Intel® SGX Technology:

Trusted Execution Environment for DRMs, CA Systems, and other applications.

June 2015

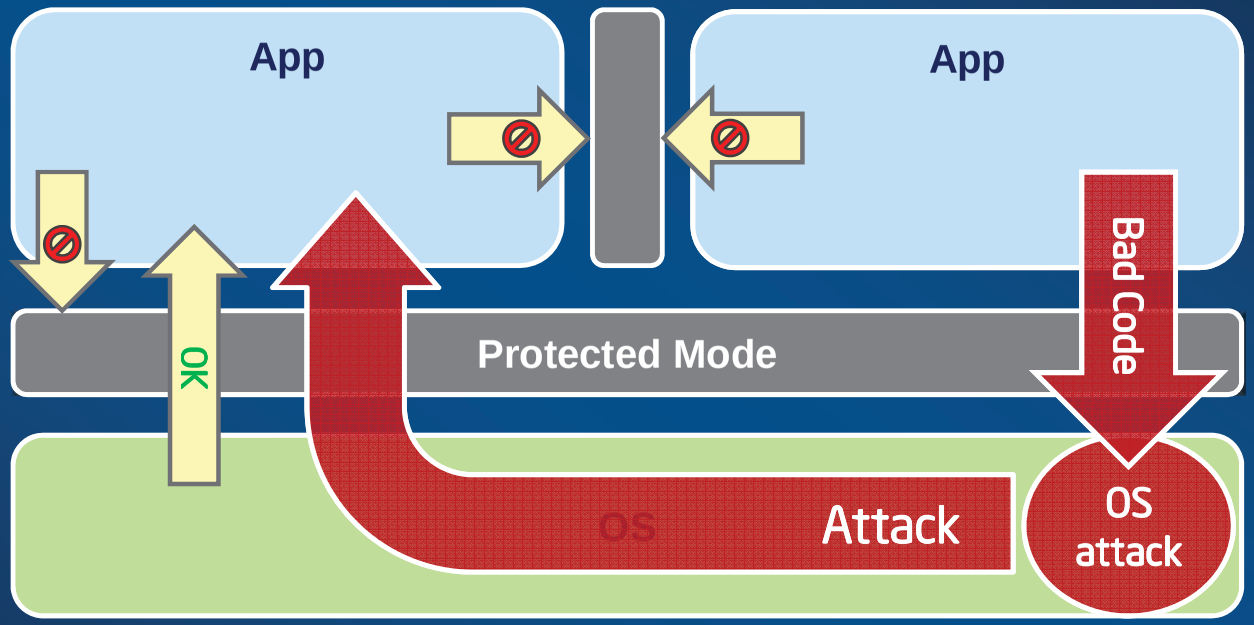
Intel® Software Guard Extensions (SGX)

- A CPU feature for upcoming Intel processors
- Provides "Enclaves," where apps can protect critical code and data
- Allows any app to keep a secret, within a standard OS environment
  - No dependency on OS (or underlying SW) correctness or configuration
  - Developers use standard and familiar development tools
  - Execution utilizing full power of main Intel CPU
- Provides confidentiality and integrity
  - Protects against software attacks, incl. privileged malware, malicious BIOS, etc.
  - Protects against hardware attacks such as bus analyzers or cold-boot
- Includes functionality to attest enclave state (incl. to a remote / 3rd party)
  - Enables secure provisioning of credentials to otherwise untrusted platforms
- "Hardware" level robust trusted execution environment

Build

Why Aren't Platforms Trustworthy?

Protected Mode (rings) protects OS from apps …



… and apps from each other …

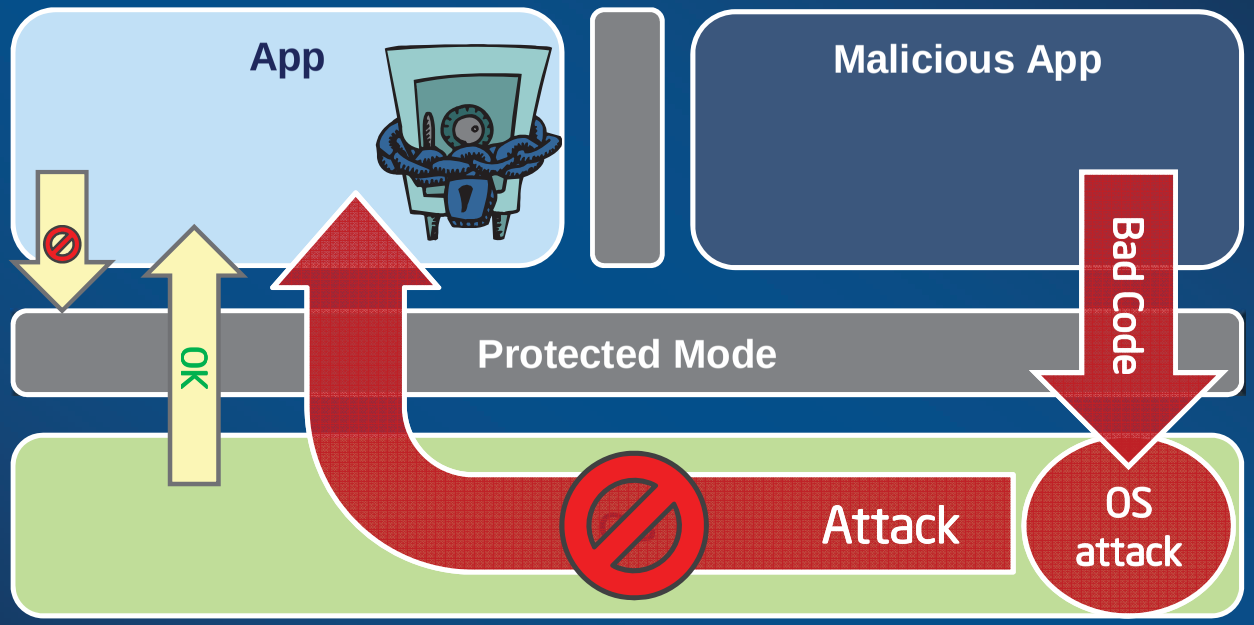
… UNTIL a malicious app exploits an OS flaw to gain full privileges and then tampers with the OS or other apps

Applications not protected from privileged code attacks

Build

Allowing App Developers to Secure Data

Intel® SGX provides a safe place for code and data in the application



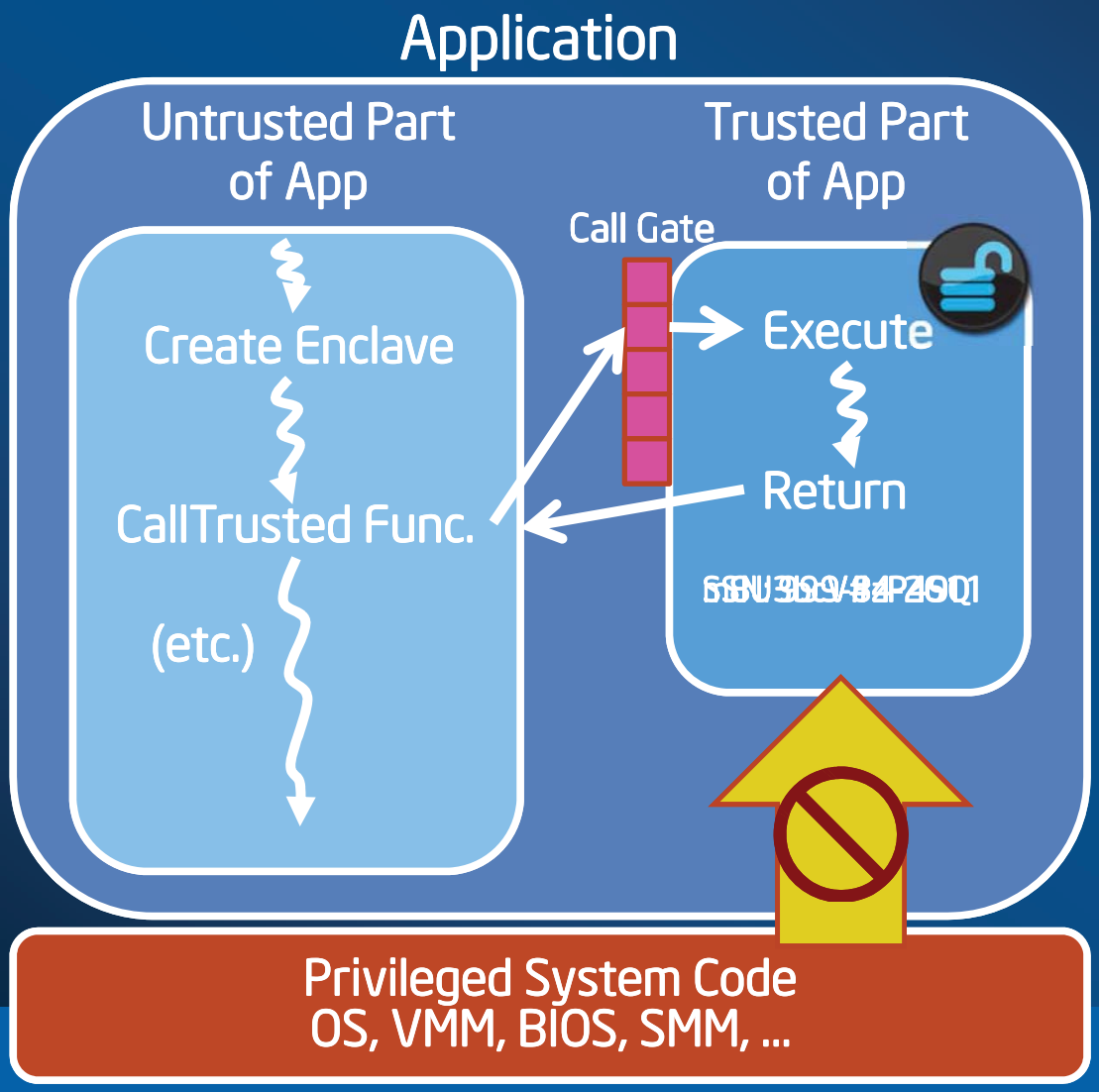
Undetected malicious software cannot access secrets

Secrets are protected from bad actors with platform access

Need a safe as well as guards

Build

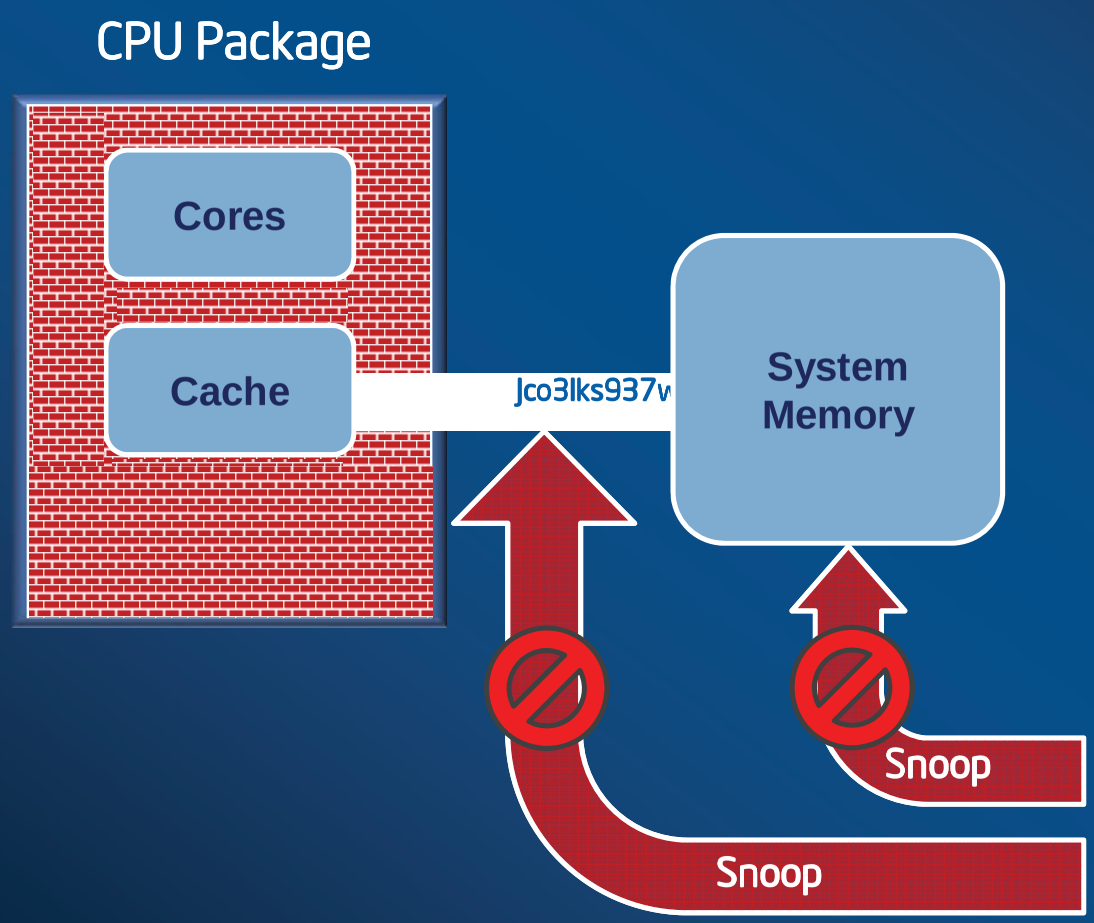
Protects Against Software Attack



1. App is built with trusted and untrusted parts
2. App runs & creates enclave which is placed in trusted memory
3. Trusted function is called; code running inside enclave sees data in clear; external access to data is denied
4. Function returns; enclave data remains in trusted memory

Build

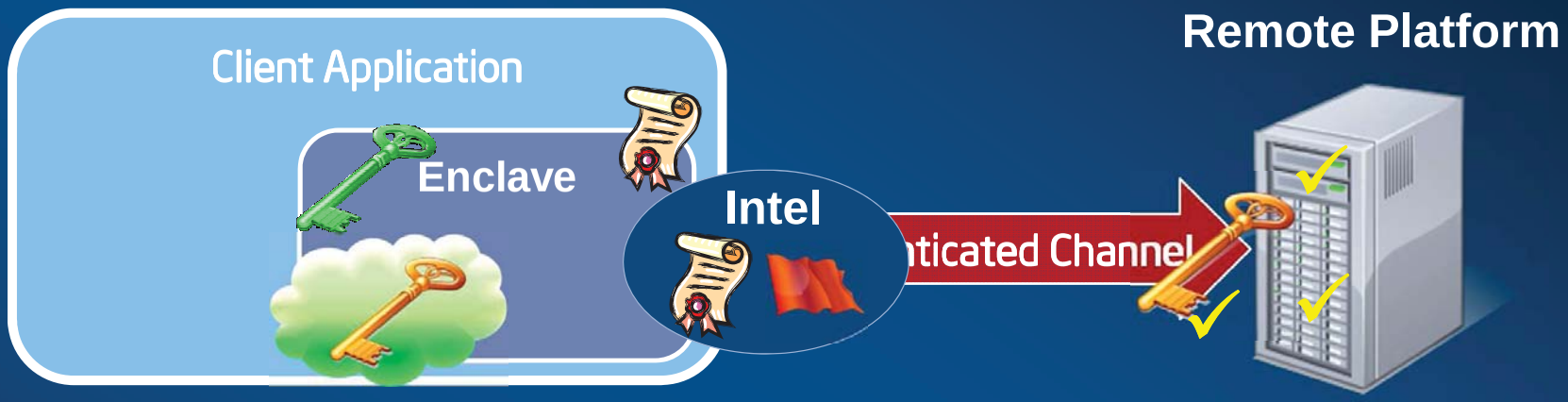
Protects Against Hardware Attack

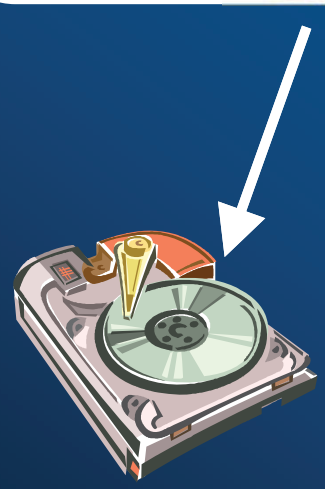


1. Security perimeter is the CPU package boundary
2. Data and code unencrypted inside CPU package
3. Data and code outside CPU package is encrypted and integrity checked
4. External memory reads and bus snoops see only encrypted data

Build

Critical Feature: Attestation and Sealing

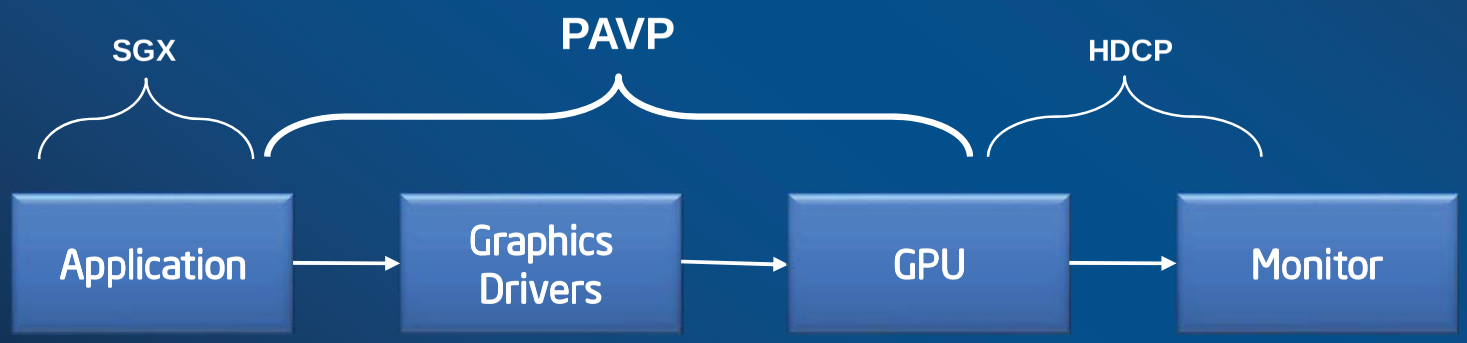




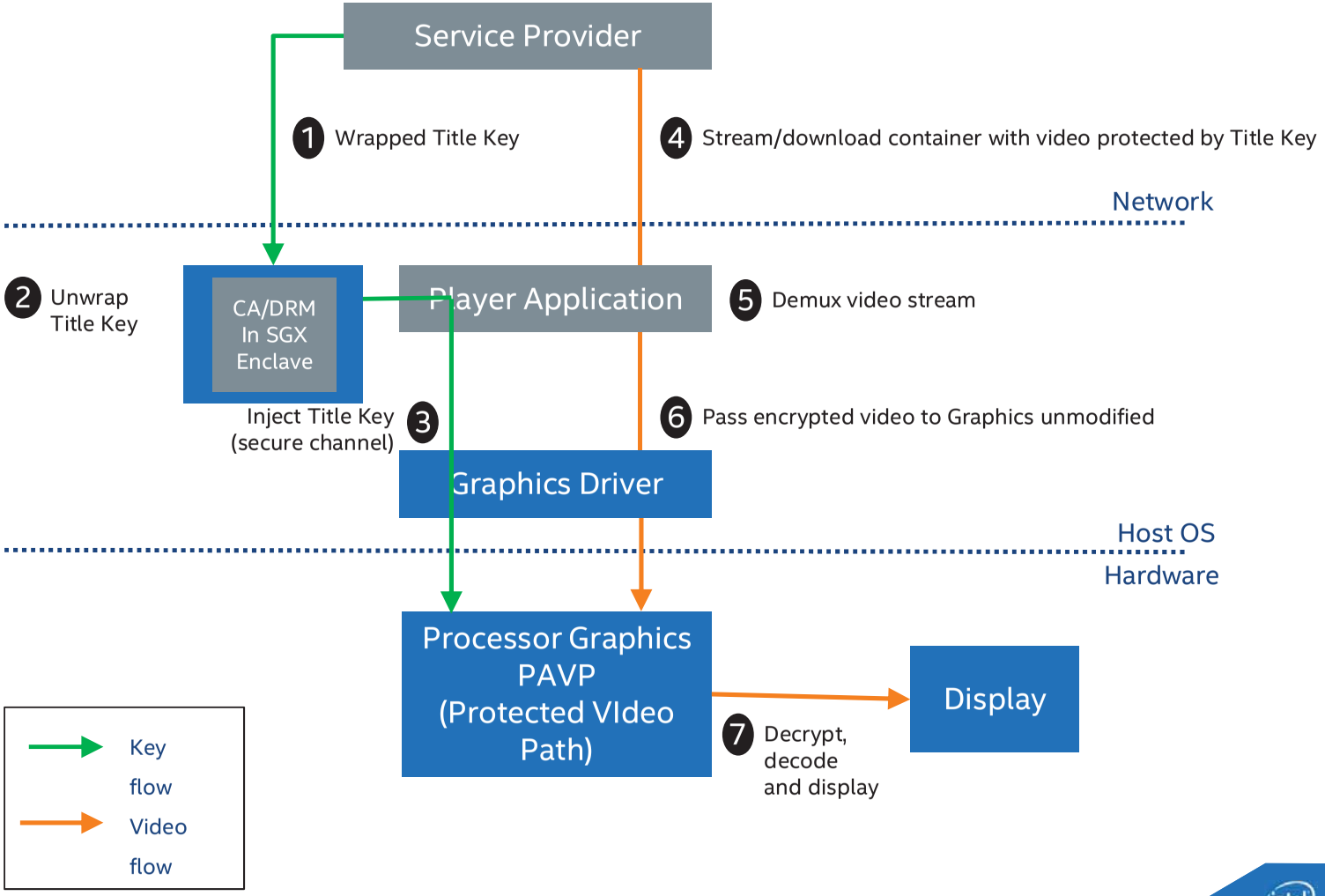
1. Enclave built & measured (initially no secrets)
2. Enclave requests REPORT (HW-signed blob that includes enclave identity information)
3. REPORT sent to server & verified
4. Application Key sent to enclave, first secret provisioned
5. Enclave-platform-specific Sealing Key generated
6. Application Key encrypted via Sealing Key & stored for later (offline) use

Protected Video Play back

- SGX use Intel® graphics for protected video playback
  - Secure key exchange
  - Video bitstream decryption
  - Memory protection



CA/DRM Example Block Diagram



SGX References

https://software.intel.com/en-us/isa-extensions/intel-sgx

- See the link above for published:
  - Overviews
  - White Papers
  - Detailed Programming reference

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