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CONFIDENCE FOR A NETWORKED WORLD

KISS: “Key it Simple and Secure” Corporate Key Management

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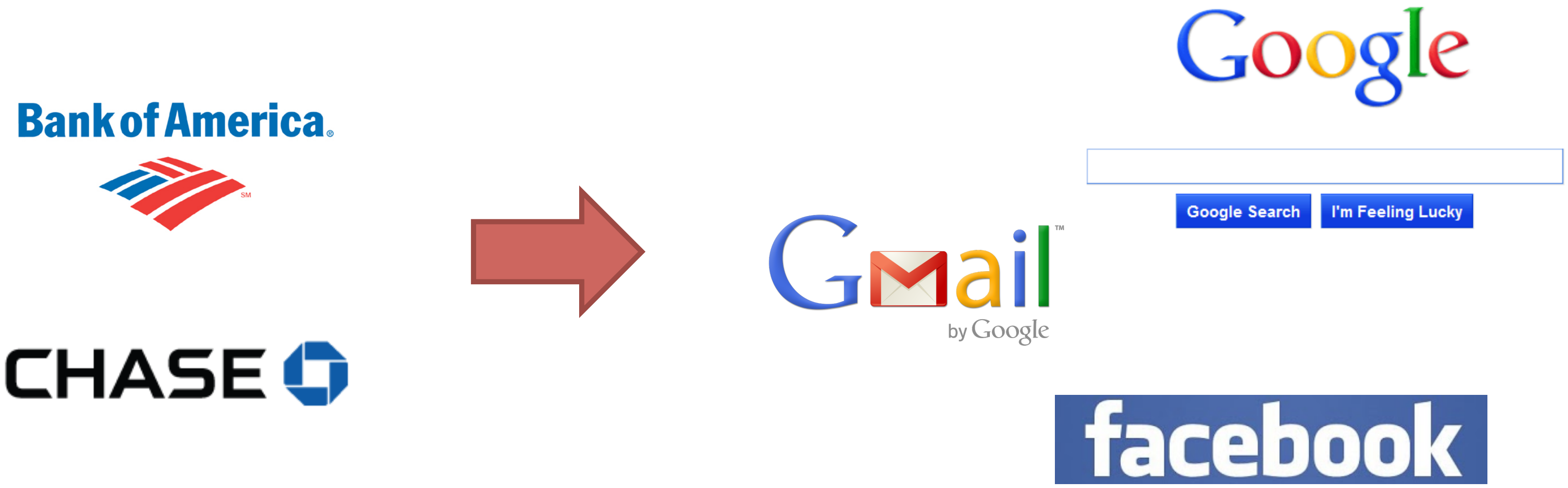
Motivation

- Deployment of cryptographic systems and protocols (e.g., HTTPS) has grown rapidly



Motivation

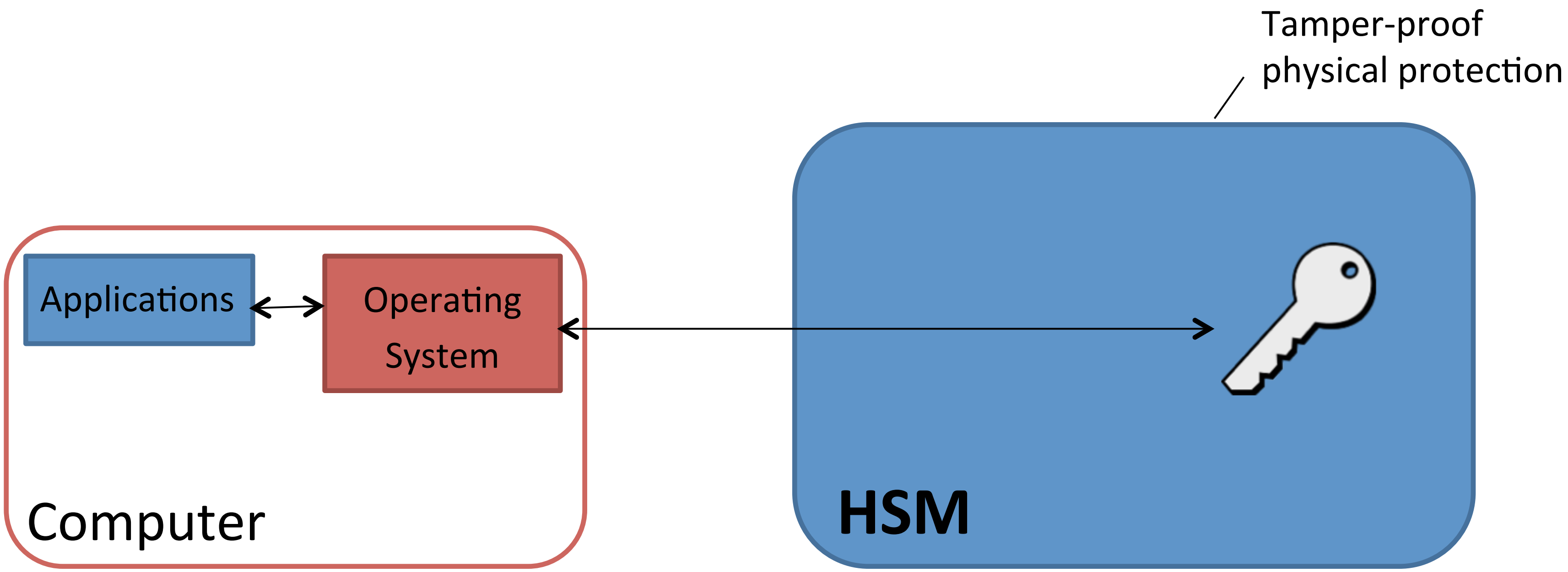
- Key management is a **fundamental building block** of all cryptosystems
- Even experts fall prey to inadequate key management mechanisms
  - **DigiNotar CA**: keys are ***misused*** to issue certificates which enabled HTTPS man-in-the-middle attacks
  - **Stuxnet**: rogue device drivers were digitally signed by keys ***stolen*** from two high-tech companies

Challenges

- Fine-grained Key-Usage Control
  - Does an application executed by a user have permission to access a certain key?
- Secure System Administration
  - Communication between administrators and the Key Management System (KMS) must be authenticated
  - Stealing authentication credentials ?
  - Insider attacks?

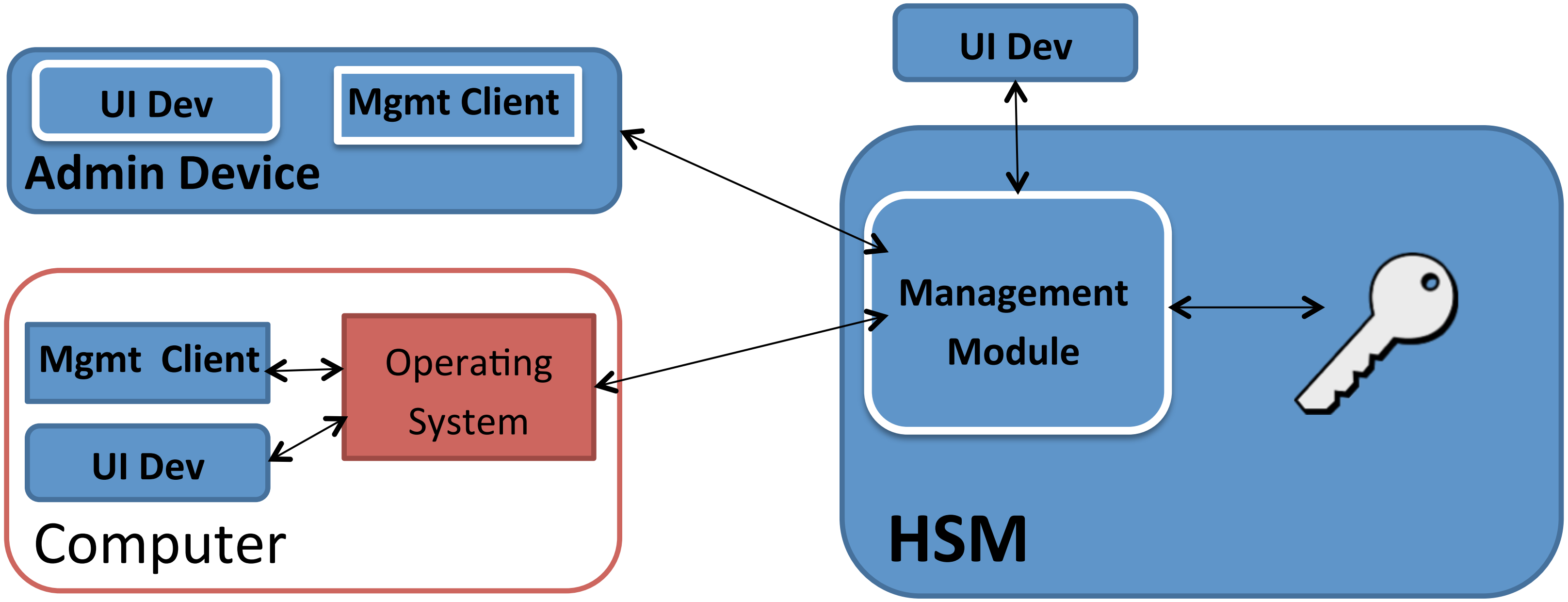
Existing Solutions

- **Hardware Security Module (HSMs)**
  - **Limited** control of key usage



Existing Solutions

- **Hardware Security Module (HSMs)**
  - **Limited** control of key usage
  - **Large TCB** for system administration



Existing Solutions

Software-only Solutions

- Deployment of KMS software on **commodity** servers
- Large TCB
  - Key protection, usage control and administration all rely on **untrustworthy operating system services** (e.g., process isolation, file system permissions)

System Goals

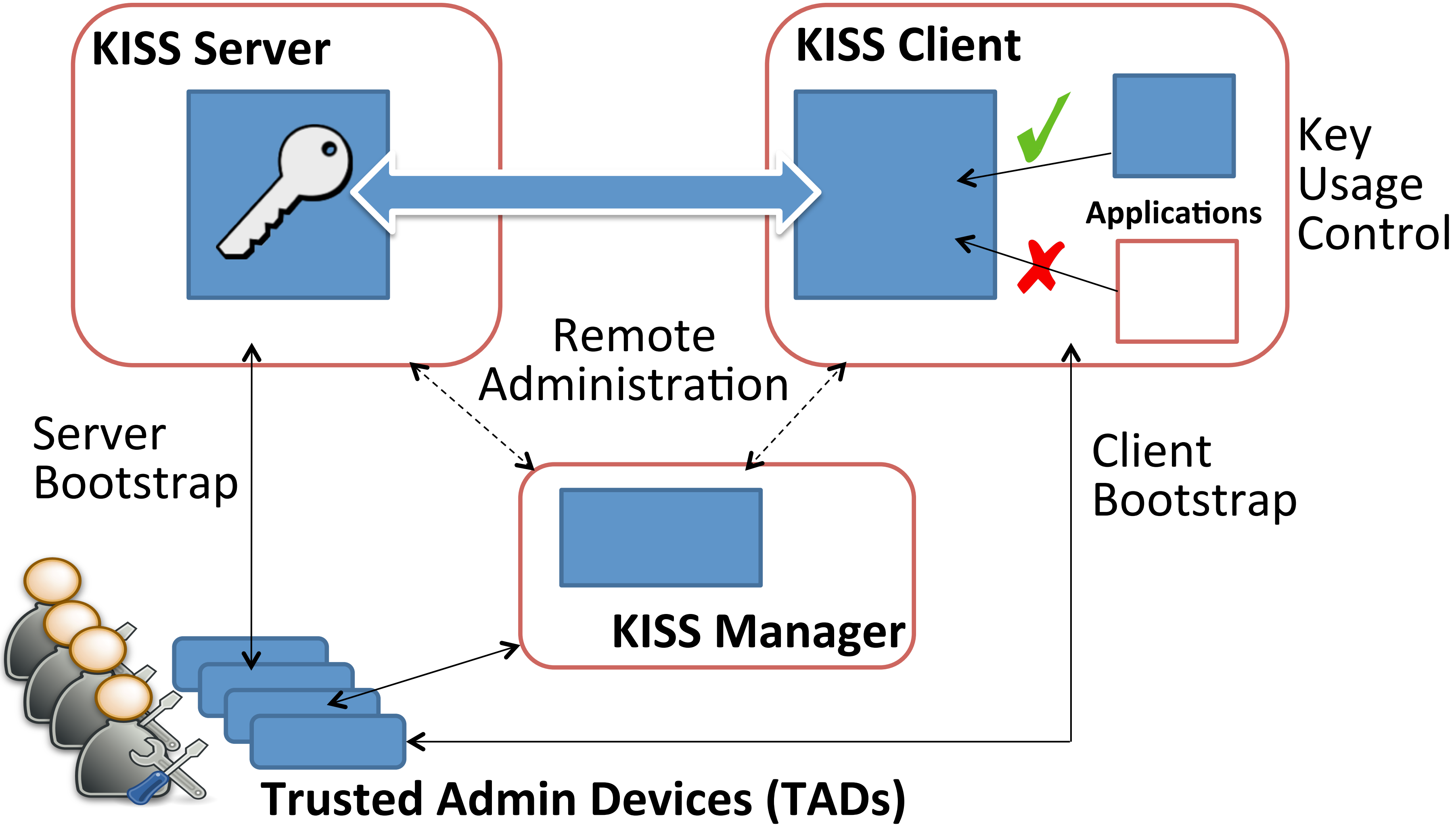
- Small and Simple TCB dedicated to KSM
- Cost-effective
- Secure System Bootstrap
- Secure System Administration
- Fine-grained Key Usage Control

Attacker Model

- **Malware** and **Malicious Administrators** attempt to leak, compromise, or misuse cryptographic keys.

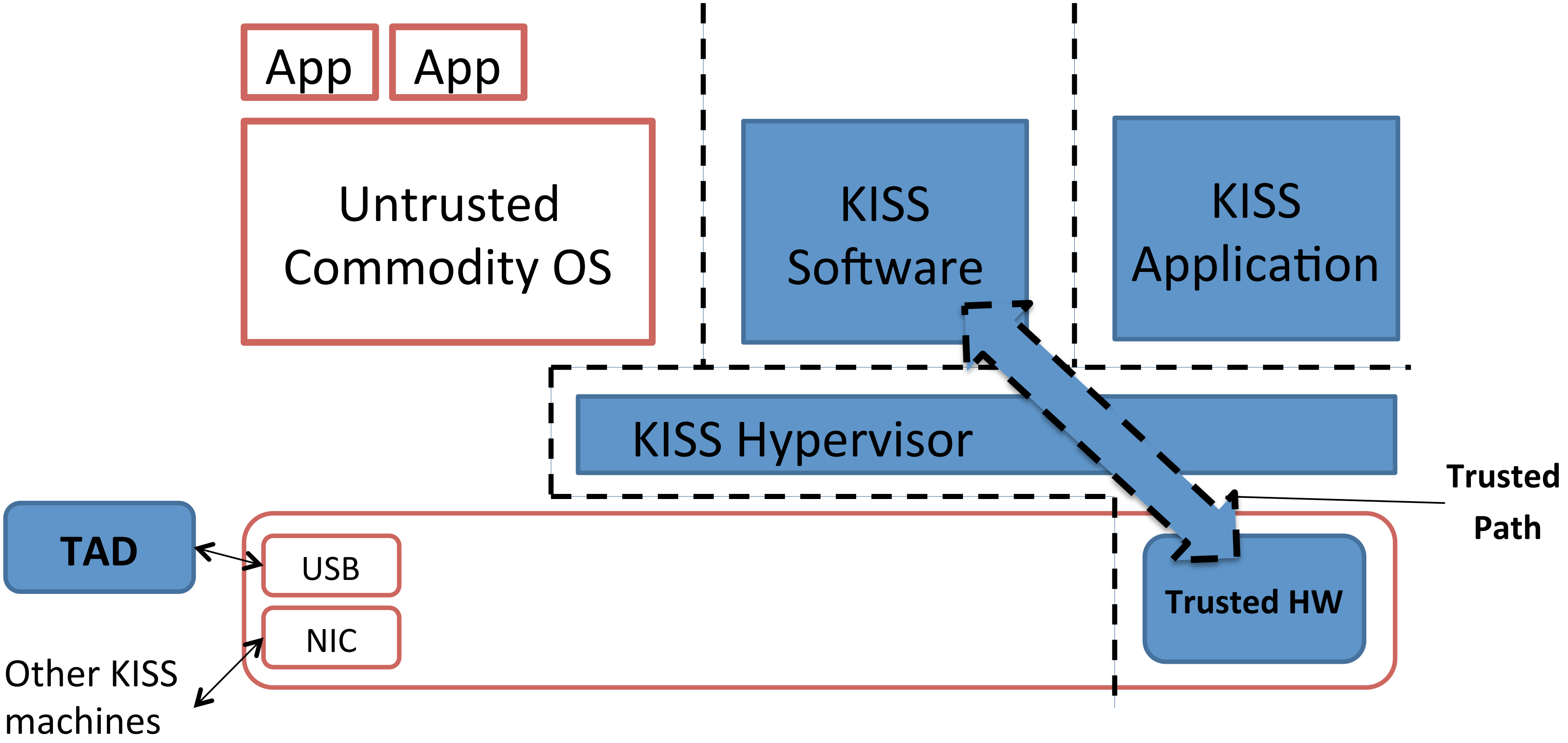
Malicious Admins

System Design



Micro-Hypervisor Architecture

- **Unified for server, client and manager**

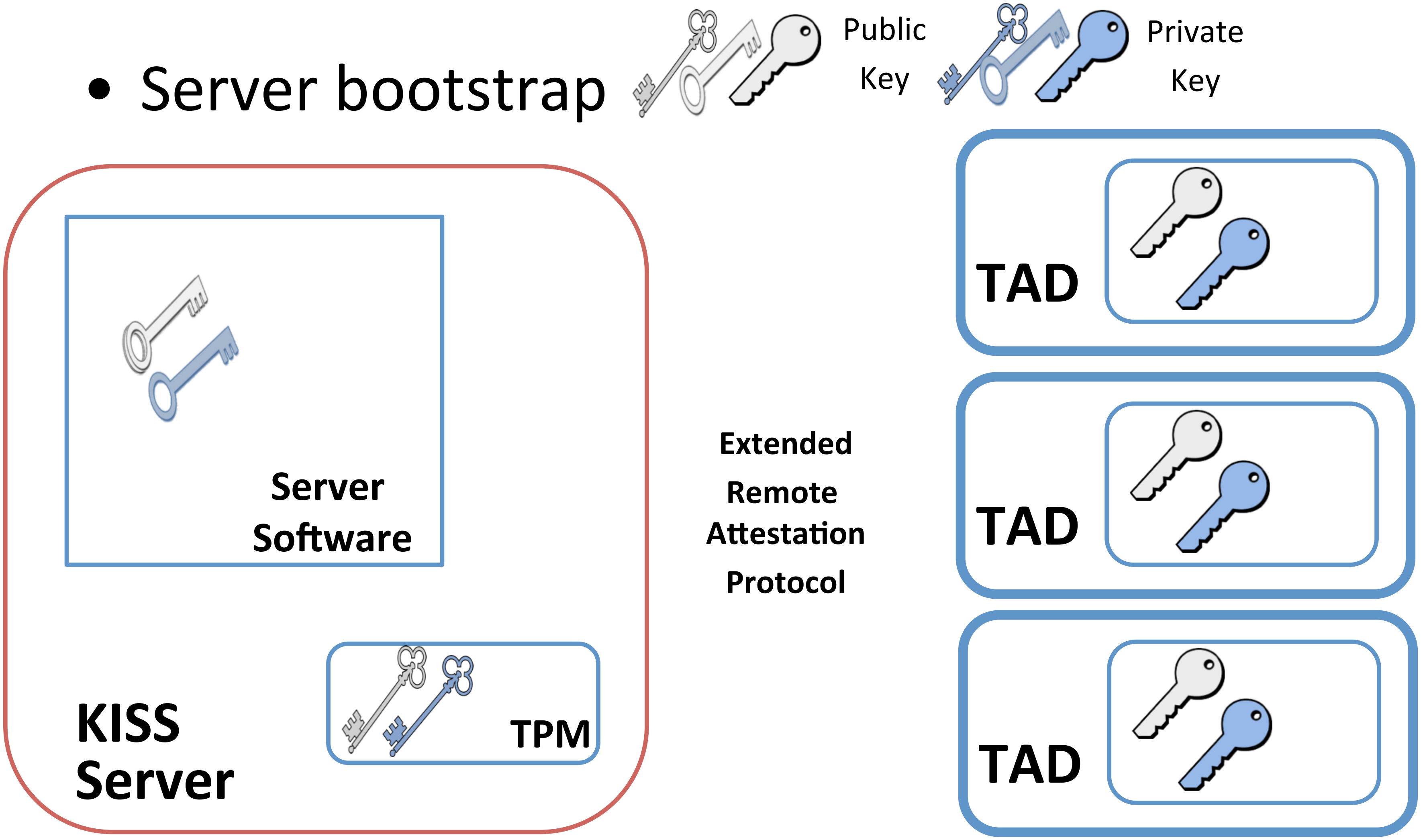


Distinct Features

- Secure System Bootstrap
- Secure System Administration
- Fine-grained Key Usage Control

System Bootstrap

- Server bootstrap

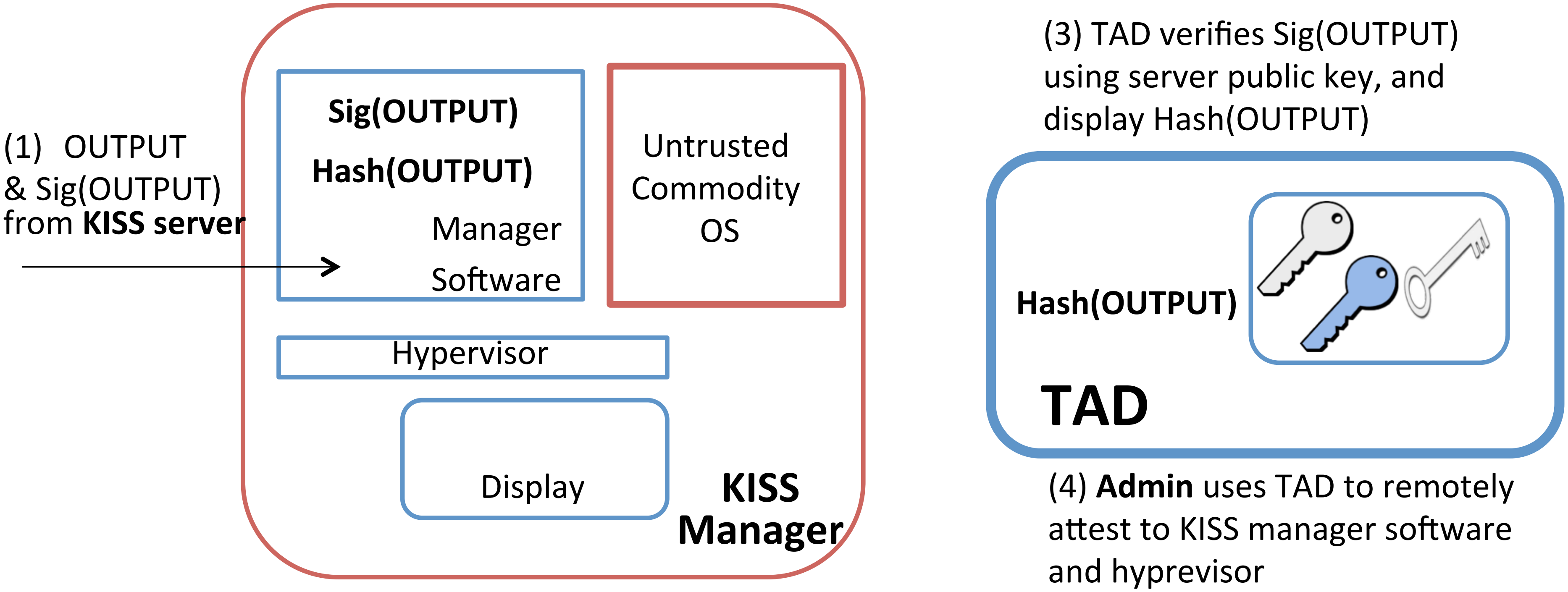


Extended Remote Attestation

- TPM Quote includes KISS hypervisor, server software, server public key, TAD public key list
- Each TAD verifies:
  - Its own key is in the received TAD public key list
  - Length of the key list = # of TADs
- Minimum administrator effort
  - Checks that all TADs display success messages
- Security Analysis (e.g., Sybil attacks)

System Administration

- e.g., remote verification of server output



(1) OUTPUT & Sig(OUTPUT) from **KISS server**

(2) Manager display OUTPUT and Hash(OUTPUT) via trusted path

(3) TAD verifies Sig(OUTPUT) using server public key, and display Hash(OUTPUT)

(4) **Admin** uses TAD to remotely attest to KISS manager software and hypervisor

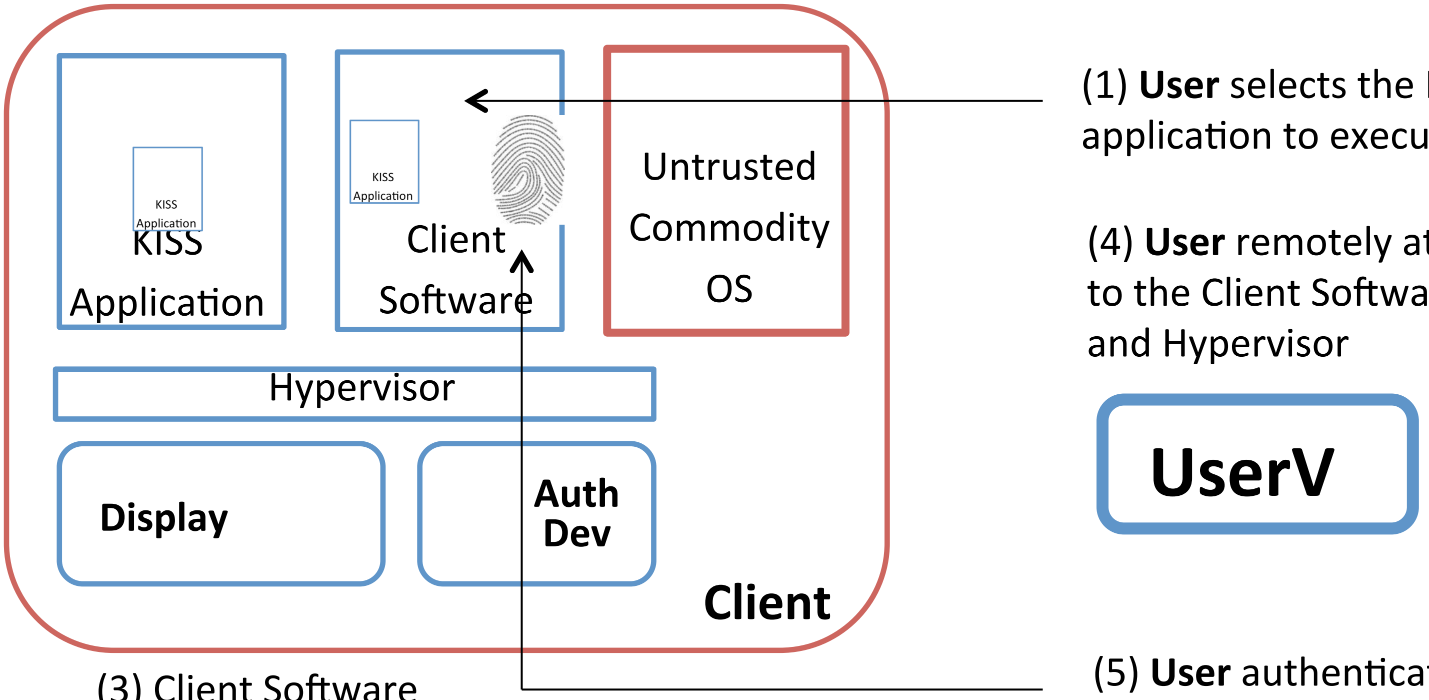
(5**) Admin** confirms that two Hash(OUTPUT) match

System Administration

- Small and Simple TAD
  - Software: attestation, msg auth and bootstrap
  - Hardware: buttons, display …
  - Usability: hash comparison
  - Used for local/remote and input/output

Key Usage Control

(2) KISS app is protected and verified by Hypervisor



(1) **User** selects the KISS application to execute

(4) **User** remotely attests to the Client Software and Hypervisor

(5) **User** authenticates to Client software

(3) Client Software displays app information via trusted path for user confirmation

Key Usage Control

- UserV helps defend against subtle attacks
  - e.g., stealing authentication credentials, or sensitive user input
- UserV is much simpler than TAD
  - Only performs remote attestation
  - Does not store any secrets

Conclusion

- A key management system architecture leveraging **trusted computing** techniques on **commodity** computers
- **Small TCB:** Micro-hypervisor-based design and lightweight administrator devices.
- Secure system bootstrap and administration, fine-grained key usage control
  - Defend against malware and insider attacks

Thanks!

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