TPM2.0 practical usage

Using a firmware TPM 2.0 on an embedded device

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Agenda

Trusted Platform Module 2.0: a practical example

- what is a TPM?
- using TPM2.0 (on a Minnowboard Max/Turbot)
- a practical example
  - generating a signing key on a TPM2.0
  - signing a document
  - verify a signature

What is a TPM?

What is a TPM

Overview

- TPM stands for **Trusted Platform Module**
- specs written by the **TCG**
  - AMD, Hewlett-Packard, IBM, Intel and Microsoft
  - standardised in **ISO/IEC 11889** (2009, TPM1.2)
- present in most computers, including embedded platforms
  - e.g. Microsoft mandated a TPM 2.0 for WM10

What is a TPM

Overview

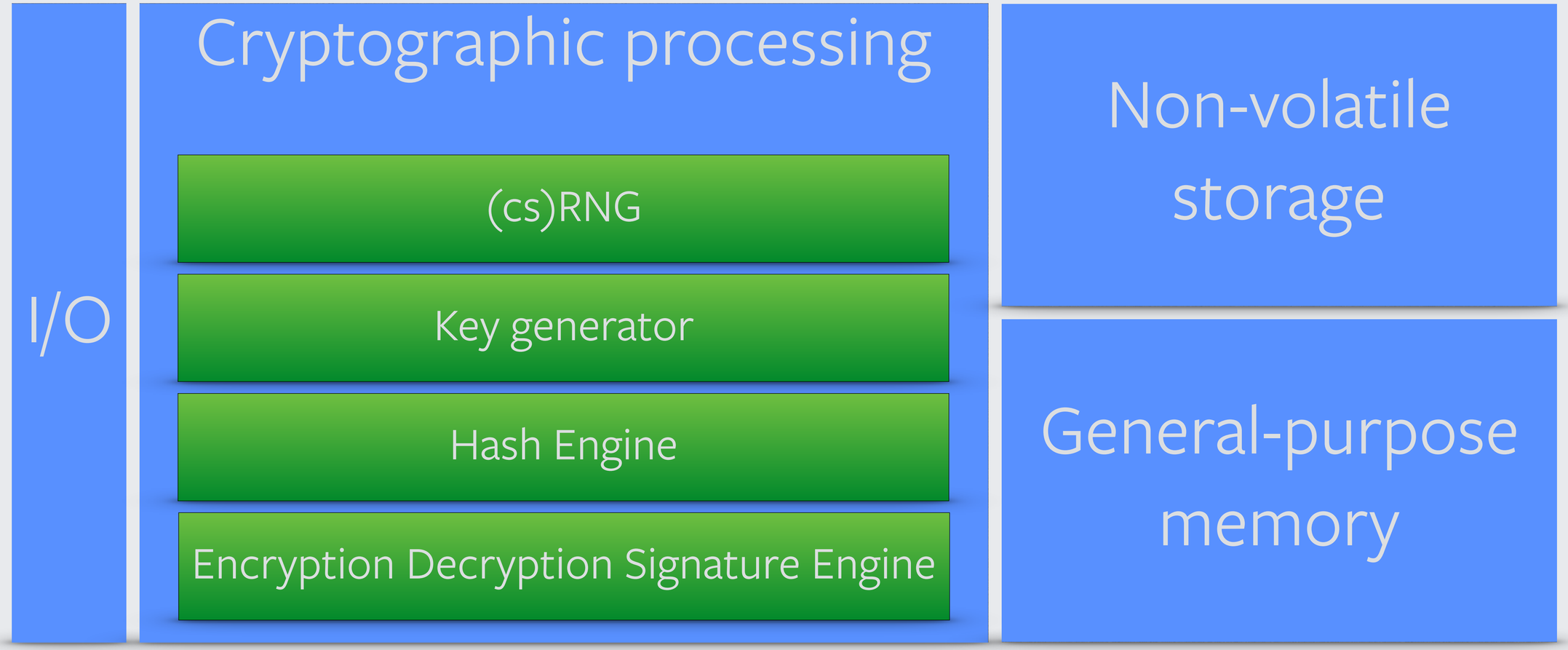
- cryptographic processor
  - **not an accelerator!**

believe it or not, **TPMs are slow "by design"**

because of import/export restriction on cryptographic technologies that some countries have

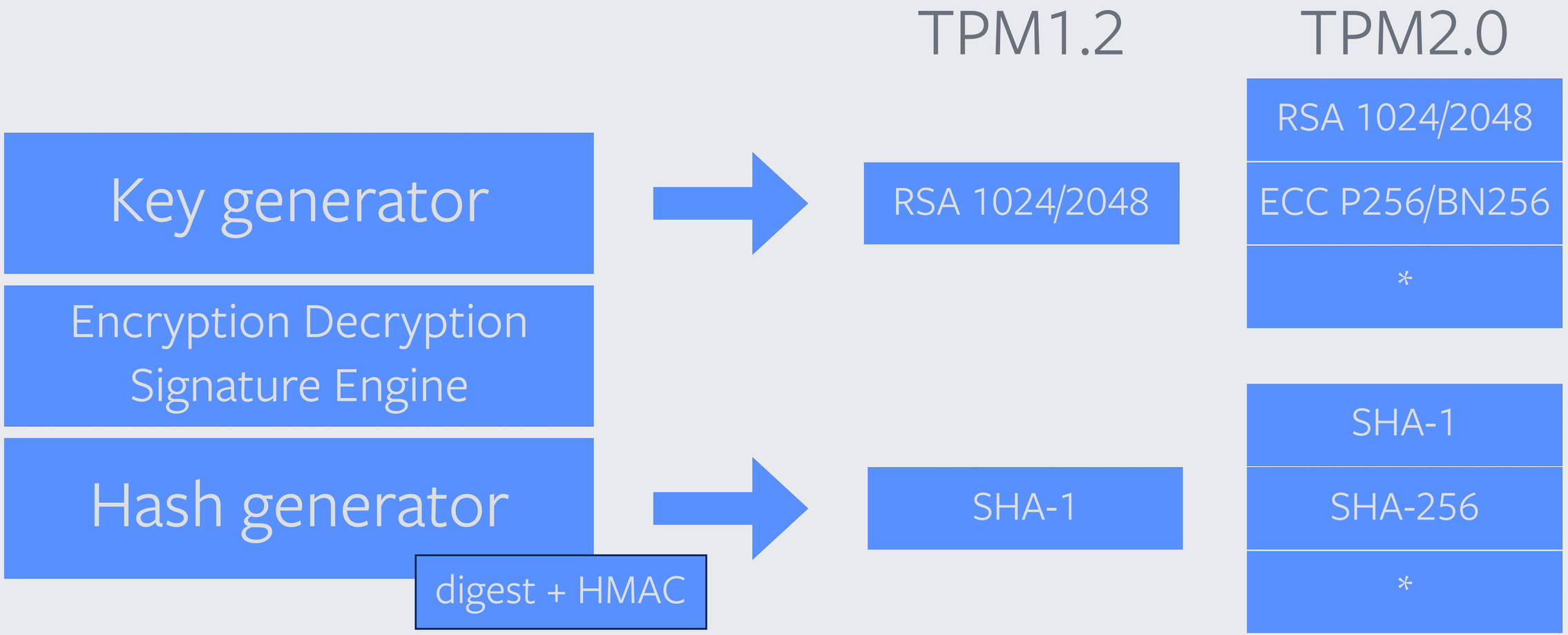
What is a TPM

Building blocks



What is a TPM

TPM1.2 vs TPM2.0



What is a TPM

TPM typical usage

- **platform integrity (secure boot, trusted boot)**
  - is a computer platform in a trusted condition?
  - incrementally, from *power-on* to OS is *up and running*
- **disk encryption**
  - TPM stores and control access to the key
- **DRM**
  - *e.g.* verify code signature

What is a TPM

Types of TPM

- **hardware (discrete) TPM**
  - physical component
- **firmware TPM (fTPM)**
  - emulated TPM using an isolated HW environment named Trusted Execution Engine (TXE)
- **simulator**
  - software TPM in user space

Using TPM2.0

Software (x86)

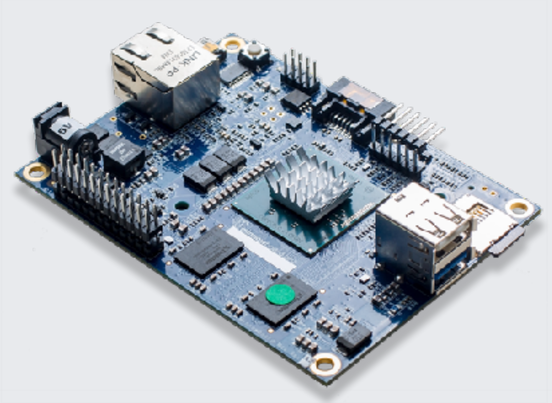
Intel vs IBM TPM2.0-TSS (TPM software stack)- highlights

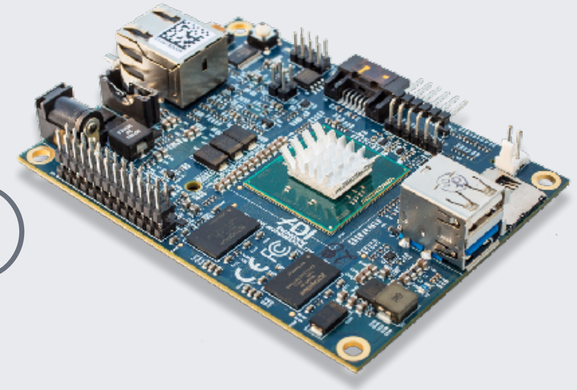
- **IBM**
  - TPM simulator running on Linux (can be used with Intel TSS)
  - source available on source forge
  - no Resource Manager
  - lots of tools
- **Intel (undergoing some important improvements)**
  - developed on Github (more "open": PRs, etc...)
  - TCP implementation of the RM (in-kernel aimed for 4.11)
  - fewer tools

Hardware!

MinnowBoard Max / MinnowBoard Turbot

- dual Core Atom E3800 family Valleyview SoC
  - 1.33 GHz / 1.46 GHz
  - 2 GB DDR3 RAM
  - Intel HD Graphics (up to 1920x1080)
  - UEFI system firmware
  - fTPM 2.0 (not enabled in the OEM firmware)
- ~150 € (used to be sold on Amazon)





A practical example

Using TPM2.0 Tools

Foreword

- using TPM2.0 tools for *"real world"* applications is not easy
  - they don't use widely supported formats like PEM or DER

- but the TSSes provide an API (SAPI) that can be used in your C/C++ apps, although the TCG spec is quite hard to digest

- let's see how to use the **Intel** tooling to do something useful with a TPM2.0

Intel TPM2.0 Tools

What's needed

- enable fTPM in UEFI configuration settings (PTT for MBM/T)
- set up Linux (> 4.4 preferred) any recent distro will do
  - flash it on a micro SD card
- install Intel TPM2.0-TSS (packages available for some distro)
  - this includes the Resource Manager daemon
- install Intel TPM2.0-Tools

Create a signing key

Endorsement Key

- Intel Tools won't allow creating a primary signing key
  - we need to create an EK and use that to generate a AIK

```
~# tpm2_getpubek -H 0x81010000 -g 0x01 -f ek.pub
```

- this will:
  - generate a 2048 RSA (`0x01`) key pair
  - store it in the NVM with handle `0x81010000`
  - export the public part in `ek.pub`

Create a signing key

Attestation Identity Key

- create an AIK with the EK just created

```
~# tpm2_getpubak -E 0x81010000 -k 0x81010010 \
     -f aik.pub -n aik.name
```

- generates a 2048 RSA key pair using the EK with handle `0x81010000`
- stores it in the NVM with handle `0x81010010`
- exports the public part in `ak.pub`
- `ak.pub` is in a format described by the TGC standard

Create a signing key

OpenSSL conversion

- extract RSA modulus (skip TPMT_PUBLIC header)

```
~# dd if=aik.pub of=modulus.bin bs=1 skip=102 count=256
```

- create the DER fixed header and mid-header

```
~# echo 'MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEA'|\
     openssl base64 -a -d > header.bin
~# echo -en '\x02\x03' > mid-header.bin
```

Create a signing key

OpenSSL conversion

- create the exponent (always 65537)

```
~# echo -ne '\x01\x00\x01' > exponent.bin
```

- compose the DER key!

```
~# cat header.bin modulus.bin mid-header.bin \
     exponent.bin > aik-pub.der
```

Signing a document

OpenSSL conversion

- create an hash from the document
  - ticket.bin is used as a proof that the hash has been created by this TPM

```
~# tpm2_hash -H e -g 0x0B -I message.txt \
     -o hash.bin -t ticket.bin
```

- sign the hash

```
~# tpm2_sign -k 0x81010010 -g 0x0B -m message.txt \
     -s sign.bin -t ticket.bin
```

Verify a signature

OpenSSL conversion

- extract the ″raw″ signature

```
~# dd if=sign.bin of=sign.raw bs=1 skip=6 count=256
```

- verify the signature

```
~# openssl dgst -verify aik-pub.der -keyform der \
     -sha256 -signature sign.raw message.txt
Verified OK
```

Thanks!

References

TPM2.0 Library specification

https://fb.me/**tpm2-spec**

Intel TPM2.0-TSS and Tools

https://fb.me/**intel-tpm2-tss**

https://fb.me/**intel-tpm2-tools**

enabling fTPM on MinnowBoard Max/Turbot

https://fb.me/**ftpm-on-mbm**

RSA signatures with TPM2.0 and OpenSSL

https://fb.me/**tpm2-openssl**