A new framework of cryptography virtio driver

Lei Gong

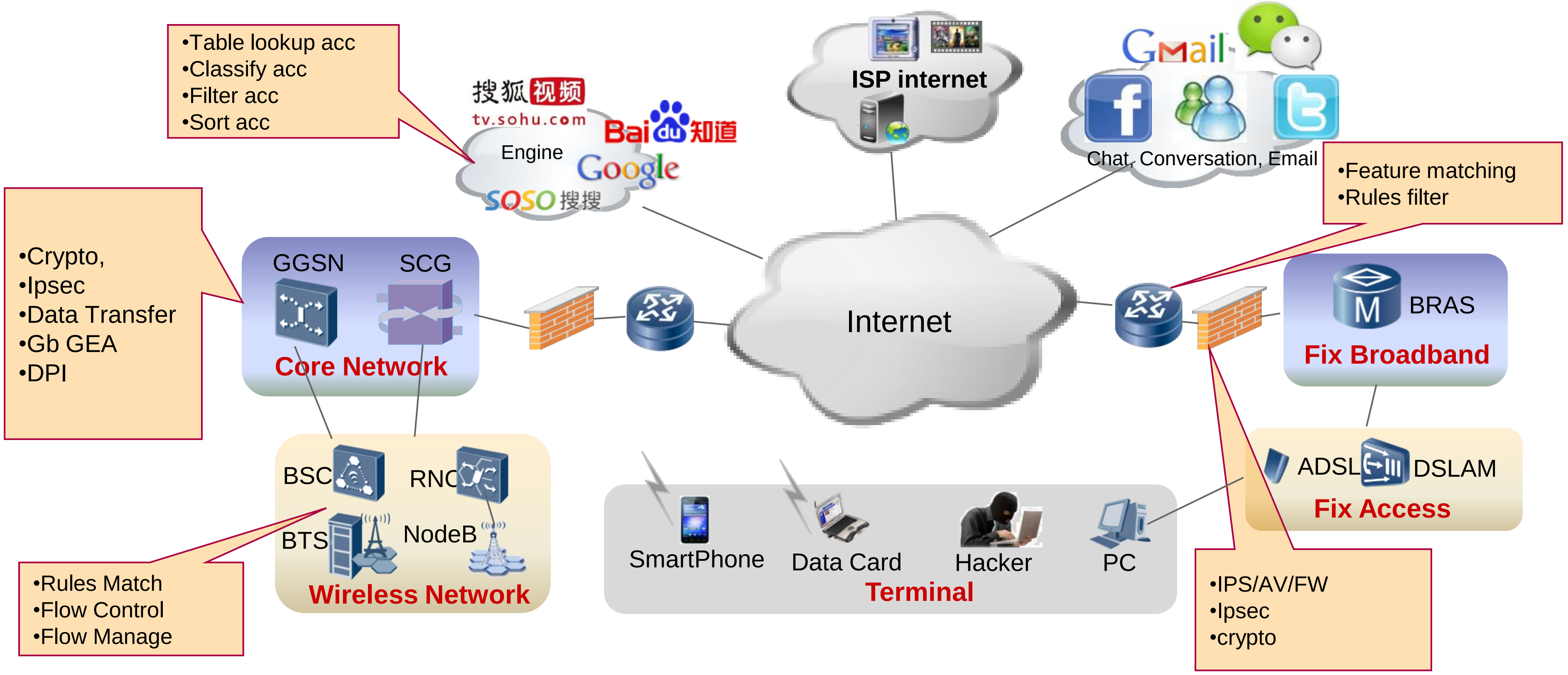
arei.gonglei@huawei.com

www.huawei.com

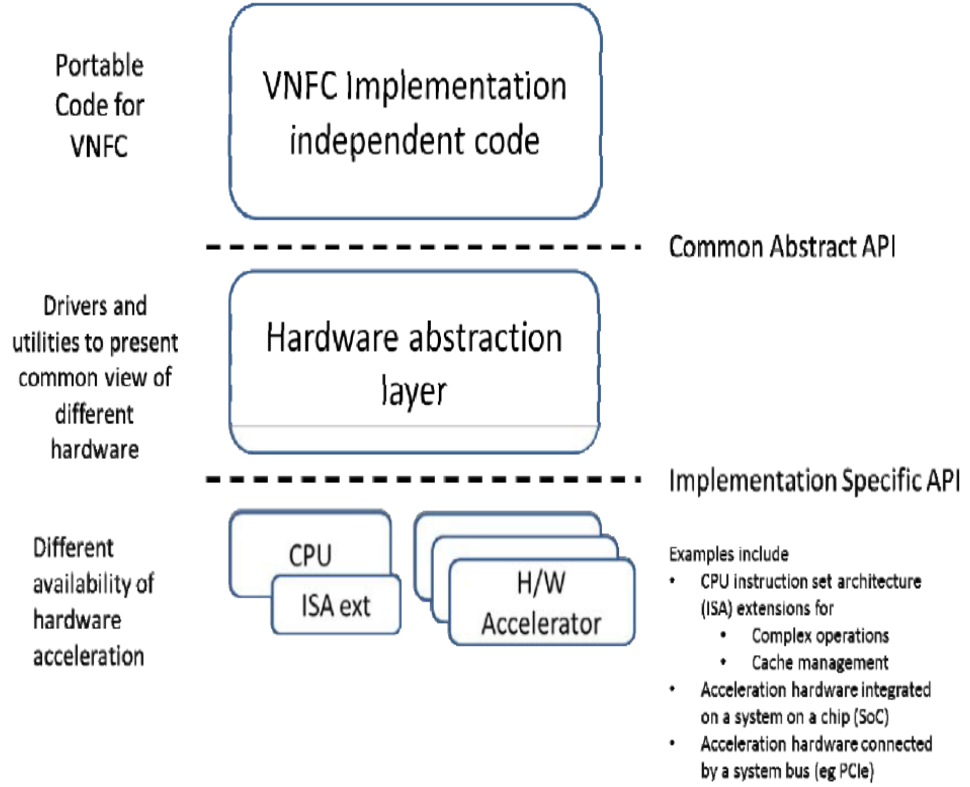
HUAWEI

HUAWEI TECHNOLOGIES CO., LTD.

Scenarios of Hardware Acceleration

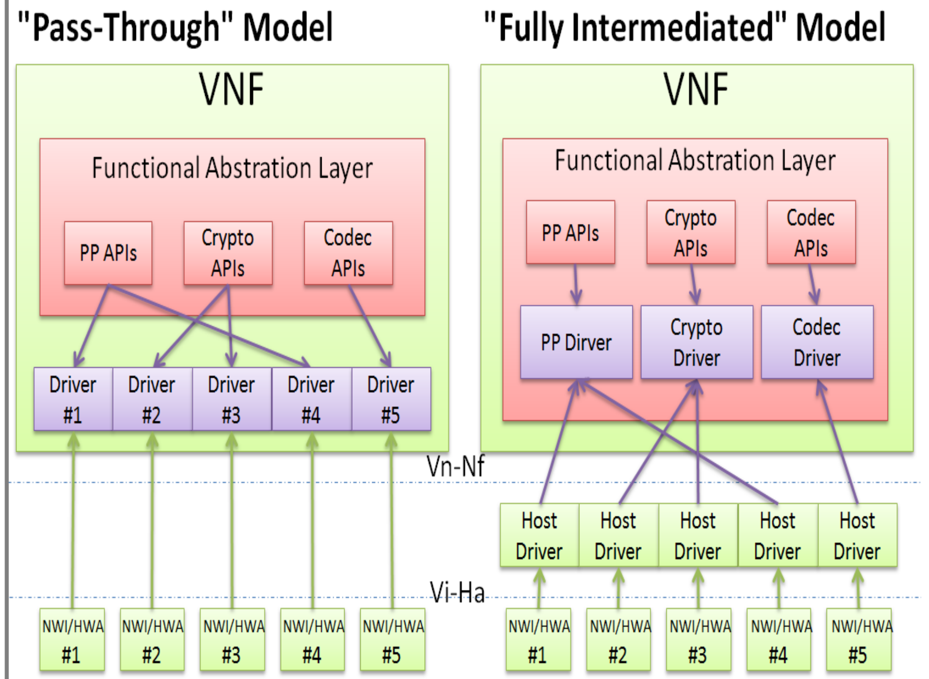


Abstract model of Accelerators (NFV)


Portable Code for VNFC
VNFC Implementation independent code
Common Abstract API
Drivers and utilities to present common view of different hardware
Hardware abstraction layer
Implementation Specific API
Different availability of hardware acceleration
CPU
ISA ext
H/W Accelerator

Examples include
- CPU instruction set architecture (ISA) extensions for
  - Complex operations
  - Cache management
- Acceleration hardware integrated on a system on a chip (SoC)
- Acceleration hardware connected by a system bus (eg PCIe)

Note: the original figure forwarded from ETSI GS NFV-INF 003 V1.1.1 (2014-12)

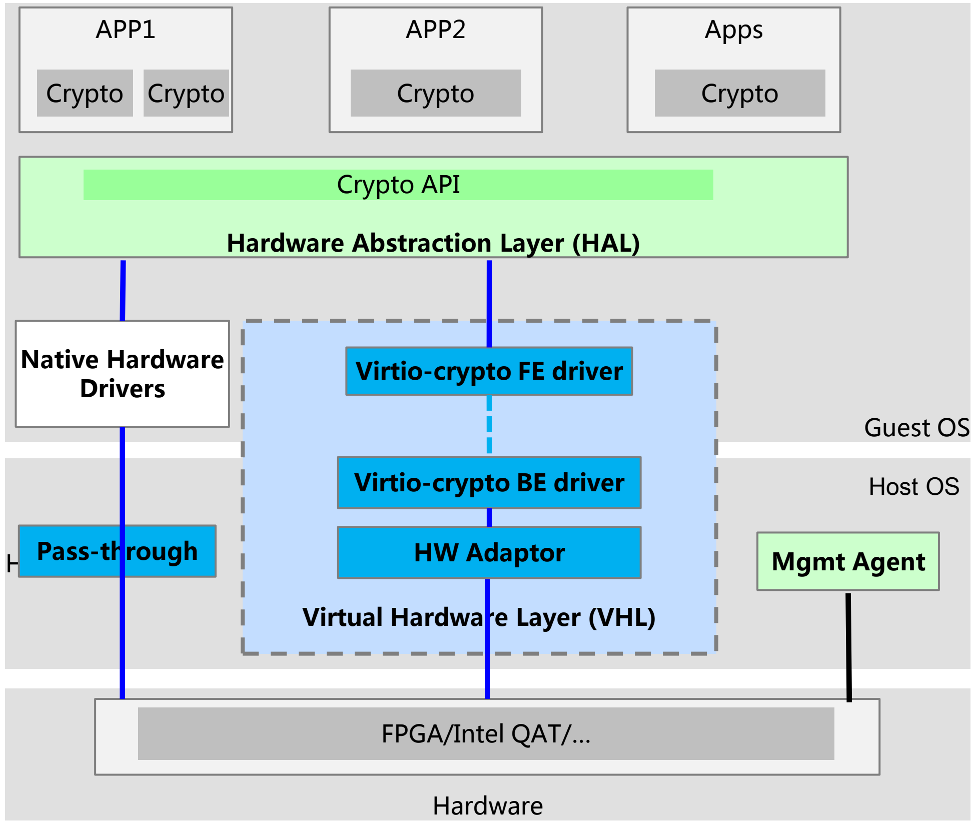


https://wiki.opnfv.org/dpacc/dpacc_project_proposal

Why Virtio-crypto?

- Programmability
- Portability
- Scalability
- Hardware agnostic

Virtualization of Cryptography Accelerator



1. **HAL**

   Provide acceleration APIs and runtimes

2. **VHL**

   Provide virtual accelerators:

   1) virito-crypto FE driver

   2) virtio-crypto BE driver

   3) HW Adaptor : support different crypto accelerators

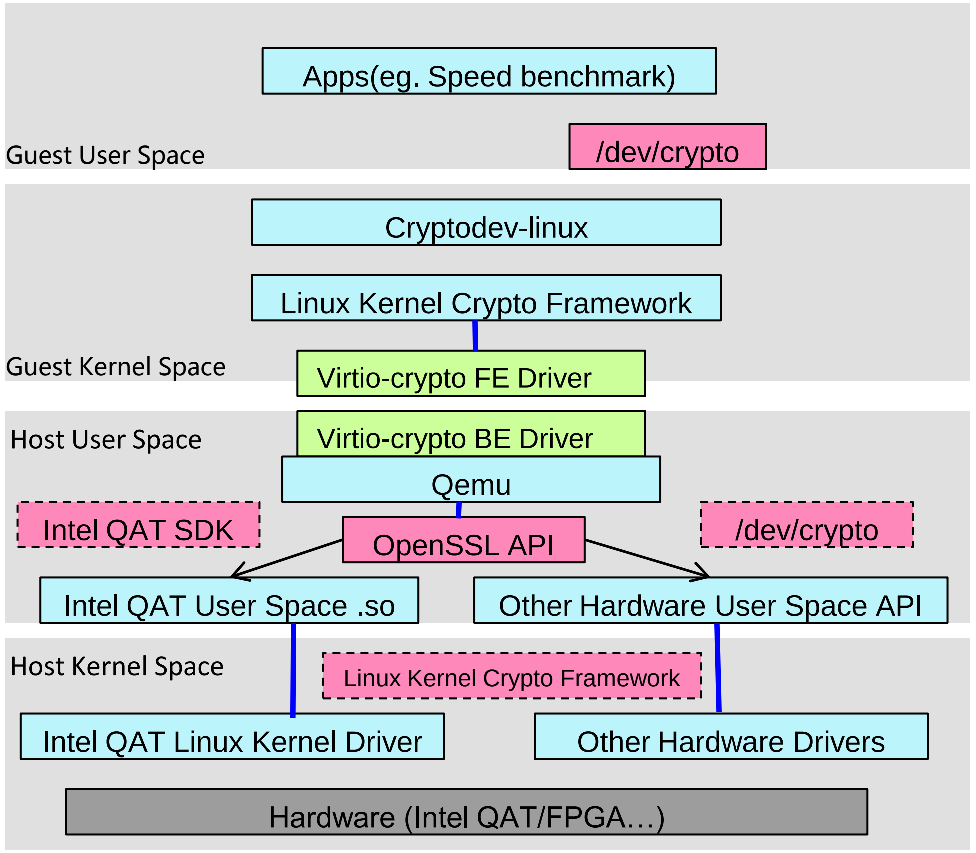
3. **Pass-through**

   Accelerator pass-through

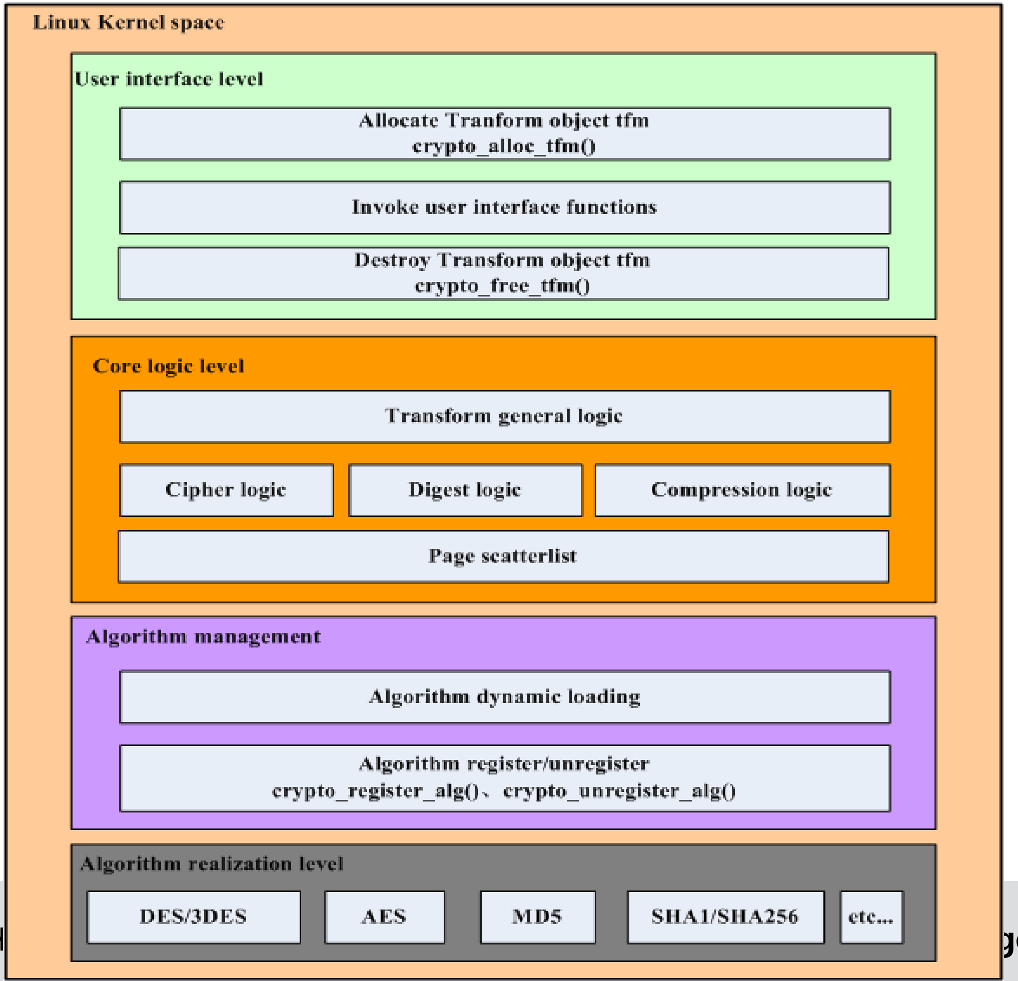
4. **Mgmt Agent**

   Accelerator management

Flow of Virtio-crypto Prototype



Linux Kernel Crypto Framework



The kernel Crypto API

- ◆A cryptography framework in the Linux kernel
- ◆Can do Cipher, Hash, Compress, RNG,. . .
- ◆ Used by:
  - ✓Network stack: IPsec, . . .
  - ✓Device Mapper: dm-crypt, RAID, . . .
  - ✓Userland Accessing:
    - ✓AF_ALG
    - ✓Cryptodev
- ◆Maillist: linux-crypto@vger.kernel.org

AF_ALG introduction

* Supports CIPHER, HASH
* Socket-based interface

+ In-kernel code for years
+ Inherently asynchronous
- OpenSSL has out-of-tree engine for AF ALG
- GnuTLS does not have support for AF ALG
- Not many examples
- Higher latency

Cryptodev introduction

* Supports CIPHER, HASH, AEAD
* Uses character device interface

+ Compatible with OpenBSD /dev/crypto
+ API compatible, not OpenBSD code
+ OpenSSL has engine for cryptodev
+ GnuTLS has support for cryptodev
+ Has nice examples
+ Lower latency
- Out of kernel tree code (for years)
- Adds arbitrary IOCTLs

Cryptodev howto

Cryptodev usage pattern:

a) int cfd = open("/dev/crypto");
b) Fill in common struct cryptodev ctx
c) Fill in struct crypt op
d) Pass struct crypt op into kernel via ioctl()
e) Retrieve results
f) close(cfd);

Virtio-crypto BE driver

* Emulate virtio-crypto devices in Qemu:

Command line: -device virtio-crypto-pci,id=crypto0

* Support different backend drivers:

OpenSSL, Cryptodev, Intel QAT SDK

* Support multiple virtio devices for each VM

* Fit Virtio-1.0 spec

* Cooperate with the virtio-crypto driver in guest

Virtio-crypto device

```
# lspci –v
[skip]
00:05.0 Unclassified device [00ff]: Red Hat, Inc Device 103f
        Subsystem: Red Hat, Inc Device ffff
        Flags: bus master, fast devsel, latency 0, IRQ 34
        I/O ports at c000 [size=512]
        Memory at febd3000 (32-bit, non-prefetchable) [size=4K]
        Capabilities: [40] MSI-X: Enable+ Count=2 Masked-
        Kernel driver in use: virtio-pci
        Kernel modules: virtio_pci
```

Virtio-crypto FE driver

* As a hardware crypto device
* Support different algorithms:

Cipher, Hash, AEAD

* Support multiple virtio devices for each VM
* Fit Virtio-1.0 spec

Virtio-crypto module

```
# modinfo virtio-crypto
filename:       virtio-crypto.ko
author:         Gonglei <arei.gonglei@huawei.com>
license:        GPL
description:    Virtio crypto device driver
srcversion:     B5B95C74287DAE3AB7C134D
alias:          virtio:d0000FFFFv*
depends:        virtio_ring,virtio
vermagic:       3.0.76-0.11 SMP mod_unload modversions
parm:           virtio_crypto_verbosity:0: normal, 1: verbose, 2:
debug (int)
```

Register algorithms

```
static struct crypto_alg virtio_crypto_algs[] = { {
        .cra_name = "cbc(aes)",
        .cra_driver_name = "virtio_crypto_aes_cbc",
        .cra_priority = 4001,
        .cra_flags = CRYPTO_ALG_TYPE_ABLKCIPHER | CRYPTO_ALG_ASYNC,
        .cra_blocksize = AES_BLOCK_SIZE,
        .cra_ctxsize  = sizeof(struct virtio_crypto_ablkcipher_ctx),
        .cra_alignmask = 0,
        .cra_module = THIS_MODULE,
        .cra_type = &crypto_ablkcipher_type,
        .cra_init = virtio_crypto_ablkcipher_init,
        .cra_exit = virtio_crypto_ablkcipher_exit,
        .cra_u = {
           .ablkcipher = {
                        .setkey = virtio_crypto_ablkcipher_setkey,
                        .decrypt = virtio_crypto_ablkcipher_decrypt,
                        .encrypt = virtio_crypto_ablkcipher_encrypt,
                        .min_keysize = AES_MIN_KEY_SIZE,
                        .max_keysize = AES_MAX_KEY_SIZE,
                        .ivsize = AES_BLOCK_SIZE,
                },
        },
},…
```

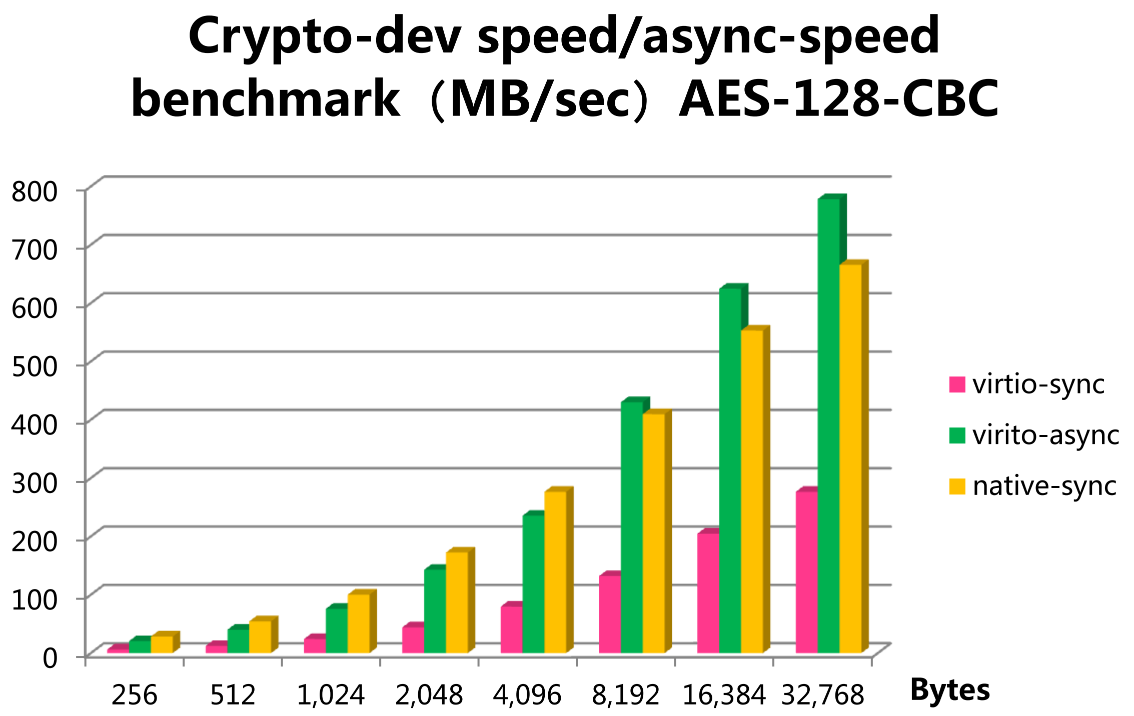
Virtio-crypto synchronize running

```
#cryptodev-linux-1.7 # ./tests/cipher -
requested cipher CRYPTO_AES_CBC, got cbc(aes) with driver virtio_crypto_aes_cbc
AES Test passed
requested cipher CRYPTO_AES_CBC, got cbc(aes) with driver virtio_crypto_aes_cbc
requested cipher CRYPTO_AES_CBC, got cbc(aes) with driver virtio_crypto_aes_cbc
Test passed
```

Virtio-crypto asynchronize running

```
#cryptodev-linux-1.7 # ./tests/async_cipher -
cryp1 written out
cryp2 written out
cryp1 + cryp2 successfully read
result 1 passed
result 2 passed
AES Test passed
running test_crypto
test_crypto: got the session
test_crypto: data encrypted
test_crypto: session finished
test_crypto: got new session
test_crypto: data encrypted
Test passed
```

Performance



- **Hardware**
  1) Intel(R) Xeon(R) CPU E5-2620 v3 @ 2.40GHz
  2) Intel QAT Coleto Creek PCIe DH895xCC SKU2
- **Software**
  Guest: Suse11.3 with 8 GB memory, 8vcpu
  Host: KVM 3.12, QEMU 2.4-rc3

TODO:

1. Performance optimization:
   virtio-crypto-dataplane, batch processing, etc.
2. Other crypto algorithms support
3. Virtio-crypto upstream:
   virtio-crypto spec, virtio-crypto code…

Q/A

Thank you!