* Cryptographic Key Management Workshop

Session 3: The Security Architecture

March 4, 2014

Miles E. Smid

*FCKMS Architecture

(Sections 6 and 10)

- The process of planning, designing, and constructing a secure FCKMS.
- The protection of cryptographic keys and metadata at creation, at rest, during distribution, when in use, and when destroyed.
- Will cover mostly Profile Requirements (PRs).

*Key and Metadata Protection (Section 6)

- Unauthorized Disclosure and Modification
  - Encryption/decryption
  - Digital signatures and cryptographic authentication codes
  - Physical Security
- Unauthorized Access and Use (Access Control)
  - Identification/Authentication Systems (source, receiver and use)
  - Physical Security

*Key Types, Lengths and Strengths (Section 6.1.1)

- **PR:6.1** A Federal CKMS **shall** support all the key types and lengths specified in the CKMS design.

*Key Protections
(Section 6.1.2)

- **PR:6.**2 A Federal CKMS **shall** physically or cryptographically protect all symmetric and private keys from unauthorized disclosure, use, and modification.
- **PR:6.3** A Federal CKMS **shall** support the protection of keys at a level that is commensurate with the impact level of the data to be protected by the keys.
- **PA:6.1** A Federal CKMS **should** cryptographically protect all keys against unauthorized disclosure and modification when outside of a cryptographic module.

*Key Assurance
(Section 6.1.3)

- **PR:6.4** A Federal CKMS **shall** verify the integrity of all keys when received or before initial use.
- **PR:6.5** A Federal CKMS **shall** obtain the following assurances (as appropriate) before the initial operational use of a key: a) Domain parameter validity, b) Public-key validity, c) Private-key possession, or d) Secret key possession.
- **PA:6.2** A Federal CMS **should** support assuring a receiver of a transported key that it came from an authenticated and authorized source.

*Metadata Protections

- **PR:6.8** and **PR:6.9** are similar to the protection requirements for keys.
- **PR:6.10** A Federal CKMS **shall** verify the integrity of all metadata when received or before the initial use of its key.
- **PR:6.11** A Federal CKMS **shall** maintain the association between a key and its metadata.
- **PA:6.5** A Federal CKMS **should** provide a cryptographic binding between a key and its metadata elements.
- **PA:6.6** A Federal CKMS **should** support a source authentication of the metadata elements for all cryptographic keys.

* Key and Metadata Management Functions (Section 6.4)

- A F/CKMS is implemented by means of key and metadata management functions (e.g., generate key, register owner, associate key with metadata, encrypt/decrypt key, store key, recover key, and revoke key).
- Twenty-eight examples are given.
- **PR:6.14** A Federal CKMS **shall** support all key and metadata management functions that are specified in its CKMS design.
- **PR:6.15** A Federal CKMS **shall** support the verification of the integrity of the request.

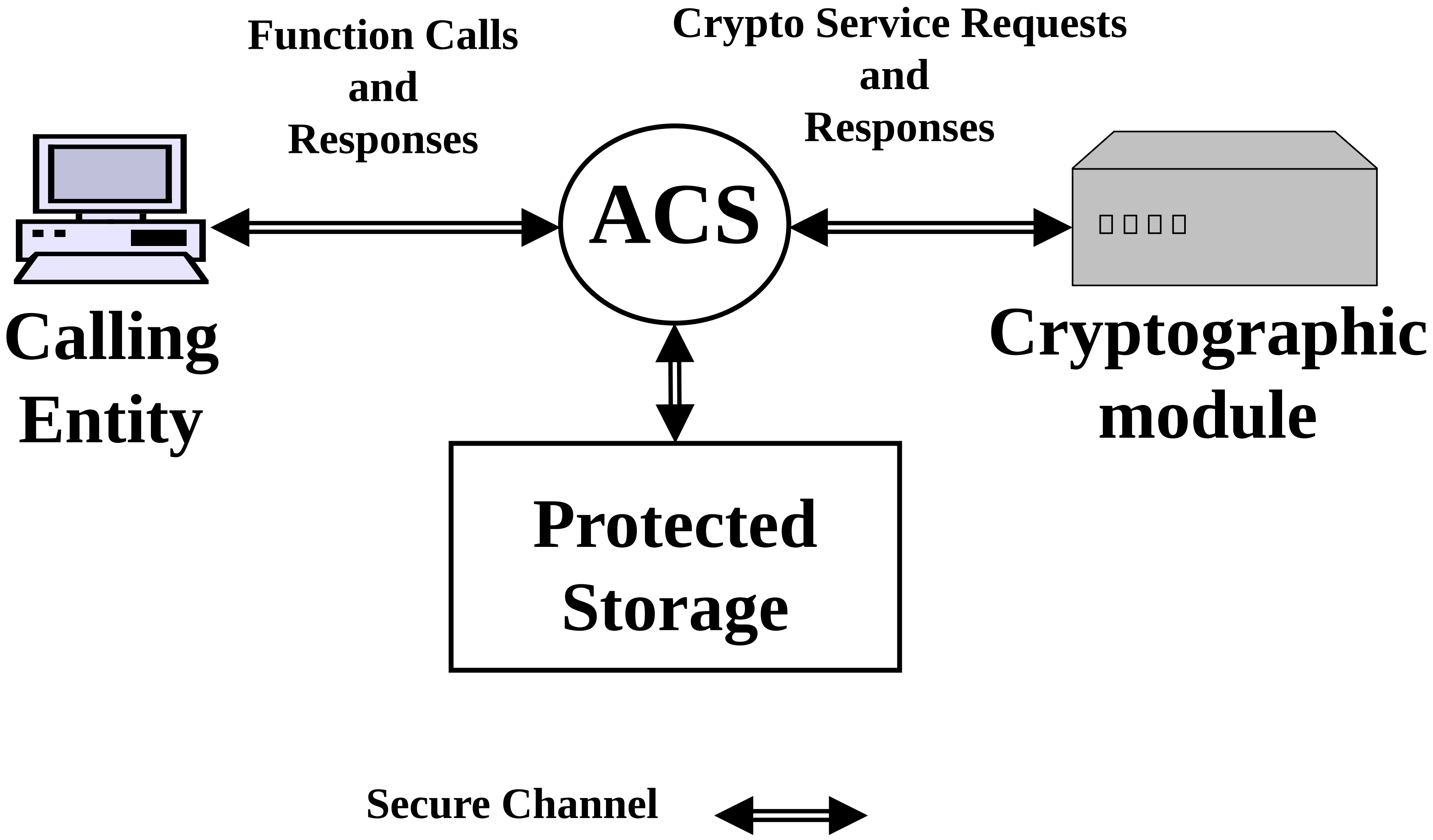
*Interoperability Requirements (Section 6.4 and Section 6.6.4)

- Profile does not automatically require interoperability.
- When interoperability is deemed to be required, then the Profile does establish requirements.
- E.g., **PR:6.42** When secure interoperability is required, a Federal CKMS **shall** support establishing a key and associated metadata between entities.
- E.g., **PR:6.61+** When interoperability is required, a Federal CKMS **shall** support one or more approved key-establishment protocols.

*The Access Control System

(Section 6.7.1)

- **PR:6.62** A Federal CKMS **shall** control access to, and the initiation of, all its key and metadata management services and functions, granting access to and permission to initiate a requested service of function only after verifying the identity and authorization of the requesting entity to perform the requested service of function.
- **PR:6.63** A Federal CKMS **shall** protect the integrity of all keys and their metadata, and the confidentiality of secret and private keys and their sensitive metadata when outside a cryptographic module.



Function Calls
and
Responses

Crypto Service Requests
and
Responses

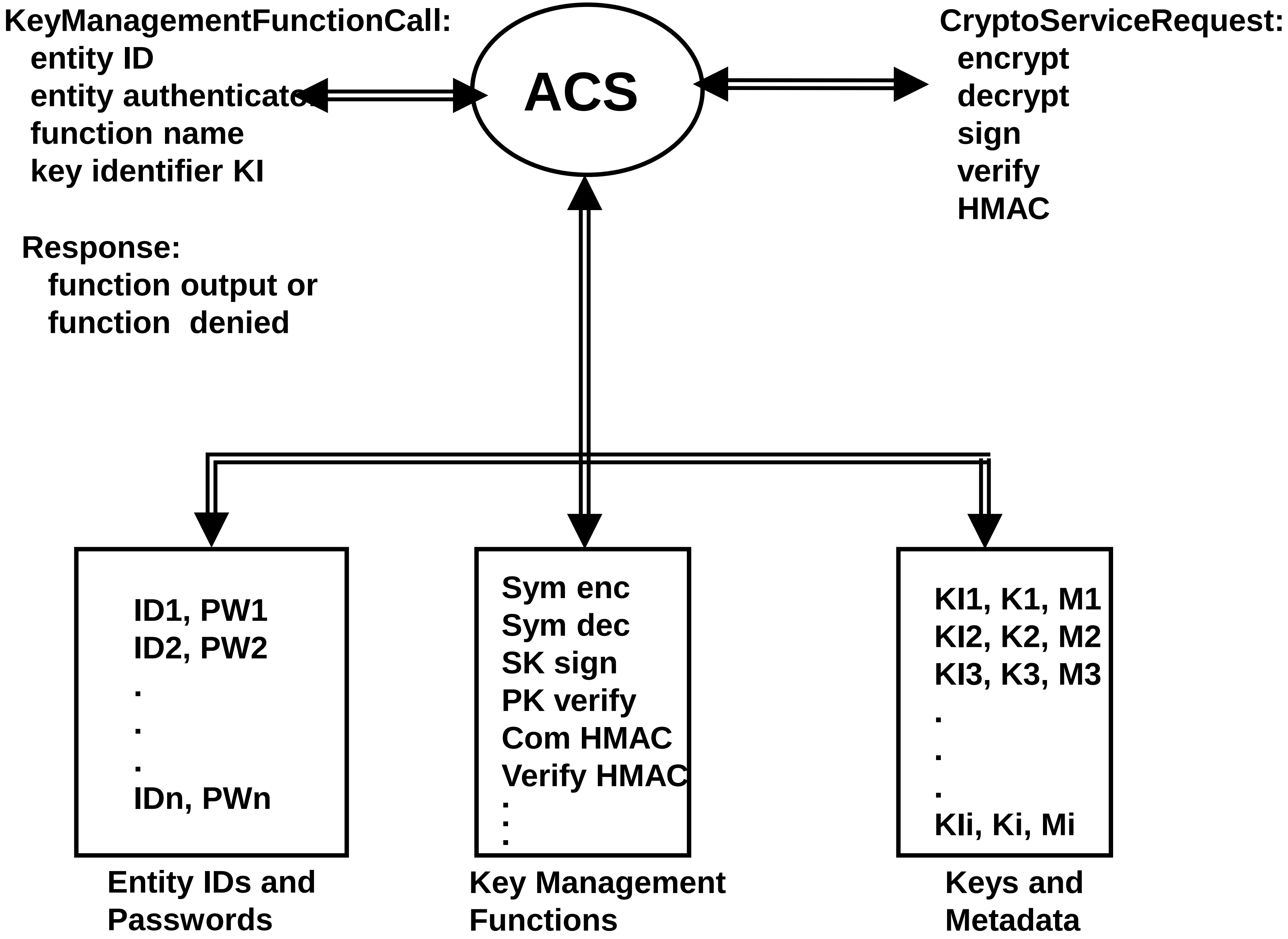
Calling
Entity

ACS

Cryptographic
module

Protected
Storage

Secure Channel



KeyManagementFunctionCall:
entity ID
entity authenticator
function name
key identifier KI

Response:
function output or
function denied

ACS

CryptoServiceRequest:
encrypt
decrypt
sign
verify
HMAC

ID1, PW1
ID2, PW2
.
.
.
IDn, PWn

Entity IDs and Passwords

Sym enc
Sym dec
SK sign
PK verify
Com HMAC
Verify HMAC
.
.
.

Key Management Functions

KI1, K1, M1
KI2, K2, M2
KI3, K3, M3
.
.
.
KIi, Ki, Mi

Keys and Metadata

*Compromise Recovery (Section 6.8)

- **PR:6.65** A Federal CKMS **shall** create and maintain a compromise-recovery plan for recovering from actual and suspected compromises of its security and availability.
- **PR:6.66** A Federal CKMS **shall** perform the following when a compromise is detected or suspected:
  - Evaluate compromise,
  - Mitigate compromise,
  - Institute corrective measures, and
  - Return to a secure operating state.

*Key and Metadata Compromise (Section 6.8.1, 6.8.2, and 6.8.3)

- **PR:6.67** A Federal CKMS **shall** revoke compromised keys.
- **PR:6.69** A Federal CKMS **shall** revoke the key associated with compromised sensitive metadata.
- **PR:6.70** A Federal CKMS **shall** support reporting and investigation a compromise of sensitive metadata.
- **PR:6.72** A Federal CKMS **shall** provide a notification when a key is revoked, including the reason for the revocation.

*Computer System Compromise Recovery (Section 6.8.5)

- **PR:6.74** A Federal CKMS **shall** support replacing modified system software with valid backup copies after the detection of an unauthorized modification to any of its computer system's software.
- **PR:6.75** A Federal CKMS **shall** support reporting any detected or suspected computer operating system compromise, installing available upgrades, and performing tests to verify that the problem has been fixed.

*Network Security Controls and Compromise Recovery

(Section 6.8.6)

- **PR:6.77** If the security of a network security-control device has been compromised, a Federal CKMS **shall:**
  - Repair or replace the device,
  - Test the repaired or replaced device, and
  - Return the FCKMS to a secure state.
- **PR:6.78** If network passwords are compromised, a Federal CKMS **shall:**
  - Replace compromised passwords
  - Notify affected entities
  - Perform damage assessment, and
  - Take corrective actions.

*Personnel Security Compromise Recovery (Section 6.8.7)

- **PR:6.79** A Federal CKMS **shall** perform an assessment of the potential consequences of personnel security compromises before the FCKMS initially becomes operational.
- **PR:6.80** A Federal CKMS **shall** develop procedures for recovering from a personnel security compromise.
- **PR:6.81** A Federal CKMS **shall** perform an audit of its personnel security actions after a compromise is detected, and issue revisions to reduce the likelihood of similar compromises.

*Physical Security Compromise Recovery (Section 6.8.8)

- **PR:6.82** A Federal CKMS **shall** support the notification of an appropriate authority of any actual or suspected physical security compromise and initiating mitigation actions by that authority.
- **PR:6.83** A Federal CKMS **shall** control physical access to FCKMS devices and restrict access to only authorized entities.
- **PR:6.84** A Federal CKMS **shall** support the evaluation of each new individual before being authorized to perform a role involving the recovery from a security compromise.

*Disaster Recovery Overview (Section 10)

- 10.1 Facility Damage
- 10.2 Utility Service Outage
- 10.3 Communication and Computation Outage
- 10.4 FCKMS Hardware Failure
- 10.5System Software Failure
- 10.6 Cryptographic Module Failure
- 10.7 Corruption of Keys and Metadata

*Facility Damage (Section 10.1)

- **PR:10.1** The components of a Federal CKMS **shall** be located in physically secure and environmentally protected facilities.
- **PR:10.2**: A Federal CKMS **shall** have redundancy to ensure operational continuity when high-availability is required.
- **PR:10.3** A Federal CKMS **shall** support recovery procedures in the event of the damage or loss of an FCKMS capability.
- **PR:10.4** A Federal CKMS **shall** be operated in facilities that provide levels of protection and availability that are commensurate with the impact level of the information being protected.

*Facility Damage (Section 10.1)

- **PR:10.5** When a primary facility is damaged, and a backup is available, a Federal CKMS **shall** activate its backup.
- **PR:10.6** A Federal CKMS **shall** be tested annually to determine that facility-damage detection and recovery mechanisms and procedures work as required.
- **PR:10.7** The procedures for maintaining and testing the environmental, physical, and disaster recovery capabilities **shall** be evaluated every five years and upgraded as needed.
- **PR:10.8** Damaged or lost FCKMS devices **shall** be reported to FKMS management personnel.

*Utility Service Outage

(Section 10.2)

- **PR:10.9** A Federal CKMS **shall** be protected with sufficient utility services to support all primary and backup fixed facilities during both normal operation and emergencies.

- **PR:10.10** A Federal CKMS **shall** conform to applicable Federal and industry standards for utility assurance and satisfy the CKMS design requirements for utility services for all primary, backup, and archive facilities.

*Communication and Computation Outage

(Section 10.3)

- **PR:10.11** When high reliability and availability of the FCKMS services is required, a Federal CKMS **shall** have alternative communications computation, and electrical services available that can be activated as needed.

*FCKMS Hardware Failure

(Section 10.4)

- **PR:10.12** A Federal CKMS **shall** perform initial and periodic tests of backup and recovery capabilities of its critical FCKMS modules and devices.

- **PR:10.13** A Federal CKMS **shall** test backup and recovery of services requiring high availability at least annually.

*System Software Failure
(Section 10.5)

- **PR:10.14** A Federal CKMS **shall** use software that has passed correctness and integrity tests.
- **PR:10.15** A Federal CKMS **shall** perform backups of its software after the current secure-state of the FCKMS software is verified.
- **PR:10.16** A Federal CKMS **shall** reload its software from the latest FCKMS secure-state backup after a software failure is detected or suspected.
- **PR:10.17** A Federal CKMS **shall** verify that it is in a secure-state following the initial loading of its software and before becoming operating.
- **PR:10.18** A Federal CKMS **shall** ensure that all software errors are analyzed and repaired before it is returned to a secure state.

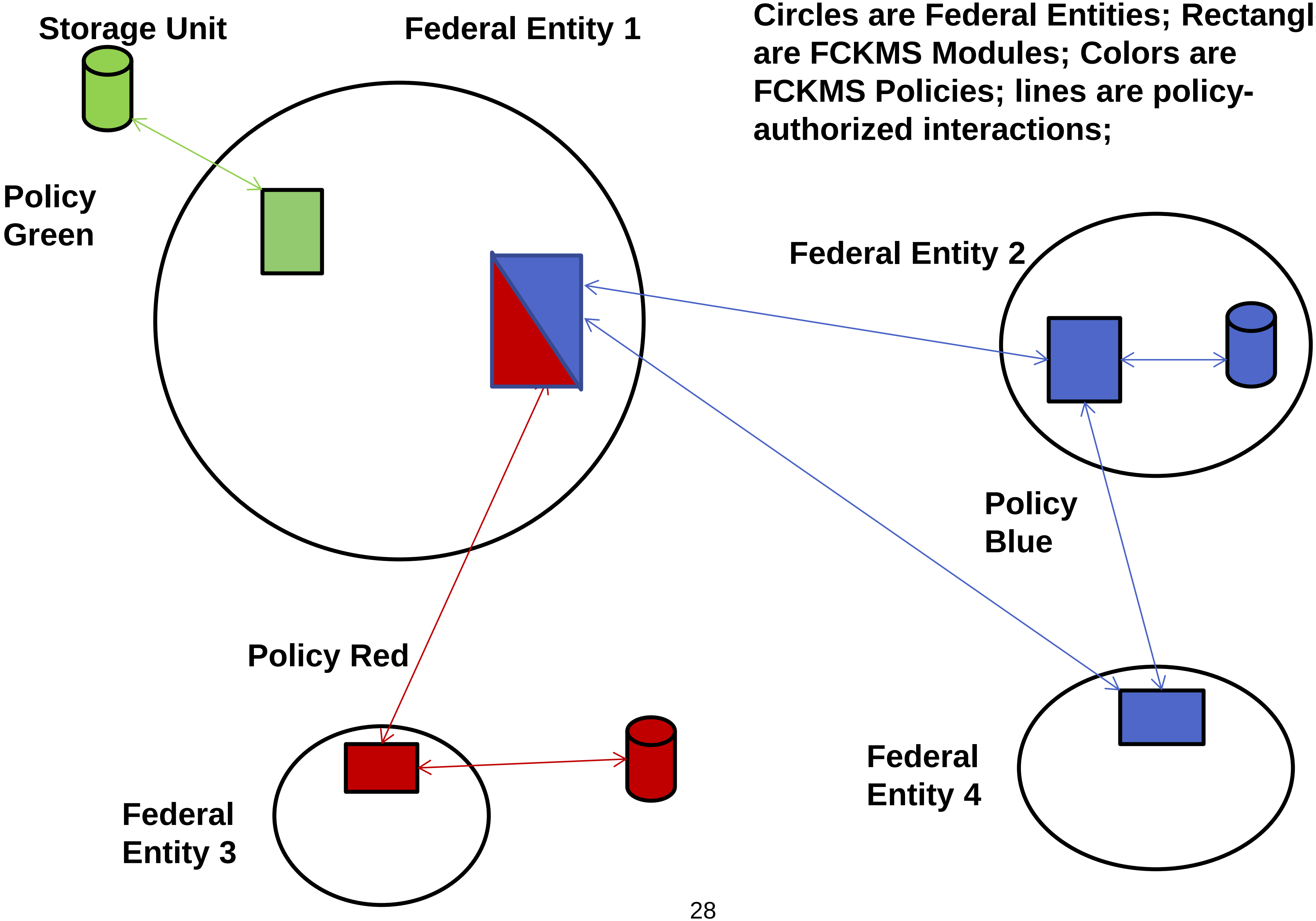
*Cryptographic Module Failure
(Section 10.6)

- No requirements listed.
- See FIPS 140-2.
- **PA:10.13** Repeat Power-up self tests after error detection already required by FIPS 140-2.

*Corruption of Keys and Metadata (Section 10.7)

- **PR:10.19** A Federal CKMS **shall** support:
  - Detecting corrupted keys and metadata,,
  - Reporting corrupted keys or metadata to the FCKMS,
  - Preventing the use of corrupted key and/or metadata,
  - Recovering or replacing corrupted keys and metadata.
- **PR:10.20** A Federal CKMS **shall** train CKMS personnel to perform key recovery and replacement.

Circles are Federal Entities; Rectangles are FCKMS Modules; Colors are FCKMS Policies; lines are policy-authorized interactions;



Storage Unit

Federal Entity 1

Policy Green

Federal Entity 2

Policy Blue

Policy Red

Federal Entity 3

Federal Entity 4

*Explanation

- Entity 1 supports three FCKMS systems, each with its own security policy: green (for external key storage), blue (for key establishment), and red (for key establishment).
- Entity 2 supports only the blue FCKMS security policy for both key establishment and internal key storage.
- Entity 3 supports only the red FCKMS security policy for both key establishment and external key storage.
- Entity 4 supports only the blue FCKMS security policy for key establishment.

*Topics for Discussion

- Is the scope of this document too large?
  - Much of the SP deals with general security topics that are not specific to CKMS or FCKMS.
  - For example, security policies, system backup, disaster recovery, operating system security, and personnel management.
  - These topics are well understood by USG agencies.
  - These topics may be better covered in other documents.
- Are some of the requirements too specific for all systems?
- Are any of the requirements too vague to be objectively tested, implemented, used, and verified?

*Other Topics for Discussion

- Are any useful terms left undefined?
  - E.g., High Availability
- Are the defined terms well-defined?