The science behind the report:

Enabling two security features on 3rd Gen AMD EPYC processors minimally affected OLTP performance on a Dell EMC PowerEdge R6525 system

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report Enabling two security features on 3rd Gen AMD EPYC processors minimally affected OLTP performance on a Dell EMC PowerEdge R6525 system.

We concluded our hands-on testing on February 22, 2021. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on February 2, 2021 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

To learn more about how we have calculated the wins in this report, go to http://facts.pt/calculating-and-highlighting-wins. Unless we state otherwise, we have followed the rules and principles we outline in that document.

Table 1: Results of online transaction processing tests with the DVD Store 3 benchmark. We tested a Dell EMC PowerEdge R7525 server powered by AMD EPYC 7543 processors. We compared the system's online transaction processing performance with two AMD security features enabled to the same system with the AMD security features disabled. The security features were AMD Secure Memory Encryption (SME) and AMD Secure Encrypted Virtualization - Encrypted State (SEV-ES). We used a 100ms think time for this test. We ran the benchmark three times and report the median score of the three runs. The reported CPU core utilization percentage is the number associated with the that run.

	AMD SEV-ES and SME enabled	AMD SEV-ES and SME disabled
Total OPM	72,417	73,636
CPU core utilization (percentage)	80	79

System configuration information

Table 2: Detailed information on the system we tested.

System configuration information	Dell EMC PowerEdge R6525
BIOS name and version	Dell 2.0.3
Non-default BIOS settings	**For runs with security features enabled:** Enable Secure Memory Encryption Set Minimum SEV non-ES ASID to 17 **For runs with security features disabled (BIOS defaults):** Disable Secure Memory Encryption Set Minimum SEV non-ES ASID to 1
Operating system name and version/build number	VMware ESXi, 7.0.1, 17325551
Date of last OS updates/patches applied	1/8/2021
Power management policy	Max Performance
Processor	
Number of processors	2
Vendor and model	AMD EPYC 7543
Core count (per processor)	32
Core frequency (GHz)	2.80
Stepping	Model 1 Stepping 1
Memory module(s)	
Total memory in system (GB)	512
Number of memory modules	16
Vendor and model	Hynix HMA84GR7CJR4N-XN
Size (GB)	32
Type	DDR-4
Speed (MHz)	3,200
Speed running in the server (MHz)	3,200
Storage controller	
Vendor and model	PERC H345
Cache size (GB)	N/A
Firmware version	51.13.0-3485
Local storage (OS)	
Number of drives	2
Drive vendor and model	Intel SSDSCKKB240G8R
Drive size (GB)	240
Drive information (speed, interface, type)	6Gbps, SATA, SSD

System configuration information	Dell EMC PowerEdge R6525
Local storage (Capacity)	
Number of drives	8
Drive vendor and model	Samsung MZ-ILS800B
Drive size (GB)	800
Drive information (speed, interface, type)	12Gbps, SAS, SSD
Network adapter	
Vendor and model	Broadcom Ethernet BCM5720
Number and type of ports	2 x 1Gb, 2 x 10Gb
Driver version	19.5.12
Cooling fans	
Vendor and model	Dell PIH040M12P
Number of cooling fans	16
Power supplies	
Vendor and model	Dell L1400E-S0
Number of power supplies	2
Wattage of each (W)	1400

How we tested

Our hands-on testing compared the performance of a dual-socket Dell EMC PowerEdge R6525 server powered by dual AMD EPYC 7543 processors with and without two AMD security features enabled: AMD Secure Memory Encryption (SME) and AMD Secure Encrypted Virtualization-Encrypted State (SEV-ES).

We loaded the system with 512GB of RAM, two SATA SSDs for the OS and eight 12Gbps SATA SSDs in RAID 0 for storage. We installed VMware ESXi 7.0.1 on the server and connected it to a VMware vCenter 7.0.1 appliance. We created and configured a gold VM with SUSE Enterprise Linux 15 SP2 and Microsoft SQL Server 2019, and applied a kernel patch to enable AMD security features in the guest OS. This was necessary as SUSE Enterprise Linux 15 SP2 did not yet officially support SEV-ES at the time of testing. To apply the patch, we followed instructions from the AMD whitepaper at https://www.amd.com/system/files/documents/2020-amd-epyc-confidentialcompute-bp-vmware-vsan.pdf. To generate CSV files to build and load our 40GB database, we used the built-in scripts provided by DVD Store 3 (DS3).

Once we created and configured the VM and database, we cloned out the gold VM to yield the full set of 16 test VMs. Because DS3 is a CPU intensive workload, we configured the VMs to have enough vCPUs to allocate all of the host's cores. Our 16 test VMs had 8 vCPUs and 16GB of RAM each. We used external client VMs running Windows Server 2019 over a 1Gb network to target our database VMs and run the DS3 driver. To monitor the performance of the host, we ran esxtop in batch mode and output the data to CSV.

We conducted our testing with SME and SEV-ES enabled in the host BIOS, vSphere 7, and the SLES 15 guest OSes. Afterward, we ran DS3 again with both features disabled.

Running DVD Store 3 on SUSE Linux Enterprise 15 SP2 with SQL Server 2019

Installing VMware ESXi 7.0U1

1. Attach the installation media.
2. Boot the server.
3. At the VMware Installer screen, press Enter.
4. At the EULA screen, to Accept and Continue, press F11.
5. Under Storage Devices, select the appropriate virtual disk, and press Enter.
6. As the keyboard layout, select US, and press Enter.
7. Enter the root password twice, and press Enter.
8. To start installation, press F11.
9. After the server reboots, press F2, and enter root credentials.
10. Select Configure Management Network, and press Enter.
11. Select the appropriate network adapter, and select OK.
12. Select IPv4 settings, and enter the desired IP address, subnet mask, and gateway for the server.
13. Select OK, and restart the management network.

Deploying the VMware vCenter Server Appliance 7.0U1

1. On a Windows server or VM, locate the VMware-VCSA installer image.
2. Mount the image, navigate to the vcsa-ui-installer folder, and double-click win32.
3. Double-click installer.exe.
4. Click Install.
5. Click Next.
6. Accept the terms of the license agreement, and click Next.
7. Leave "vCenter Server with an Embedded Platform Services Controller" selected, and click Next.
8. Enter the FQDN or IP address of the host onto which the vCenter Server Appliance will be deployed.
9. Provide the server's username and password, and click Next.
10. To accept the certificate of the host to which you chose to connect , click Yes.
11. Provide a name and password for the vCenter Appliance, and click Next.
12. Set an appropriate Appliance Size, and click Next.
13. Select the appropriate datastore, and click Next.
14. At the Configure Network Settings page, configure the network settings as appropriate for your environment, and click Next.
15. Review your settings, and click Finish.
16. When the deployment completes, click Next.
17. At the Introduction page, click Next
18. At the Appliance configuration page, select the time synchronization mode and SSH access settings, click Next
19. Select Create a new SSO domain.
20. Provide a password, and confirm it.

21. Provide an SSO Domain name and SSO Site name, and click Next.
22. At the CEIP page, click Next.
23. At the Ready to complete page, click Finish.
24. When installation completes, click Close.
25. Using the VMware vSphere web client, log into the vCenter server using the credentials you previously provided.

Installing VMware ESXi 7.0U1

1. Log into vCenter, and navigate to Hosts and Clusters.
2. Select the vCenter deployed above.
3. Right-click the vCenter object, and select New Datacenter…
4. Enter a name for the new data center, and click OK.
5. Right-click the new data center object, and click Add Host…
6. Enter the host's IP address, and click Next.
7. Enter the host's root username and password, and click Next.
8. Click Next four more times, and click Finish.

Creating the SUSE SLE15 SP2 VM

1. Log into vCenter, and click Hosts and Clusters.
2. Right-click the host to which you wish to deploy, and click New Virtual Machine.
3. Click Next.
4. Enter a name for the virtual machine, and click Next.
5. Ensure the desired host is selected as the compute resource, and click Next.
6. Select the appropriate datastore to host the VM, and click Next.
7. Ensure compatibility is set to ESXi 7.0 U1 and later (hardware version 18), and click Next.
8. Set Guest OS Family to Linux, and set Guest OS Version to SUSE Linux Enterprise 15 (64-bit). Click Next.
9. In the Customize Hardware section, use the following settings:
    a. Set CPU to 8.
    b. Set Memory to 16GB and Reservation to 16GB.
    c. Add 1 x 120GB Hard Disk for OS / Backup
    d. Add 1 x 100GB Hard Disk for database files
    e. Add 1 x 50GB Hard Disk for database logs.
    f. Set the OS Hard Disk to thin provisioning, and set the other disks to thick provision eager zeroed.
10. Create two additional VMware Paravirtual SCSI controllers, and assign the database and log disks to the new controllers.
11. Under VM Options -> Boot Options, set Firmware to EFI, and disable Secure Boot.
12. Attach the SUSE SLE15 SP2 installer ISO to the CD/DVD drive.
13. Click Next.
14. Click Finish.

Installing and configuring SUSE SLE15 SP2

1. Start the VM, and open its remote console in vCenter.
2. Wait for the installer to finish updating itself.
3. Select SUSE Linux Enterprise Server 15 SP2, and click Next.
4. Select I agree to the license terms, and click Next.
5. Enter your SUSE Customer Center email and registration code, and click Next.
6. When prompted to enable update repositories, click Next.
7. Check Development Tools Module, and click Next.
8. Click Next four times.
9. Enter a username and password, select Use this password for system administrator, and click Next.
10. Enter a root password, and click Next.
11. On the Installation Settings page, change the following settings:
    a. Click Kdump, select Disable Kdump, and click OK.
    b. Disable the firewall.
    c. Disable secure boot.
12. Click Install, and click Install again to confirm.
13. Open an SSH connection to the VM as root.

14. To create a 100GB partition for the database files, run the command `parted /dev/sdb` and enter the following:

```
mklabel gpt
mkpart primary 0 107GB
quit
```

15. Specify the filesystem for the partition, and mount it:

```
mkfs -t xfs /dev/sdb1
mkdir /home/ptuser/data
mount /dev/sdb1 /home/ptuser/data
chown username:users /home/ptuser/data
```

16. Repeat steps 14 and 15 for the logs partition using `/dev/sdc1`

Enabling SEV-ES in the guest OS

1. Open a terminal or SSH session to the VM, and log in as root.
2. To install the packages, run the following commands:

```
zypper update
zypper install bc flex bison
zypper install libopenssl-devel
zypper install gcc
zypper install git
zypper install libelf-devel
```

3. Download kernel sources for SEV-ES enablement from the AMD GitHub site:

```
git clone https://github.com/AMDEPYC/linux.git
cd linux
git checkout SEV-ES_VMware_ESXi_7.0_U1
```

4. Build the new kernel:

```
make mrproper
make config-5.9.0-rc2-24.9-default_x86_defconfig
make all --jobs=16
make modules_install --jobs=5
make install
```

5. Open `/boot/grub2/grub.cfg` with a text editor. Navigate to line 154 (before the `${extra_cmdline}` parameter), and add the following boot option command line parameter:

```
swiotlb=262144
```

6. Note: To test the workload without SME and SEV-ES security features, skip steps 7 through 10, in addition to disabling them in BIOS as noted in the system configuration. To test the workload with SME and SEV-ES enabled, continue through the next steps.
7. Save the boot config file, and reboot the VM into the new kernel.
8. Power off the VM. On a different machine, open VMware PowerCLI.
9. From PowerCLI, connect to the host server, and enter root credentials:

```
Connect-VIServer <IP Address>
```

10. Set SEV-ES to enabled on the VM you created above:

```
Get-VM YourVMName | Set-VM -SEVEnabled $true
```

11. Reboot the VM.
12. If the console is not visible after booting, SSH into the machine, and do the following:
    a. Run the following command:

    ```
    zypper remove xf86-video-vmware
    ```

    b. Open `/etc/modprobe.d/50-blacklist.conf` in a text editor and add the following lines:

    ```
    blacklist vmwgfx
    blacklist ttm
    ```

    c. Rebuild the kernel with the fixes:

    ```
    cd linux
    make install
    ```

    d. Finally, redo step 5 above, and reboot into the updated kernel.

Installing and configuring SQL Server 2019

1. SSH into the VM as root.
2. Add the MS-SQL Server 2019 SLES repository:

```
zypper addrepo -fc https://packages.microsoft.com/config/sles/12/mssql-server-2019.repo
zypper --gpg-auto-import-keys refresh
```

3. Install Python2 and SQL Server 2019 and add a symbolic link to ensure SLES15 compatibility:

```
zypper install python2
zypper install mssql-server
cd /usr/lib64
ln -s libldap_r-2.4.so.2.10.9 libldap-2.4.so.2
```

4. Set up SQL Server 2019. When prompted, enter the license type and desired password:

```
/opt/mssql/bin/mssql-conf setup
```

5. Install full text search:

```
zypper install mssql-server-fts
```

6. Install SQL Server Tools, and add to PATH:

```
zypper addrepo -fc https://packages.microsoft.com/config/sles/15/prod.repo
zypper --gpg-auto-import-keys refresh
zypper install mssql-tools unixODBC-devel
export PATH=$PATH:/opt/mssql-tools/bin
```

Configuring and running the DVD Store 3 benchmark

Data generation overview

We generated the data using the Install.pl script included with DVD Store version 3 (DS3), providing the parameters for our 40GB database size and the database platform we used. We ran the Install.pl script on a utility system running Linux® to generate the database schema. After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server 2014. We built the 40GB database in Microsoft SQL Server and performed a full backup, storing the backup file remotely for quick access. We used that backup file to restore the database when necessary.

The only modification we made to the schema creation scripts were the specified file sizes for our database. We explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Other than this file size modification, we created and loaded the database in accordance to the DVD Store documentation. Specifically, we followed these steps:

1. Generate the data. Using the database creation scripts from the DS3 download, create the database and file structure. Make size modifications specific to our 40GB database, and make the appropriate changes to drive letters.
2. Transfer the files from the Linux data generation system to a Windows system running SQL Server.
3. Using the provided DS3 scripts, create database tables, stored procedures, and objects.
4. To prevent excess logging, set the database recovery model to bulk-logged.
5. Load the data you generated into the database. For data loading, use the import wizard in SQL Server Management Studio. Where necessary, retain options from the original scripts, such as Enable Identity Insert.
6. Using the database-creation scripts, create indices, full-text catalogs, primary keys, and foreign keys.
7. Update statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, create a ds2user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
DEFAULT_DATABASE=[master],
DEFAULT_LANGUAGE=[us_english],
CHECK_EXPIRATION=OFF,
CHECK_POLICY=OFF
GO

EXEC master..sp_addsrvrolemember @loginame = N'ds2user',
@rolename = N'sysadmin'

USE [DS3]
CREATE USER [ds3DS3user] FOR LOGIN [ds2user]
```

```
EXEC sp_addrolemember N'db_owner', N'ds3DS3user'

USE [master]
CREATE USER [ds3masteruser] FOR LOGIN [ds2user]
EXEC sp_addrolemember N'db_owner', N'ds3masteruser'
```

9. Set the database recovery model back to Full.
10. Using SQL Server Management Studio, create the necessary full-text index.
11. Create a database user, and map this user to the SQL Server login.
12. To restore the databases to a pristine state, perform a full backup of the database.

Cloning additional SQL Server VMs

Once you have generated the database, created the ds2user login, and stored the backup on the Master SQL VM, you can clone the rest of the VMs from the Master. For our testing, we created 16 SQL VMs.

1. From a web browser, log into vCenter.
2. Right-click the Master SQL VM and select Clone -> Clone to Virtual Machine
3. Select a name for the VM and a datastore location to store it, and click Next.
4. Select the compute resource which the VM will reside on, and click Next.

```
Set "Select virtual disk format" to "Same format as source."
Set "VM Storage Policy" to "Keep existing VM storage policies."
```

5. Select the appropriate datastore, and click Next.
6. Deselect all clone options, and click Next.
7. Review your settings, and click Next.

Running the DVD Store 3 tests

We created a series of batch files, SQL scripts, and shell scripts to automate the complete test cycle. DVD Store 3 outputs an orders-per-minute metric, which is a running average calculated through the test. In this report, we report the last OPM that each target reported.

Each complete test cycle consisted of general steps:

1. Clean up prior outputs from the target system.
2. Drop the database from the target.
3. Restore the database on the target.
4. Reboot the target.
5. Wait for a ping response from the server under test and the client system.
6. Let the test server idle for 10 minutes.
7. Start the DVD Store driver on the clients.

We used the following DVD Store 3 parameters for testing:

```
ds3sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=30 --n_threads=16 --db_size=40GB
--think_time=0.1 --detailed_view=Y --warmup_time=15 --report_rate=1 --pct_newcustomers=20 --csv_
output=<drivepath>
```

Read the report at http://facts.pt/zFbVc8z ▶

This project was commissioned by Dell EMC.

Principled Technologies®

Facts matter.®