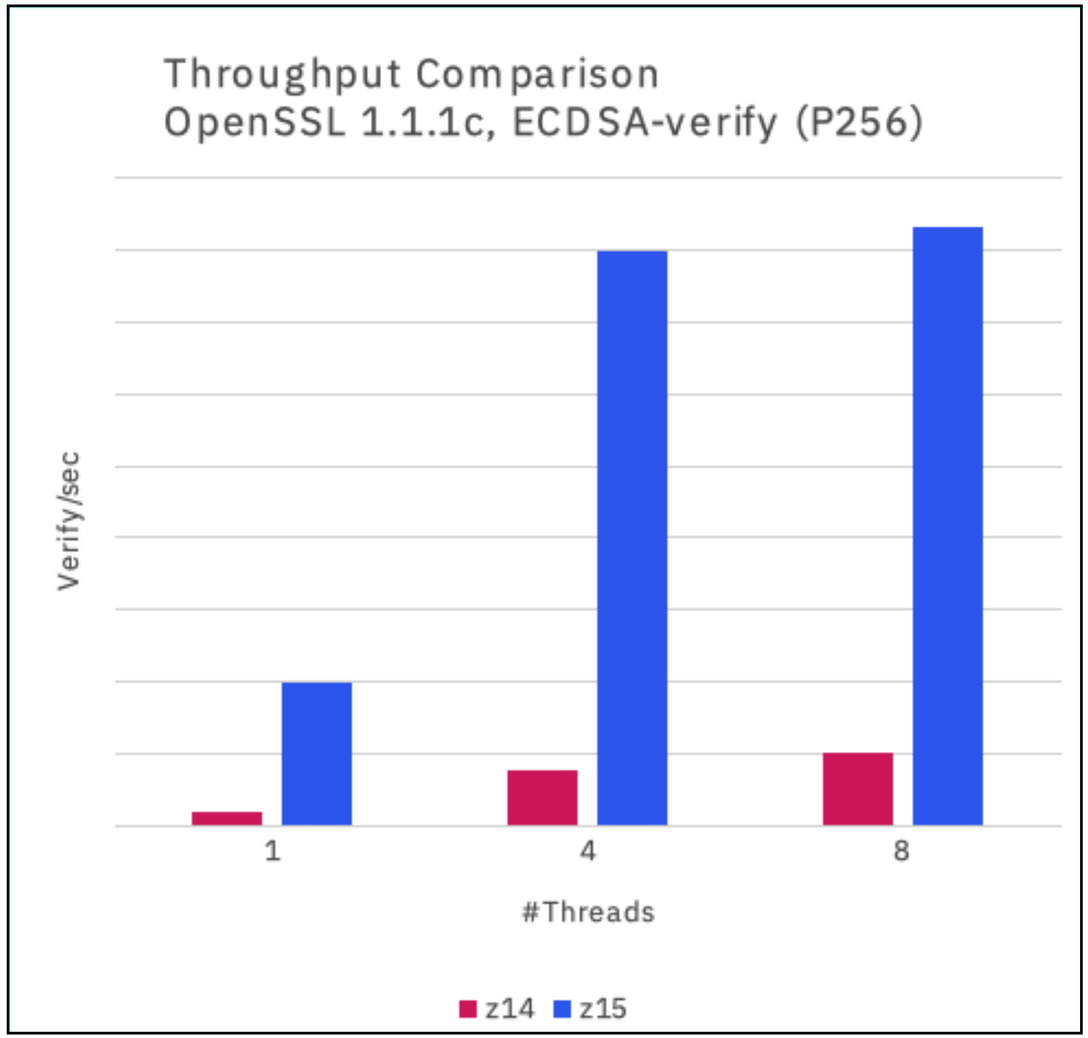
CPACF

- OpenSSL speed test for ECHD-ECDSA
- Up to **38x more sign** operations
- On a z15 with PU hardware support for ECC



CPACF

- OpenSSL speed test for ECHD-ECDSA
- Up to **10x more verify** operations
- On a z15 with PU hardware support for ECC



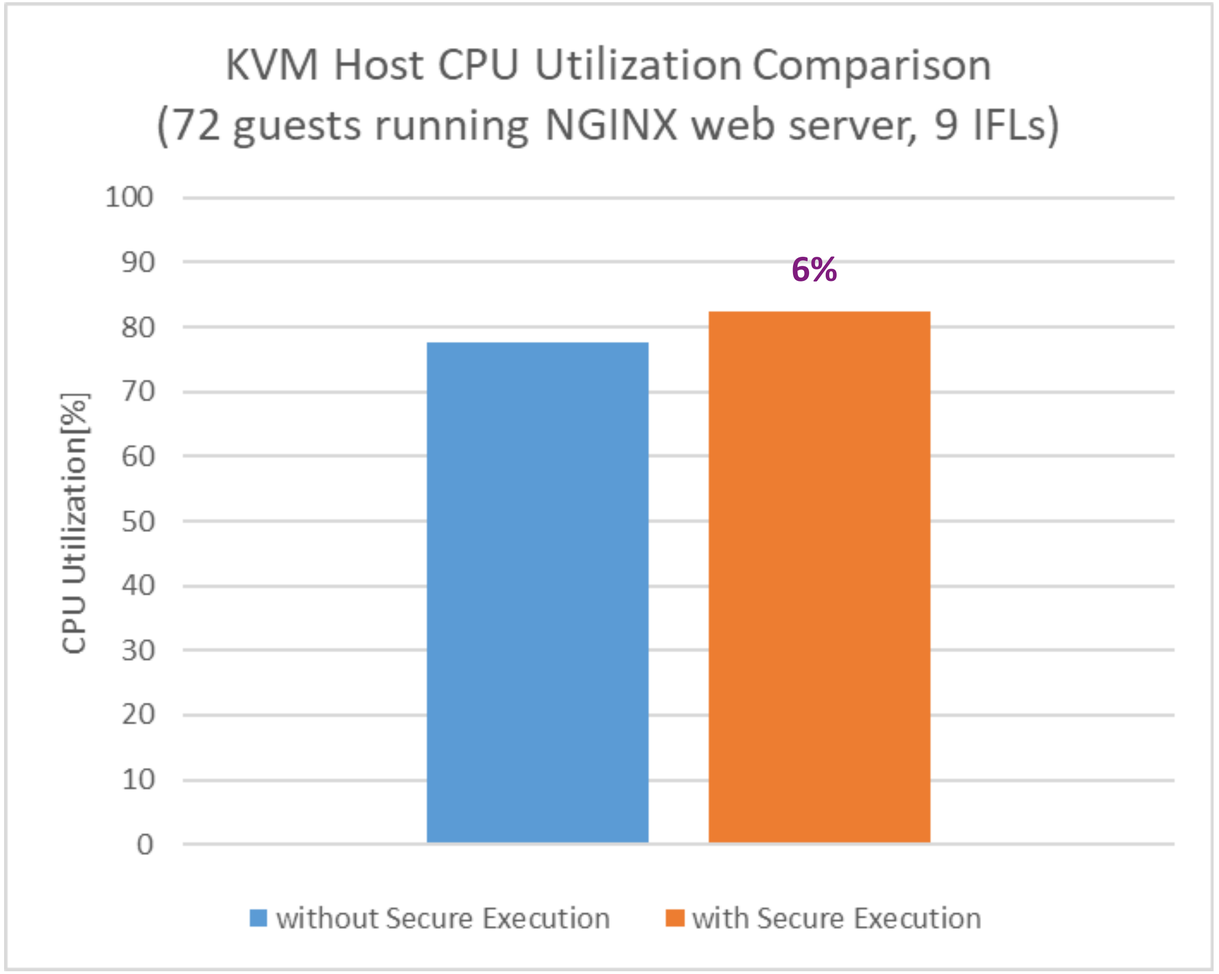
IBM Secure Execution for Linux

- Encrypted KVM guest image
- Isolate workloads from internal and external threats
- Protect runing KVM guest from hypervisor
- Encrypted image can only be run on host(s) it has been prepared for

IBM Secure Execution for Linux

Overhead of Secure Execution on z15 T01

Run NGINX web servers on KVM guests on z15 T01 with only 6% CPU overhead when using IBM Secure Execution



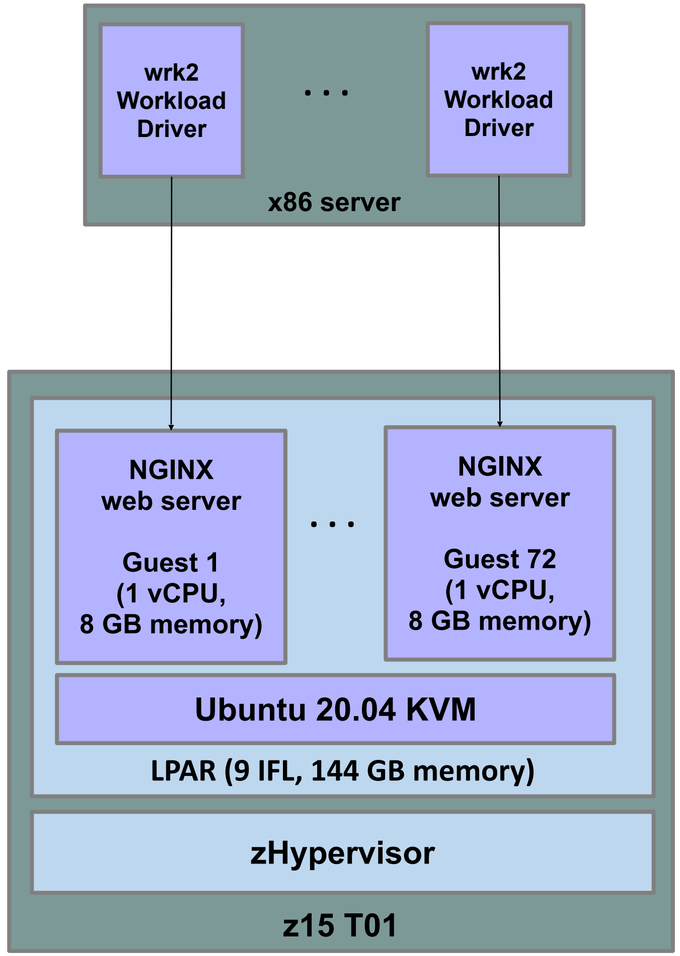
DISCLAIMER: Performance results based on IBM internal tests running in a z15 T01 LPAR with 9 dedicated IFLs and 144 GB memory, an Ubuntu 20.04 KVM instance in SMT mode with 72 guests using Secure Execution versus not using Secure Execution. Each guest was configured with 1 vCPU, 8 GB memory and running a dockerized NGINX 1.15.9 web server on Ubuntu 20.04. Each NGINX web server was driven remotely by an instance of the wrk2 4.0.0.0 benchmarking tool (https://github.com/giltene/wrk2) with 2 parallel threads and 8 open HTTPS connections. The transferred web pages had a size of 644 bytes. KVM guests were stored using qcow2 images. Results may vary.

IBM Secure Execution for Linux

Overhead of Secure Execution on z15 T01

In total 396k HTTPS requests/sec,
5.5k HTTPS requests/sec per KVM guest

- **Benchmark Setup**
  - Ran 72 KVM guests with and without using Secure Execution
  - Each KVM guest was configured with 1 vCPU, 8 GB memory running an NGINX 1.15.9 web server on Ubuntu 20.04
  - Each NGINX web server was driven remotely by a wrk2 benchmark instance
  - The transferred web pages had a size of 644 bytes
- **System Stack**
  - z15 T01
    - LPAR with 9 dedicated IFLs, 144 GB memory, running Ubuntu 20.04 with SMT enabled
    - 1 TB FlashSystem 900 storage

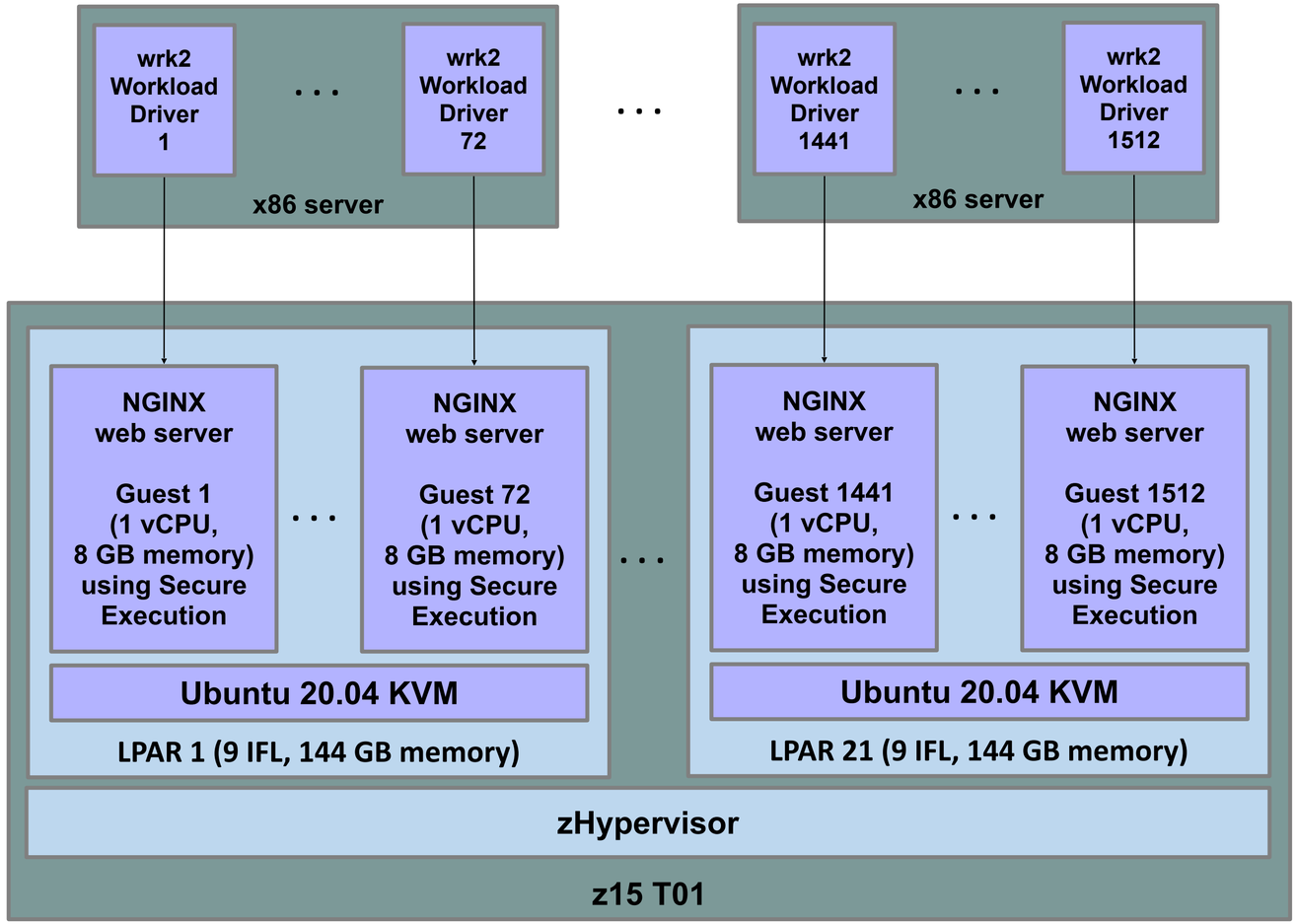


IBM Secure Execution for Linux

Scale-out with KVM guests on z15 T01 using Secure Execution

In total 8.3 million HTTPS requests/sec,
5.5k HTTPS requests/sec per Secure Execution KVM guest

Scale up to 1500 KVM guests running a web page serving workload on a z15 T01 server using IBM Secure Execution



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Kernel News

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19. Juni 2020

Tag Legend

- Supported distributions

  x.y for SUSE SLES <X> Service Pack <Y>

  e.g for 12.1 SLES12 SP1

  x.y for RHEL <X> Update <Y>

  e.g for 7.2 RHEL7.2

  x.y for Ubuntu <X>.<Y>

  e.g for 16.04 Ubuntu 16.04 LTS

- Supported environments

  LPAR usable for systems running in LPAR

  z/VM usable for systems running under z/VM

  KVM usable for systems running under KVM

Base IBM Z Support

- Kernel Address Space Layout Randomization (kernel 5.2)
  - Security improvements by making the address of the kernel harder to predict

LPAR z/VM KVM

- CPU-MF Counters for z15 (kernel 5.3)
  - Adds Measurement Facility (MF) counters for ECC
  - Access using lscpumf command:

```
# lscpumf -c|fgrep ECC_
r50 ECC_FUNCTION_COUNT
r51 ECC_CYCLES_COUNT
r52 ECC_BLOCKED_FUNCTION_COUNT
r53 ECC_BLOCKED_CYCLES_COUNT
```

LPAR z/VM KVM

Block Device Support

- Thin Provisioning Base Support for DASD (kernel 5.3)
  - Use with DASD devices configured for thin provisioning on storage server:
    - Not all disk space is allocated in the storage server when the disk is empty
    - Disk space gets allocated only if in use
  - Use dasdfmt options `-M quick` or `--mode quick`
    - Formats first two tracks of disk only
    - Significantly speeds up formatting process
  - **Note:** Slow write performance for the first write of each newly used track

Other Packages

- **s390-tools** v2.12 (12/2019)
  - Userspace tools for use with the Linux kernel and its device drivers on IBM Z
  - Held in sync with latest kernel releases
  - v2.12 supports Linux kernel 5.4

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- **smc-tools** v1.2.2 (10/2019)
  - Package with utilities in support of SMC-R and SMC-D
  - Latest changes:
    - Support for new API as introduced with Linux kernel 5.1
    - Added bash autocompletion support

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- **qclib** v2.0.1 (01/2020)
  - C library providing information on system, capacity, and virtualization layers
  - Latest changes:
    - Support for zCX environment
    - Attributes to query model name in clear text

LPAR z/VM KVM

Summary

Thank You !

- Marc Beyerle
- Stefan Raspl
- Dominic Röhm

Summary

- Distributions and Support
- New z15
  - Integrated Accelerator for zEDC
  - IBM Secure Execution for Linux
- Kernel News

Links

Documentation

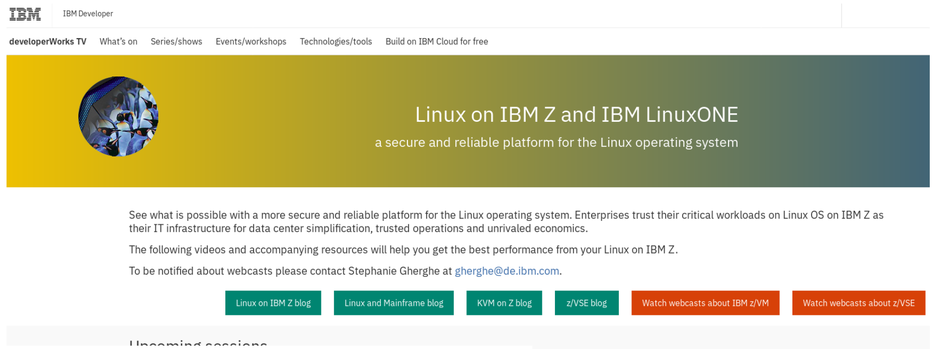
- Linux on Z and LinuxONE Knowledgecenter
  https://www.ibm.com/support/knowledgecenter/linuxonibm/liaaf/lnz_r_main.html

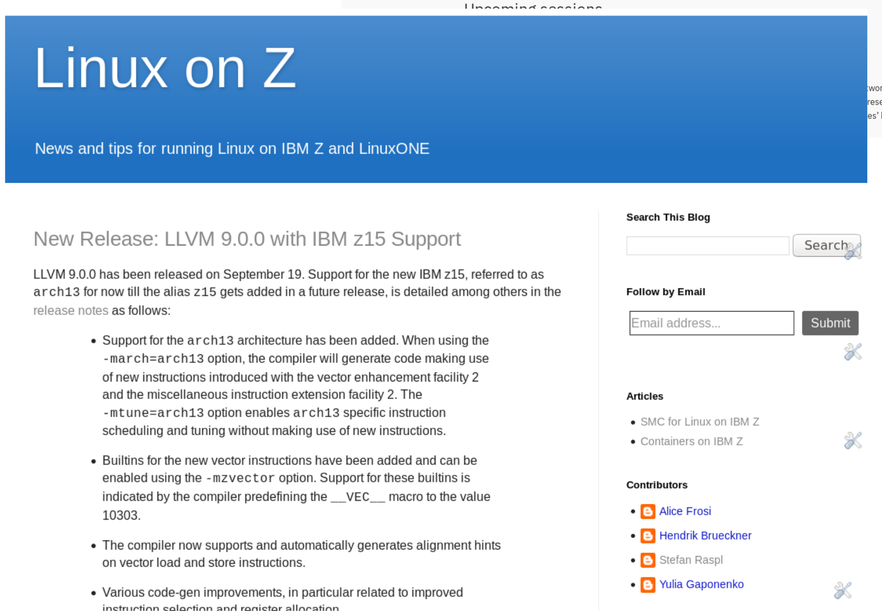
Webcasts

- In-depth sessions on Linux on Z topics
- Provided by Linux on Z development team
  For future sessions and session recordings
  https://developer.ibm.com/tv/linux-ibm-z/

Blogs

- Latest news from the development team
- Focus on upstream submissions
- Feature articles on specific in-depth topics
  Linux on Z, including containers
  http://linux-on-z.blogspot.com/
  KVM on Z
  http://kvmonz.blogspot.com/





Questions ?

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Linux on IBM Z
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