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1.0 Introduction

This document was designed to help debug issues with Intel® QuickAssist Technology (Intel® QAT).

It contains the following sections:

- How To...
- Intel® QAT Driver Installation Issues
- System Configuration Issues
- Application Issues
- Intel® QAT Virtualization Issues
- Intel® QAT Performance Issues
- NGINX* Issues
- OpenSSL*/QAT_Engine Issues
- HAProxy* Issues
- DPDK Issues
- Miscellaneous Issues

1.1 Terminology

<table>
<thead>
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<th>Description</th>
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<tr>
<td>API</td>
<td>Application Programming Interface</td>
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<tr>
<td>BIOS</td>
<td>Basic Input/Output System</td>
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<tr>
<td>DC</td>
<td>Data Compression</td>
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<tr>
<td>GRUB</td>
<td>GRand Unified Bootloader</td>
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<tr>
<td>O.S.</td>
<td>Operating System</td>
</tr>
<tr>
<td>PCH</td>
<td>Platform Controller Hub</td>
</tr>
<tr>
<td>PCI</td>
<td>Peripheral Component Interconnect</td>
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<tr>
<td>P.F.</td>
<td>Physical Function</td>
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<table>
<thead>
<tr>
<th>Term</th>
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<td>Intel® QAT</td>
<td>Intel® QuickAssist Technology</td>
</tr>
<tr>
<td>SoC</td>
<td>System-on-a-Chip</td>
</tr>
<tr>
<td>SRIOV</td>
<td>Single Root-I/O Virtualization</td>
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1.2 Reference Documents and Software

Table 2. Reference Documents and Software

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<td>Intel® QuickAssist Technology Software for Linux* – Release Notes – Hardware Version 1.7</td>
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<td>01.org</td>
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<tr>
<td>Intel® QuickAssist Technology API Programmer’s Guide</td>
<td>330684</td>
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<td>Intel® QuickAssist Technology – Performance Optimization Guide</td>
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<td>Using Intel® Virtualization Technology (Intel® V.T.) with Intel® QuickAssist Technology Application Note</td>
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<tr>
<td>HAProxy* with Intel® QuickAssist Technology Application Note</td>
<td>337430</td>
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1.3 Resources

- https://01.org/intel-quickassist-technology
Introduction

- https://github.com/intel/QAT_Engine
- http://www.intel.com/quickassist
- https://github.com/intel/QATzip
- https://github.com/intel/asynch_mode_nginx
- https://www.haproxy.org/
- Intel® Select Solutions for NFVI

§
This chapter describes how to perform various status checks on Intel® QAT.

2.1 How to Determine if Intel® QAT is Installed

1. Determine if Intel® QAT is installed by running the following command:
   
   ```
   lsmod | grep qa
   ```

   If Intel® QAT is installed, you should see output like the following:
   
   ```
   ]#  lsmod | grep qa qat_c62x
   13473  0 intel_qat             141688  1
   qat_c62x authenc                17776  1
   intel_qat dh_generic             13323
   intel_qat rsa_generic            18819
   intel_qat
   ```

   2. If Intel QAT is not installed, follow the instructions in 336212, Intel® QuickAssist Technology Software for Linux* Getting Started Guide Hardware Version 1.7, at 01.org or in the Intel® QuickAssist Technology Videos at https://software.intel.com/enus/networking/quickassist.

   3. Then rerun the command above to verify Intel® QAT is installed.

2.1.1 Relevant Collateral

- 336212, Intel® QuickAssist Technology Software for Linux* – Getting Started Guide – Hardware Version 1.7, at 01.org
- Intel® QuickAssist Technology Videos at https://software.intel.com/enus/networking/quickassist

2.1.2 How to Determine if Intel® QAT is Running by Looking at Firmware Counters

Monitor the Intel® QAT firmware counters to determine if Intel® QAT is running as in the following example:

```
watch cat /sys/kernel/debug/qat_c6xx_0000\:3d:\:00.0/fw_counters
```

These firmware counters are the -

`/sys/kernel/debug/qat_<devicetype>_bus_device_function>/fw_counts`
Intel® QAT firmware counters increase when Intel® QAT is running. If Intel® QAT is not running, the firmware counters remain at their current value.

2.1.3 Relevant Collateral


2.2 How to Determine if Intel® QAT is Active

Run one of the following commands: systemctl status qat_service
or service qat_service status

You should see the resulting output similar to the following:

```bash
[...]
# systemctl status qat_service
qat_service.service - LSB: modprobe the QAT modules, which loads dependant modules, before calling the user space utility to pass configuration parameters
Loaded: loaded (/etc/init.d/qat_service; generated)
Active: active (exited) since Fri 2019-12-20 18:32:32 UTC; 28min ago
Docs: man:systemd-sysv-generator(8)
Process: 48577 ExecStop=/etc/init.d/qat_service stop
  (code=exited, status=0/SUCCESS)
Process: 48635 ExecStart=/etc/init.d/qat_service start
  (code=exited, status=0/SUCCESS)
Dec 20 18:32:30 dbubuntu qat_service[48635]: Restarting all devices.
Dec 20 18:32:30 dbubuntu qat_service[48635]: Processing /etc/c6xx_dev0.conf
Dec 20 18:32:30 dbubuntu qat_service[48635]: Processing /etc/c6xx_dev1.conf
```
Dec 20 18:32:31 dbubuntu qat_service[48635]: Processing /etc/c6xx_dev2.conf
Dec 20 18:32:32 dbubuntu qat_service[48635]: Checking status of all devices. Dec 20 18:32:32 dbubuntu qat_service[48635]: There is 3 QAT acceleration device(s) in the system:
Dec 20 18:32:32 dbubuntu qat_service[48635]: qat_dev0 - type: c6xx, inst_id: 0, node_id: 0, bsf: 0000:3d:00.0, #accel: 5 #engines: 10 state: up
Dec 20 18:32:32 dbubuntu qat_service[48635]: qat_dev1 - type: c6xx, inst_id: 1, node_id: 0, bsf: 0000:3f:00.0, #accel: 5 #engines: 10 state: up
Dec 20 18:32:32 dbubuntu qat_service[48635]: qat_dev2 - type: c6xx, inst_id: 2, node_id: 1, bsf: 0000:da:00.0, #accel: 5 #engines: 10 state: up
Dec 20 18:32:32 dbubuntu systemd[1]: Started LSB: modprobe the QAT modules, which loads dependant modules, before calling the user space utility to pass configuration parameters.
} # service qat_service status Checking status of all devices. There is 3 QAT acceleration device(s) in the system: qat_dev0 - type: c6xx, inst_id: 0, node_id: 0, bsf: 0000:3d:00.0, #accel: 5 #engines: 10 state: up
qat_dev1 - type: c6xx, inst_id: 1, node_id: 0, bsf: 0000:3f:00.0, #accel: 5 #engines: 10 state: up
qat_dev2 - type: c6xx, inst_id: 2, node_id: 1, bsf: 0000:da:00.0, #accel: 5 #engines: 10 state: up
Note: You can also run the systemctl <start, restart or stop> qat_service command, or qat_service <start, restart or stop> to perform the specific request.

2.2.1 Relevant Collateral


2.3 How to Determine if the Intel® QAT Device Has Failed or Hung with Heartbeat Monitoring

You can use Heartbeat monitoring to determine if the Intel® QAT device is in a functional state.

To simulate the Heartbeat management process, run the following commands:

```
cat /sys/kernel/debug/<device>/heartbeat
```

If 0 is returned, it indicates the device is responding. If –1 is returned, it indicates the device is not responding.

```
cat /sys/kernel/debug/<device>/heartbeat_sent
```

This number will increase each time the CAT heartbeat is sent because it tracks the number of times the control process checks to see if the device is responsive.

```
cat /sys/kernel/debug/<device>/heartbeat_fail
```

This number will increase each time the return value of the cat heartbeat is –1 because it keeps track of the number of times the control process finds the device unresponsive.

```
cat /sys/kernel/debug/<device>/heartbeat_sim_fail
```

This command simulates a failure on the Intel® QAT device. The return value will be zero. In addition, you can use the icp_sal_heartbeat_simulate_failure() API to simulate a heartbeat failure as well. For examples of other types of applications, refer to the following subdirectory of the Intel® QAT directory where the acceleration software is unpacked:

```
quickassist/lookaside/access_layer/src/sample_code/functional/common
```

Note: To simulate the heartbeat failure, Intel® QAT has to be configured as follows:

```
./configure --enable-icp-hb-fail-sim
```

2.3.1 Relevant Collateral

2.4 How to Reset or Restart the Intel® QAT device When it has Failed or Hung, Using adf_ctl

When the Heartbeat monitoring detects that the Intel® QAT device has failed or hung, the device can be reset or restarted with the adf_ctl utility. In addition, the Intel® QAT device can be configured for auto-reset via the configuration file. For more information, please refer to Document Number 336210, Intel® QuickAssist Technology Software for Linux* – Programmer’s Guide. Sections 3.3 and 5.2.6 contain information on the adf_ctl utility. “Resetting a Failed Device,” under Section 3.17.1, contains information on Intel® QAT device auto-resetting via the configuration file.

The adf_ctl tool is in the subdirectory quickassist/utilities/adf_ctl of the Intel® QAT directory, where the acceleration software is unpacked. In the following steps, /opt/APP/driver/QAT is the directory where the acceleration software is unpacked.

```
/opt/APP/driver/QAT/quickassist/utilities/adf_ctl
```

```
# ./adf_ctl qat_dev0 reset
# ./adf_ctl qat_dev0 restart
```

The first example above resets the QAT_dev0 device, while the second example restarts the QAT_dev0 device. Note that if AutoResetOnError is set to 1 in the [GENERAL] section of the Intel® QAT Config file (i.e., c6xx_dev0.conf), the reset is done automatically, and there is no need to perform the first example.

2.4.1 Relevant Collateral


2.5 How to Gather Necessary Information for Debugging

The icp_dump.sh tool is in the quickassist/utilities/debug_tool subdirectory of the Intel® QAT directory, where the acceleration software is unpacked. In the following steps, the Intel® QAT directory is /opt/APP/driver/QAT and the tar file (created from icp_dump.sh) will be stored in the /root/iss_nfvi/icp_dump directory.

**Note:** Run the command `mkdir /root/iss_nfvi/icp_dump` (or the directory of your choice) before running these steps.

1. Define ICP_ROOT as the directory you have installed Intel® QAT

   ```
   export ICP_ROOT=/opt/APP/driver/QAT
   ```
2. Run `icp_dump.sh` with one parameter: the directory where you would like the tar file to be stored.

   ```bash
   debug_tool ]# ./icp_dump.sh /root/iss_nfvi/icp_dump
   ```

   **Note:** Accept and run the debug tool, type `yes` when prompted.

3. Unzip the file and verify Intel® QAT acceleration devices in the system are up.

   ```bash
   iss_nfvi]# tar -xzf ICP_debug_18h_52m_07s_17d_10m_19y.tar.gz
   iss_nfvi]# cd ICP_debug
   ICP_debug]# cat adf_ctl_status.txt
   Checking status of all devices.
   There are three Intel® QAT acceleration devices in the system:
   qat_dev0 - type: c6xx, inst_id: 0, node_id: 0, bsf: 0000:3d:00.0, #accel: 5 #engines: 10 state: up
   qat_dev1 - type: c6xx, inst_id: 1, node_id: 0, bsf: 0000:3f:00.0, #accel: 5 #engines: 10 state: up
   qat_dev2 - type: c6xx, inst_id: 2, node_id: 1, bsf: 0000:da:00.0, #accel: 5 #engines: 10 state: up
   ```

4. Verify that all Intel® QAT configuration files are the same.

   **Note:** The SHIM section needs to be in place when Intel® QAT SHIMs is used, and this includes the Intel® QAT Engine and QATqzip. The CPA sample code uses the default Intel® QAT configuration files that are installed along with the Intel® QAT driver.

   The following is an example of the configuration that contains the `[SHIM]` section:

   ```bash
   ICP_debug]# cd config_files/
   config_files]# cat c6xx_dev0.conf ...
   # User Process Instance Section
   [SHIM]
   NumberCyInstances = 1
   NumberDcInstances = 0
   NumProcesses = 10
   # Crypto - User space
   Cy0Name = "UserCY0"
   Cy0IsPolled = 1
   Cy0CoreAffinity = 0
   ```
2.5.1 Relevant Collateral


§
3.0 Intel® QAT Driver Installation Issues

The following sections describe steps for resolving Intel® QAT driver installation issues.

3.1 Intel® QAT Driver Does Not Compile

If you experience compile errors, try one or more of the following steps:

- Update to the latest Intel® QAT Driver version
- Study the errors and warnings
- Update driver to use the kernel functions that correspond with your kernel and structures
- Install dependencies as described in the Intel® QAT Getting Started Guide

**Note:** Compile errors related to the kernel version are usually observed with newer kernels.

Please update to the latest version of the Intel® QAT driver available on 01.org. If you still experience issues, consult with your Intel representative.

3.1.1 Relevant Collateral


3.2 Linux* Crypto API Doesn't Use Intel® QAT

Users may be attempting to use Intel® QAT integrated into the Linux* Crypto API and looking for confirmation that Intel® QAT is being used. Users can look to the Intel® QAT FW counters and verify that they increase as crypto operations are performed. If Intel® QAT counters are not increasing, it may be due to one of the following:

- Depending on the user’s version of Intel® QAT, the Linux* Crypto API may not be enabled by default. In Intel® QAT HW Version 1.7 L.4.7 and earlier, the Linux* Crypto API was enabled by default. With Intel® QAT HW Version 1.7 L.4.8 and later, the option must be enabled when installing Intel® QAT, with the following command:
  ```bash
  ./configure --enable-qat-lkcf
  ```
- The required algorithm may not be installed. The user may add the algorithm or ask their Intel representative to add the algorithm. The following is an example of how to determine the algorithms supported in the current installation:
# cat /proc/crypto | grep
qat driver : qat-dh
module : intel_qat
driver : qat-rsa
module : intel_qat
driver :
qat_aes_cbc_hmac_sha512
module : intel_qat
driver :
qat_aes_cbc_hmac_sha256
module : intel_qat
driver :
qat_aes_cbc_hmac_sha1
module :
intel_qat driver
qat_aes_xts module
intel_qat driver
qat_aes_ctr module
intel_qat driver
qat_aes_cbc module
intel_qat

3.2.1 Relevant Collateral

Driver code and O.S. registered functions

3.3 Issues with the Intel® QAT Make or with Starting Intel® QAT

For the issues listed below, the root cause may be a mismatch of the install kernel and/or headers.

- Kernel Header Files Missing:

  make[1]: Entering directory `/opt/APP/driver/QAT'
  make[2]: Entering directory `/opt/APP/driver/QAT/quickassist/qat'

  Makefile:66: *** ERROR: Kernel header files not found. Install the appropriate kernel development package necessary for building external kernel modules or run 'make oldconfig && make modules_prepare' on kernel src to fix it. Stop.

  make[2]: Leaving directory `/opt/APP/driver/QAT/quickassist/qat'
  make[1]: *** [qat-driver-all] Error 2

  make[2]: Leasing directory `/opt/APP/driver/QAT/quickassist/qat'
  make[1]: *** [qat-driver-all] Error 2

- Errors in Intel® QAT Make:

  include/asm-generic/pgtable.h:632:19: note: previous definition of ‘pud_trans_huge’ was here static inline int
pud_trans_huge(pud_t pud) ^ In file included
from ./arch/x86/include/asm/pgtable.h:1235:0,
from include/linux/mm.h:63, from
./arch/x86/include/asm/pci.h:4, from
include/linux/pci.h:1641, from
../opt/APP/driver/QAT/quickassist/qat/compat/ qat_compat.h:87,
from <command-line>:0: include/asm-generic/pgtable.h: At top
toplevel: include/asm-generic/pgtable.h:632:19: error: redefinition
of 'pud_trans_huge' static inline int pud_trans_huge(pud_t pud)

- Unable to Start/Restart Intel® QAT:
  Failed to restart qat_service.service: Unit not found.

3.3.1 Resolution

Follow these steps:
1. Use the following code to determine what kernels are installed on your system, as
   in the following example:
   # yum list installed kernel

   Loaded plugins: langpacks, product-id, search-disabled-repos,
   subscription-manager Installed Packages kernel.x86_64
   3.10.0-957.el7 @anaconda/7.6 kernel.x86_64
   3.10.0-957.12.2.el7 @rhel-7-server-rpms kernel.x86_64
   3.10.0-1062.12.1.el7 @rhel-7-server-rpms

2. If there is no kernel list as shown in the previous step, then install it as follows:
yum install kernel-devel-$\text{(uname -r)}$

3. If multiple kernels are installed, remove the kernels that you do not need as in the
   following example:
yum remove kernel-devel-3.10.0-1062.12.1.el7.x86_64

4. If the only kernel installed is the one you want, then reinstall it by performing Step
   3, followed by Step 2.

Reinstalling the kernel will verify the correct headers are being used (i.e., there may be
a chance that Intel® QAT was previously built with a different Linux® kernel, with
different headers.)

3.3.2 Relevant Collateral

336210, Intel® QuickAssist Technology Software for Linux® – Programmer's Guide –
Hardware Version 1.7, at 01.org
4.0 System Configuration Issues

This section describes resolution steps for system configuration issues.

4.1 Intel® QAT Endpoint is Trained to Less than the PCIe* Max Capability

This issue includes one or more of the following symptoms:
- `lspci` returns a trained value below the maximum PCIe* capability
- Intel® QAT performance is low
- Platform issues: BIOS, jumpers, or analog issues
- Intel® QAT endpoint is trained correctly, but the internal switches report at lower speeds

4.1.1 Resolution

Verify that the `cpa_sample_code` gives the expected performance.

Contact your Intel representative for the expected performance numbers, if necessary.

4.1.2 Relevant Collateral

- 330687, Intel® QuickAssist Technology – Performance Optimization Guide, at 01.org

4.2 "adf_ctl status" Shows Fewer than Expected Devices

If `adf_ctl status` shows fewer than expected devices, try the resolution steps below.

4.2.1 Resolution

Check for one or more of the following conditions:
- Intel® QAT modules were not successfully installed with `insmod`
- Intel® QAT modules were not installed with `insmod` in the correct order
4.2.2 Relevant Collateral

- 336212, Intel® QuickAssist Technology Software for Linux* – Getting Started Guide – Hardware Version 1.7, at 01.org

4.3 Firmware Authentication Error

If you see the following symptom, please try the resolution steps below: `dmesg` Intel® QAT: authentication error (FCU_STATUS = 0x3), retry = 0

4.3.1 Resolution

If there is not a PCIe AER error, double-check the firmware version. Mismatching the firmware version and driver version will cause an authentication error.

4.3.2 Relevant Collateral

336212, Intel® QuickAssist Technology Software for Linux* – Getting Started Guide – Hardware Version 1.7, at 01.org
5.0 Application Issues

This section describes resolution steps for application issues.

5.1 Intel® QAT app fails to run

Error messages result when starting the Intel® QAT app, usually during the userStart function.

5.1.1 Resolution

Try one or more of the following:

• Install Intel® QAT.
• Update Intel® QAT configuration files to include the correct section name.

Note: Run the CPA Sample App first to verify that you get good results.

Please refer to Section 4.1 of the Intel® QAT Getting Started Guide.

5.1.2 Relevant Collateral


336212, Intel® QuickAssist Technology Software for Linux* – Getting Started Guide – Hardware Version 1.7, at 01.org

Intel® QuickAssist Technology Videos at https://software.intel.com/enus/networking/quickassist

For example, Section 3, “Building and Installing Software,” and Section 4, “Sample Applications,” in the Getting Started Guide, will show all the necessary steps.

Also, please refer to the following entries in Section 2.0 of this document:

− How to Determine if Intel® QAT is Installed
− How to Determine if Intel® QAT is Active

5.2 Application is Not Using Intel® QAT

Intel® QAT counters are not increasing. For example,
watch cat /sys/kernel/debug/qat_c6xx_0000:3d:00.0/fw_counters

*Note:* Check /sys/kernel/debug for your applicable qat_c6xx* directory.

### 5.2.1 Resolution

Applications may not be patched or configured to use Intel® QAT. Consult the relevant documentation.

### 5.2.2 Relevant Collateral

- 330687, Intel® QuickAssist Technology – Performance Optimization Guide, at 01.org

### 5.3 Intel® QAT Endpoint Hangs

If the Intel® QAT device is not responsive, try the resolution steps below.

#### 5.3.1 Resolution

Try one or more of the following:

- Step through the application to identify the operation that led to the hang, i.e., focus on replication.
- Run `adf_ctl reset` to recover.
- Verify that all Intel® QAT API operations and addresses are valid.

#### 5.3.2 Relevant Collateral


### 5.4 Error Reading /dev/qat_dev_processes File

When testing the driver (e.g., with functional sample code), you receive the error reading /dev/qat_dev_processes file:

```
# ./ipsec_sample main(): Starting IPSec Sample Code App ...
ADF_UIO_PROXY err: icp_adf_userProcessToStart: Error reading
```

...
/dev/qat_dev_processes file main(): Failed to start user process

5.4.1 **Resolution Steps**

1. Ensure that the configuration files match the application code, i.e., that `icp_sal_userStart` references "SSL" and that the configuration files in `/etc/` also mention "SSL" sections with a declared number of instances.
2. Restart `qat_service`.

5.4.2 **Relevant Collateral**

336212, Intel® QuickAssist Technology Software for Linux* – Getting Started Guide – Hardware Version 1.7, at 01.org

5.5 **HKDF or ECEDMONT Operations do not Succeed**

There are multiple options for this issue, such as the following:
"The device does not support ECEDMONT"
"The device does not support HKDF"
"ExtAlgChain feature not supported"

5.5.1 **Resolution Steps**

There are multiple steps you can take, such as follows:

- Ensure that you have the correct `ServicesProfile` option
- Ensure that you are on the latest release. 4.10 on the host and guest may solve the issue.

5.5.2 **Relevant Collateral**

- 336210, Intel QuickAssist Technology Software for Linux* Programmers Guide Hardware Version 1.7, at 01.org
5.6 **Proxy Application+QAT, no Performance Improvement using Multi-threads**

Try the resolution steps below if there is no performance improvement with 1 process and multithreading (multi workers).

5.6.1 **Resolution Steps**

Try setting the flag `ICP_WITHOUT_THREAD` in the USDM (quickassist/utilities/libusdm_drv) and recompile the USDM alone. Set the additional environment variables mentioned below to recompile USDM alone.

```bash
export ICP_WITHOUT_THREAD=1
export ICP_BUILDSYSTEM_PATH=$ICP_ROOT/quickassist/build_system
export ICP_ENV_DIR=$ICP_ROOT/quickassist/build_system/build_files/env_files
```

5.7 **QAT1.7 shows a hang or slice hang but recovers automatically**

When an automatic recovery occurs after a hang or slice hang, there is no longer a possibility to perform a register or ring dump analysis to determine the root cause of the hang. Kernel messages may be seen that mention slice hang, with a possible application error.

5.7.1 **Resolution**

Increase `CySymAndDcWatchDogTimer` and/or `CyAsymWatchDogTimer` (in ms) in the general section of the config file to set the watchdog timer to a high value (e.g. 1000000).
6.0 Intel® QAT Virtualization Issues

This section describes resolution steps for Intel® QAT virtualization issues.

6.1 Too Many Intel® QAT VFs are Created

When trying to create fewer virtual functions than the maximum, the maximum number always gets created.

6.1.1 Resolution

None; this is a hardware limitation, currently.

6.1.2 Relevant Collateral

• 330689, Using Intel® Virtualization Technology (Intel® V.T.) with Intel® QuickAssist Technology Application Note, at 01.org
• Videos at https://software.intel.com/en-us/networking/quickassist

6.2 Intel® QAT VFs are Not Created

If the virtual functions are not created try resolving this issue using the resolution steps below.

6.2.1 Resolution

Check for one or more of the following causes:

• configure was not run with the right options and needed to be run with the correct option.
• intel_iommu=on is not part of the GRUB boot settings and needs to be included in the grub
• Virtualization is not enabled in the BIOS and needs to be enabled

6.2.1.1 Example Outputs

1. Run lscpu to check if virtualization (vmx) is enabled in the BIOS:

```
# lscpu | grep vmx
```

```
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
aperfimperf eagerfpu pni pclmulqdq dtes64 monitor ds_cpl vmx smx
est tm2 sse3 sdbg fma cx16 xtrr pdcm pcid dca sse4_1 sse4_2
x2apic movbe popcnt tsc_deadline_timer aes xsave avx f16c rdrand
lahf_1m abm
3dnwprefetch epb cat_13 cdp_13 invpcid_single intel_ppin
intel_pt ssbd mba ibps ibpb stibp ibrs_enhanced tpr_shadow vnum
flexpriority ept vpid fsqbase tsc_adjust bmi1 hle avx2 smep bmi2
ermv invpcid rtm cqm mpx rdt_a avx512f avx512dq rdseed adx smap
ciflushopt clwb avx512cd avx512bw avx512vl xsaveopt xsavect
xgetbvl cqm_llc cqm_occup_llc cqm_mbm_total cqm_mbm_local dtherm
arat pln pts hwp hwp_act_window hwp_epp hwp_pkg_req pku ospke
avx512_vnni md_clear spec_ctrl intelor_stibp flush_l1d
arch_capabilities

2. Check `dmesg` to see if Virtualization (DMAR) is enabled for your particular device:
   ```
   # dmesg | grep -i DMAR | grep d8:00.0
   [    5.361824] DMAR: Hardware identity mapping for device 0000:d8:00.0
   ```

6.2.2 Relevant Collateral
   - 330689, Using Intel® Virtualization Technology (Intel® V.T.) with Intel® QuickAssist
     Technology Application Note, at 01.org

6.3 Virtualization Use Case Issues

You may encounter a kernel message such as "PTAE Read access is not set" and/or "Cannot use PF with IOMMU enabled."

6.3.1 Resolution
   - Get `cpa_sample_code` working by referring to Table 2, Using Intel® Virtualization
     Technology (Intel® VT) with Intel® QuickAssist Technology Application Note.
   - Ensure that the BIOS enables virtualization.
   - Ensure that `intel_iommu=on` is set in grub, verified using "cat /proc/cmdline".

   **Note:** If `intel_iommu=on` is not set in the grub, then it implies that QAT should be run
   without the configure script option `enable-icp-sriov`. The converse is also true.
   - Ensure that host configure script was run with "./configure --enable-icp-sriov=host"
     and that the guest configure script (if applicable) was run with "./configure --enable-
     icp-sriov=guest"
6.3.2 Relevant Collateral

- 330689, Using Intel® Virtualization Technology (Intel® V.T.) with Intel® QuickAssist Technology Application Note, at 01.org
7.0 Intel® QAT Performance Issues

This section describes resolution steps for Intel® QAT performance issues.

7.1 CPU Performance Beats Intel® QAT Performance

If the CPU performance beats Intel® QAT performance resolve this by using the resolution steps below.

7.1.1 Resolution

Try one or more of the following steps:

- Optimize the particular application for memory recycling
- Increase application concurrency and Intel® QAT configuration to use full parallelization
- Increase buffer/packet sizes (small packets may not see the offloading benefit)
- CPU performance may beat Intel® QAT for certain algorithms, for certain packages, with enough cores

7.1.2 Relevant Collateral

- 330687, Intel® QuickAssist Technology – Performance Optimization Guide, at 01.org

7.2 Intel® QAT Performance is Low

When Intel® QAT is not performing as expected try one or more of the following resolution steps to resolve the issue.

7.2.1 Resolution

Try one or more of the following steps:

- Optimize the particular application for memory recycling
- Increase application concurrency and Intel® QAT configuration to use full parallelization
- Increase buffer/packet sizes (small packets may not see the offloading benefit)
• CPU performance may beat Intel® QAT for certain algorithms, for certain packages, with enough cores
• Remove software stack layers to verify that Intel® QAT performance at the lower-lever layers is as expected

7.2.2 Relevant Collateral

• 330687, Intel® QuickAssist Technology – Performance Optimization Guide, at 01.org
• 336210, Intel® QuickAssist Technology Software for Linux® – Programmer’s Guide – Hardware Version 1.7, at 01.org
• Videos at https://software.intel.com/en-us/networking/quickassist
8.0 **NGINX* Issues**

This section describes steps to resolve NGINX* issues.

8.1 **NGINX* + Intel® QAT Performance is Low**

If performance is low with NGINX and Intel® QAT, follow the resolution steps below.

8.1.1 **Resolution**

Try one or more of the following steps:

- Use the [Intel® Select Solutions for NFVI](#) script to apply the correct settings (i.e., more worker processes, keep-alive settings, high concurrency, etc.)
- Ensure that Intel® QAT is being used with the firmware counters
- Ensure that GRUB does not have idle=poll
- Isolating cores in the GRUB has been shown to reduce performance

8.1.2 **Relevant Collateral**

[Intel® Select Solutions for NFVI](#)

8.2 **Core Dump Occurs During NGINX Reload**

The following is an example of a core dump that occurred during NGINX Reload (i.e. backtrace stack):

Core dump during Nginx reload, backtrace stack:

```
#0  0x00007f6964a20544 in Lac_MemPoolCleanUpInternal () from /usr/local/lib/libqat_s.so
#1  0x00007f6964a208a0 in Lac_MemPoolCreate () from /usr/local/lib/libqat_s.so
#2  0x00007f6964a3cb5a in SalCtrl_AsymInit () from /usr/local/lib/libqat_s.so
#3  0x00007f6964a3d573 in SalCtrl_CryptoInit () from /usr/local/lib/libqat_s.so
#4  0x00007f6964a40ac5 in SalCtrl_ServiceInit.constprop.2 () from /usr/local/lib/libqat_s.so
```
#5  0x00007f6964a41918 in SalCtrl_ServiceEventHandler () from 
/usr/local/lib/libqat_s.so

#6  0x00007f6964a4821d in adf_user_subsystemInit () from 
/usr/local/lib/libqat_s.so

#7  0x00007f6964a48edc in adf_proxy_get_device () from 
/usr/local/lib/libqat_s.so

#8  0x00007f6964a49030 in adf_proxy_get_devices () from 
/usr/local/lib/libqat_s.so

#9  0x00007f6964a47688 in icp_adf_userProxyInit () from 
/usr/local/lib/libqat_s.so

#10 0x00007f6964a450cc in do_userStart 
(process_name=0x7ffd66ddd660 "SHIM_INT_33") at 
/root/qat_upstream_driver/quickassist/lookaside/access_layer/src/
user/sal_user.c:137

#11 icp_sal_userStart (process_name=<optimized out>) at 
/root/qat_upstream_driver/quickassist/lookaside/access_layer/src/
user/sal_user.c:187

#12 0x00007f6964a45335 in icp_sal_userStartMultiProcess 
(pProcessName=<optimized out>, 
limitDevAccess=limitDevAccess@entry=CPA_FALSE) at 
/root/qat_upstream_driver/quickassist/lookaside/access_layer/src/
user/sal_user.c:220

#13 0x00007f69627a4e4f in qat_engine_init 
e=e@entry=0x55d014708140) at e_qat.c:475

#14 0x00007f69627a4f30 in engine_init_child_at_fork_handler () at 
quat_fork.c:91

#15 0x00007f6964d8caae in fork () from /lib64/libc.so.6

#16 0x000055d01326c90a in ngx_spawn_process 
(cycle=cycle@entry=0x55d01473c3f0, proc=proc@entry=0x55d01326e380 <ngx_worker_process_cycle>, data=data@entry=0x1, 
name=name@entry=0x55d0132d11db "worker process", 
respa=respawn@entry=0x55d01326d1db) at 
src/os/unix/ngx_process.c:186

#17 0x000055d01326db10 in ngx_start_worker_processes 
(cycle=cycle@entry=0x55d01473c3f0, n=32, type=type@entry=-4) at 
src/os/unix/ngx_process_cycle.c:361
8.2.1 Resolution

There is a work around. Allocate enough Hugepage Memory for Nginx. If there are 32 Nginx worker processes, during reload, the maximum number of work processes will be 64.

```bash
insmod ./usdm_drv.ko max_huge_pages=N
max_huge_pages_per_process=32
```

N should be larger than or equal to 32 * 64
9.0 OpenSSL*/QAT_Engine Issues

This section describes resolution steps for OpenSSL*/QAT_Engine issues.

9.1 Error with Version of OpenSSL*

If you see a result like the following:
[root@SR1B011 apps]# ./openssl version

./openssl: error while loading shared libraries:
libssl.so.1.1: cannot open shared object file: No such file or directory

Then most likely, the library path is not set up.
[root@SR1B011 apps]# echo $LD_LIBRARY_PATH

9.1.1 Resolution

Export the $LD_LIBRARY_PATH and rerun the command as follows:
[root@SR1B011 apps]# export
LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/local/ssl/lib

[root@SR1B011 apps]# ./openssl version

OpenSSL 1.1.1 11 Sep 2018

9.1.2 Relevant Collateral

https://github.com/intel/QAT_Engine (including the Troubleshooting section)

9.2 Errors with make/make install of the Intel® QAT OpenSSL* Engine

You experience errors with make or make install as in the following:
qat_ciphers.c:464:26: note: each undeclared identifier is reported only once for each function it appears in make[1]: ***
[qat_rsa.lo] Error 1 qat_ciphers.c: In function
'qat_chained_ciphers_do_cipher':

qat_ciphers.c:1651:59: error: 'ASYNC_STATUS_OK' undeclared (first use in this function) if ((job_ret = qat_pause_job(done.opDone.job, ASYNC_STATUS_OK)) == 0)
^ qat_ciphers.c: In function 'qat_sym_perform_op':
qat_ciphers.c:1778:48: error: 'ASYNC_STATUS_EAGAIN' undeclared
            (first use in this function)                  if
            ((qat_wake_job(opDone->job, ASYNC_STATUS_EAGAIN)
              == 0) ||

9.2.1 Resolution

The root cause could be you have cloned the QAT_Engine with the OpenSSL repository. It is not normally advised to clone one git repo within another. In this case, clone the QAT_Engine somewhere other than in the OpenSSL repository.

9.2.2 Relevant Collateral

https://github.com/intel/QAT_Engine (including the Troubleshooting section)
10.0 **HAProxy** Issues

This section describes resolution steps for HAPerxy issues.

10.1 **HAProxy** + Intel® QAT Error when Starting HAPerxy

Starting HAPerxy results in the following message:
"ssl-engine qat: failed to get structural reference"

10.1.1 Resolution

Review the **HAProxy with Intel® QuickAssist Technology Application Note** to verify that all required steps were covered.

10.1.2 Relevant Collateral

337430, HAPerxy with Intel® QuickAssist Technology Application Note, on 01.org

10.2 **HAProxy** + Intel® QAT Performance is Low

If you experience a low performance of HAPerxy and Intel® QAT, refer to the resolution steps below to isolate the issue.

10.2.1 Resolution

- Use the **Intel® Select Solutions for NFVI** script to reapply the correct settings (i.e., more worker processes, keep-alive settings, high concurrency, etc.)
- Ensure that Intel® QAT is being used, with the firmware counters
- Ensure that GRUB does not have idle=poll
- Isolating cores in the GRUB has been shown to reduce performance

10.2.2 Relevant Collateral

Intel® Select Solutions for NFVI
**10.3 Error with HAProxy* Version**

If you experience the following error:
```
# ./haproxy -vv
```
```
./haproxy: error while loading shared libraries: libssl.so.1.1: cannot open shared object file: No such file or directory
```

It is likely that the `LD_LIBRARY_PATH` variable is not set up.

**10.3.1 Resolution**

Define the `LD_LIBRARY_PATH` and verify that the “Built with” and “Running on” OpenSSL versions are the same.
```
# export LD_LIBRARY_PATH=/usr/local/ssl/lib

# ./haproxy -vv
```

HAProxy version 1.9.4 2019/02/06 - https://haproxy.org/

**10.3.1.1 Build Options**

- `TARGET = linux2628`
- `CPU = generic`
- `CC = gcc`
- `OPTIONS = USE_OPENSSL=1`

**10.3.1.2 Default settings:**

- `maxconn = 2000, bufsize = 16384, maxrewrite = 1024, maxpollevents = 200`
- Built with OpenSSL version: OpenSSL 1.1.1 11 Sep 2018
- Running on OpenSSL version: OpenSSL 1.1.1 11 Sep 2018

**10.3.2 Relevant Collateral**

337430, HAProxy* with Intel® QuickAssist Technology Application Note, at 01.org, especially the following sections:
HAProxy* Issues

- Section 3.0, “HAProxy* Setup and Testing for HTTP Connections”
- Section 3.1, “Installing HAProxy*”
- Section 3.2, “Verifying HAProxy* Installation”

10.4 HAProxy* Shared Libraries libssl.so.1.1 and libcrypto.so.1.1 are Not Found

The HAProxy shared libraries `libssl.so.1.1` and `libcrypto.so.1.1` are not found when running the command "ldd haproxy":

```
$ ldd haproxy
        linux-vdso.so.1 => (0x00007ffe4853e000)
        libcrypt.so.1 => /lib64/libcrypt.so.1 (0x00007ff32d26e000)
        libdl.so.2 => /lib64/libdl.so.2 (0x00007ff32d06a000)
        libpthread.so.0 => /lib64/libpthread.so.0 (0x00007ff32ce4e000)
        librt.so.1 => /lib64/librt.so.1 (0x00007ff32cc46000)
        libssl.so.1.1 => not found
        libcrypto.so.1.1 => not found
        libc.so.6 => /lib64/libc.so.6 (0x00007ff32c878000)
        libfreebl3.so => /lib64/libfreebl3.so (0x00007ff32c675000)
```

10.4.1 Resolution

Define the `LD_LIBRARY_PATH` variable and verify that the `libssl.so.1.1` and `libcrypto.so.1.1` files point to the correct libraries.

```
$ export LD_LIBRARY_PATH=/usr/local/ssl/lib
$ ldd haproxy
        linux-vdso.so.1 => (0x00007ffd75bbf000)
        libcrypt.so.1 => /lib64/libcrypt.so.1 (0x00007feaeb0e4000)
        libdl.so.2 => /lib64/libdl.so.2 (0x00007feaeaee000)
        libpthread.so.0 => /lib64/libpthread.so.0 (0x00007feaeaacc4000)
        librt.so.1 => /lib64/librt.so.1 (0x00007feaeaabc000)
        libssl.so.1.1 => /usr/local/ssl/lib/libssl.so.1.1 (0x00007feaa82a000)
        libcrypto.so.1.1 => /usr/local/ssl/lib/libcrypto.so.1.1 (0x00007feaa35000)
        libc.so.6 => /lib64/libc.so.6 (0x00007feae9f77000)
        libfreebl3.so => /lib64/libfreebl3.so (0x00007feae9d74000)
```

10.4.2 Relevant Collateral

337430, HAProxy* with Intel® QuickAssist Technology Application Note, at 01.org, especially the following sections:
- Section 3.0, “HAProxy* Setup and Testing for HTTP Connections”
- Section 3.1, “Installing HAProxy***
10.5 Fatal Errors with HAProxy* Configuration File

If you experience fatal errors with the HAProxy configuration file, like the following:

```
#] ./haproxy -f /etc/haproxy/allhaproxy.cfg
[ALERT] 178/155753 (38095) : ssl-engine qat: failed to get structural reference
[ALERT] 178/155753 (38095) : parsing [/etc/haproxy/allhaproxy.cfg:3] : (null)
[ALERT] 178/155753 (38095) : Error(s) found in configuration file:
/etc/haproxy/allhaproxy.cfg [ALERT] 178/155753 (38095) : Fatal errors found in configuration.
```

It is likely that the `LD_LIBRARY_PATH` variable is not set up.

10.5.1 Resolution

Run the following commands:
```
#] export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/local/ssl/lib
#] ./haproxy -f /etc/haproxy/allhaproxy.cfg
```

10.5.2 Relevant Collateral

337430, HAProxy* with Intel® QuickAssist Technology Application Note, at 01.org, especially the following sections:

- Section 3.0, “HAProxy* Setup and Testing for HTTP Connections”
- Section 3.1, “Installing HAProxy*.”
- Section 3.2, “Verifying HAProxy* Installation.”

10.6 HAProxy* Test Does not Appear to Produce the Expected Results using ApacheBench as a Load Generator

If you experience this issue, you may need to use the OpenSSL* `s_time` command as a load generator, with a new HAProxy Intel® QAT configuration file.
10.6.1 Resolution

An example of a recommended HAProxy Intel® QAT configuration file is listed below for use when running the OpenSSL s_time command. Please note that the bold line would be removed if you were running the test without Intel® QAT (i.e., with software).

```
j# cat myhaproxy-qat.cfg
    global
      user root
      group root
      nbproc 15
      maxconn 200000
      ulimit n 700000
daemon

ssl-engine qat algo ALL
ssl-mode-async

ssl-default-bind-ciphers AES128-SHA

ssl-default-bind-options
  no-tls-tickets
  no-sslv3
  no-tlsv10
  no-tlsv11
  tune.bufsize 65536
  defaults
  backlog 327680
  balance
  source
  retries 3

frontend myfrontend
  mode http

bind 127.0.0.1:4400
  ssl
crt /etc/ssl/myhaproxy/myhaproxy.pem

option
  forceclose
  option httpclose
  option http-server-close
  option nolinger
  timeout client 100s

  timeout client-fin 0s
  timeout http-keep-alive 0s
  default_backend
  mybackend
  backend
  mybackend
  balance
  roundrobin
  option httpclose
  option http-server-close
  timeout connect 100s
  timeout server 100s
  timeout server-fin 0s
  option nolinger
  option forceclose
  mode http

  timeout http-keep-alive 0s
  server myvm 127.0.0.1:80

check
```

10.6.2 Relevant Collateral

337430, HAProxy* with Intel® QuickAssist Technology Application Note, at 01.org, especially the following sections:

- Section 3.0, “HAProxy* Setup and Testing for HTTP Connections”
- Section 3.1, “Installing HAProxy*.”
- Section 3.2, “Verifying HAProxy* Installation.”
10.7 Issues making ssl Connection against HAProxy Launched with Intel® QAT Configured as Non-root User.

**Note:** You may be able to start HAProxy, and everything is fine. Intel® QAT reports no warnings, but issues occur as soon as a request is made.

One example of debug output:

```plaintext
[DEBUG][qat_rsa.c:911:qat_rsa_priv_enc()] - Started.
[DEBUG][qat_rsa.c:403:build_decrypt_op_buf()] - Started
[DEBUG][qat_rsa.c:415:build_decrypt_op_buf()] flen = 256, padding = 3
[WARNING][qat_asym_common.c:112:qat_BN_to_FB()] Failed to allocate fb-
>pData
[WARNING][qat_rsa.c:460:build_decrypt_op_buf()] Failed to convert privateKeyRep2 elements to flatbuffer
[WARNING][qat_rsa.c:944:qat_rsa_priv_enc()] Failure in build_decrypt_op_buf
[DEBUG][qat_rsa.c:210:rsa_decrypt_op_buf_free()] - Started
[DEBUG][qat_rsa.c:233:rsa_decrypt_op_buf_free()] - Finished
```

Another example:

```plaintext
[DEBUG][qat_rsa.c:845:qat_rsa_priv_enc()] - Started.
[DEBUG][qat_rsa.c:369:build_decrypt_op_buf()] - Started
[DEBUG][qat_rsa.c:381:build_decrypt_op_buf()] flen = 256, padding = 3
[MEM_DEBUG][cmn_mem_drv_inf.c:87:qaeCryptoMemAlloc()]
(pthread_mutex_lock
[DEBUG][cmn_mem_drv_inf.c:95:qaeCryptoMemAlloc()] Address: (nil)
Size: 128 File: qat_asym_common.c:104
[MEM_DEBUG][cmn_mem_drv_inf.c:99:qaeCryptoMemAlloc()]
(pthread_mutex_unlock
[WARNING][qat_asym_common.c:107:qat_BN_to_FB()] Failed to allocate fb-
>pData
[WARNING][qat_rsa.c:426:build_decrypt_op_buf()] Failed to convert privateKeyRep2 elements to flatbuffer
[WARNING][qat_rsa.c:872:qat_rsa_priv_enc()] Failure in build_decrypt_op_buf
[DEBUG][qat_rsa.c:209:rsa_decrypt_op_buf_free()] - Started
[DEBUG][qat_rsa.c:232:rsa_decrypt_op_buf_free()] - Finished
```

10.7.1 Resolution

The Intel® QAT Engine/libqat uses usdm_drv and mmap()'s physical memory regions it gets from the memory driver. On some distro's with systemd, non-root users have a
**memlock** limit set by default to a too low value, and that triggers `mmap()` error with `-EAGAIN`.

To see if this is the case, run:

1. The Linux* command **strace** to see the error.
2. See the **memlock** limit for your HAProxy process.
3. If **memlock** is your problem, set a bigger value, e.g., for your **haproxy.service** by adding an override .conf to it:

   ```
   [Service]
   LimitMEMLOCK=<some value, e.g, 16M>
   ```

### 10.7.2 Relevant Collateral

337430, HAProxy* with Intel® QuickAssist Technology Application Note, at 01.org, especially the following sections:
11.0 **DPDK Issues**

This section describes resolution steps for DPDK issues.

11.1 **DPDK cryptodev failure**

If you experience the following issue, please follow the resolution steps below: There is no Intel® QAT PMD available for the DPDK application.

If you experience a DPDK cryptodev failure because there is no Intel® QAT PMD available for the DPDK application, please follow the resolution steps.

11.1.1 **Resolution**

Quick instructions for Intel® QAT cryptodev PMD are as follows:

```bash
  cd to the top-level DPDK directory
  make defconfig
  sed -i 's,\(CONFIG_RTE_LIBRTE_PMD_QAT_SYM\)=n,\l=y,\' build/.config
  or/and sed -i 's,\(CONFIG_RTE_LIBRTE_PMD_QAT_ASYM\)=n,\l=y,\' build/.config
  make
```

11.1.2 **Relevant Collateral**

[https://doc.dpdk.org/guides/cryptodevs/qat.html](https://doc.dpdk.org/guides/cryptodevs/qat.html)
12.0 Miscellaneous Issues

This section describes resolution steps for otherwise uncategorized issues.

12.1 Possible Errors Due to BIOS Setting

Issues like the following may be due to BIOS settings:

- Running `make install` on the Intel® QAT Engine returns an error similar to error -14:
  
  ```
  dh895xcc: probe of 0000:b1:00.0 failed with error -14
  ```

  **Note:** The above result may be seen in `dmesg` and/or `/var/log/syslog`.

- Error "Failed to send admin msg to accelerator":
  
  ```
  dh895xcc 0000:b1:00.0: Failed to send init message
  ```

  **Note:** The above result may be seen in `/var/log/messages`.

- Fewer qat acceleration devices than you expect when starting Intel® QAT:
  
  For example, you may see all the c6xx type devices, but not the dh895x device.

12.1.1 Resolution

Please refer to Section 4.5 of *QuickAssist Technology Software for Linux* - *Release Notes - H.W. version 1.7* (Document ID 336211). The title of the section is, "When trying to start the Intel QuickAssist Technology driver, I see errors similar to one of the following..."

12.1.2 Relevant Collateral


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