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Abstract

Trusted Computing Group (TCG) Trusted Storage Specification

The Trusted Computing Group (TCG) Storage WorkGroup recently published formal specifications for security and trust services on storage devices, including hard drives, flash, and tape drives. The majority of hard drive and other storage device manufacturers participated. Putting security directly on the storage device avoids the vulnerabilities of platform OS-based software security. The details of the Specification will be highlighted, as well as various use cases, including Full Disk Encryption with enterprise key/credential management.
General Risk Model: Storage

Peripheral Controller Electronics

- Primary Host Interface
- Power
- Loadable Firmware
  - Firmware Functions
- Diagnostic Ports
- Data Sink / Source
  - Special Hardware Functions
- Probe Points

Trust = systems operate as intended

Objective: Exercise control over operations that might violate trust

Needed: Trusted Storage commands
TRUSTED SEND/IN
(Protocol ID = xxxx .....)

TRUSTED RECEIVE/OUT

T10/T13 defined the "container commands"

TCG/Storage defining the "TCG payload"

Protocol IDs assigned to TCG, T10/T13, or reserved
Implementation Overview

TRUSTED STORAGE

- (Partitioned) Hidden Memory
- Security firmware/hardware
- Trusted Send/Receive Commands
- Assign Hidden Memory to Applications

FDE

TCG/T10/T13

Controller

Storage

Enterprise Support

ISV Application (on the Host)

ATA or SCSI

Hidden Storage

TRUSTED

Assign Hidden Memory to Applications

Security Providers

Firmware/hardware enhancements for security and cryptography

TCG Trusted Storage Specification
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system behaves as designed

Trust “Toolkit”:

Cryptographic SIGNING

CREDENTIALS (eg, signed X.509 Certificates)
Root of Trust

- **Hardware** that cannot change
- can digitally sign
- and therefore initiate a **chain of trust**

- **TPM (trusted platform module)** is a tiny processor on the motherboard that can sign and whose firmware cannot be modified

- **Storage Devices** can be **roots of trust**
Extending Trust to Peripherals

TPer = Trusted Peripheral

Ability to interact with the Platform

Authentication/Attestation

Capability Level

LOW

HIGH
Trusted Storage with Trusted Platform

Trusted Storage

Secure Communications

Root Of Trust

Trusted Platform

TPM

OR

Trusted Element

Life Cycle: Manufacture, Own, Enroll, PowerUp, Connect, Use, …
Why Security in the Hard Drive

3 Simple reasons

› Storage for secrets with strong access control
  • Inaccessible using traditional storage access
  • Arbitrarily large memory space
  • Gated by access control

› Unobservable cryptographic processing of secrets
  • Processing unit “welded” to storage unit
  • “Closed”, controlled environment

› Custom logic for faster, more secure operations
  • Inexpensive implementation of modern cryptographic functions
  • Complex security operations are feasible
TCG Storage Use Cases (examples)

Full Disc Encryption
- Laptop Loss or Theft
- Re-Purposing
- End of Life
- Rapid Erase

DriveLocking

Forensic Logging

Crypto Key Management

ALL Encrypted

Crypto Chip

Personal Video Recorders

DRM Building Blocks
TCG Storage Workgroup

Specification Overview and Core Architecture Specification

Specification Version 1.0
Revision 0.9 (DRAFT)
19 June 2007
SPs (Security Providers)
- Logical Groupings of Features
- SP = Tables + Methods + Access Controls

Tables
- Like “registers”, primitive storage and control

Methods
- Get, Set – Commands kept simple with many possible functions

Access Control over Methods on Tables
MCTP = Multi-Component Trusted Platform
TPer = Trusted Peripheral (eg, Storage)
Communications Infrastructure

Methods

Transactions (optional)

Sessions

ATA/SCSI Interface Commands
- SPs have own storage, functional scope, and security domain

- Created by:

  1) manufacturer (during Storage Device creation) AND/OR

  2) Issuance Process

- **Tables**: rows = security associations, columns = related elements

- **Persistent State Information**: remains active through power cycles, reset conditions, and spin up/down cycles

- **Methods** are actions such as: table additions, table deletion, table read access, and table backup

- **Authorities** are authentication agents. Authorities specify passwords or cryptographic proofs required to execute the methods in the SP

- **Access Control Lists (ACLs)** bind methods to valid authorities
**SP Issuance & Personalization Overview**

**Issuance** is the act of creating a new SP (exchange/validation of credentials)

**Templates** define the initial tables and methods. All SPs = Base Template tables and methods + other Templates: Admin Template, Crypto Template, and Templates for Forensic Logging and Locking/Encryption etc

**Personalization** is the customization of a newly created SP: modify initial table data and/or admin authority, customization of the default access control settings

Note: **Admin SP** manages Templates, creates other SPs under issuance control, and maintains information about other SPs and the TPer as a whole. Admin SP cannot be deleted or disabled.
Issuing an SP

Issuance Server

REQUEST

ISSUANCE CREDENTIAL

ISV application

SP

Admin SP

ISSUE SP

PERSONALIZE SP

USE SP

ISV SP

TCG Trusted Storage Specification
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- Cryptographic methods: utilize public and symmetric key store tables
- Credential tables + additional tables provided by Base and other Templates
- Encryption, Decryption, Signing, Verifying, Hashing, HMAC, and XOR
- AES, RSA, SHA, HMAC, Elliptic Curve, Random Numbers
ComPacket is the unit of communication transmitted as the payload of an Interface command. A ComPacket is able to hold multiple packets in its payload.

Packet is associated with a particular session and may hold multiple SubPackets.

SubPacket may hold multiple Tokens.
Secure Communications

ComID: allow TPer to identify caller of IF-RECV command
**Credentials:** Permission “secrets”

**Authentication Operation:** proof of knowledge of a secret

The Authority table associates specific Credential-Operation pairs together in Authority objects

**Access Control Lists (ACLs):** lists of Access Control Elements (ACEs)

ACEs are Boolean combinations of Authorities.
Management of (Full) Disk Encryption (FDE) Drives

- **Enterprise Server:**
  - Key generation and distribution
  - Key/Password archive, backup and recovery

- **Laptop (Application):**
  - Master/User passwords, multi-factor authentication, TPM support
  - Secure log-in, “Rapid Erase”

- **FDE Trusted Drive:**
  - Disk or sector encryption, sensitive credential store, drive locking
Key Management

- Key Management Services Subgroup (KMSS)
- Define Best Practices for Key Management
  - Mechanisms to Define and Manage Keys
- Support for Any Device using the TCG Storage Specification
  - A Uniform Way to Manage Keys for a Variety of Storage Devices
- Application Support
  - Ease Development with a Key Management Application Note
Key Management Operations

- KMSS Addresses Operations Between
  - Host Platform
  - Application
  - Trusted Devices

Levels of Interaction and Security
- Requesting Key Generation
- Key Usage
- Storage of Keys
- Retrieving Keys
- Modifying Keys
- Searching for Keys
- Key Access Rights
- Disabling of Keys
- Destruction of Keys
Home Banking (or, Remote Medical, or…)

Trusted Platform w/ Trusted Storage

- Multi-factor authentication: password, biometrics, dongles
- Secure/hardware storage of credentials, confidential financial/medical data
- Trusted life cycle management of personal information
- Integrity-checking of application software
- Cryptographic functions for storage and communications security
- Trusted/secure computation of high-value functions (protection from viruses/etc)
THANK YOU!

www.trustedcomputinggroup.org
Q&A / Feedback

⚠️ Please send any questions/comments on this presentation to SNIA:

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Many thanks to the following individuals for their contributions to this tutorial.

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