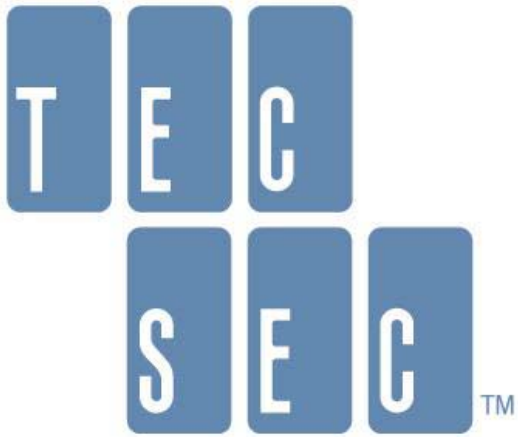

CKM® Enabling DRM

ANSI March 2002

Mark Odell

Vice President, Systems Engineering

TECSEC, Inc.

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Agenda

- What Is CKM®?
- How Does CKM Work? (High Level)
- Example Application of CKM Technology
  - Digital Rights Management (DRM)
- Questions?

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What Is CKM®?

- CKM, Short for Constructive Key Management®, is a Technology That Provides Role Based Access Control that Is Enforced Via Cryptography.

- Properties of CKM:
  - Key Material Not Specific to Individuals
  - Addresses the One-to-many Distribution Problem of Key Management
  - Access Privileges Bound to Data Via Cryptography
  - Built-in Key Recovery Performed by System Owner

- What Is CKM Good for?
  - Modeling Role Based Access Control (RBAC)
  - Content-based Security
  - Complementing PKI

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Roles and Credentials

- Roles Are Established by Function and Responsibility
- A Role Is Defined by a Set of Credentials
  - Each Credential Represents an Attribute of the Data Described in the Underlying Information Classification Model (E.G. Project X, Software Engineer, Company Employee)
  - Credentials May Be Further Refined by Access Mode:
    - Read
    - Write
- Individuals May Perform Multiple Roles
- Those Performing the Same Role, and Thus Having the Same Credential(s), Share the Same Ability to Access Information

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Anatomy of a Credential

Credential

Label: <descriptive name>
Credential ID: <unique number>
Issue Date: <date>
Expiration Date: <date>

Public Key (Write Access)

Private Key (Read Access)

Unlike PKI Certificates, a Credential's Public and Private Key Must Both Be Kept Secret.

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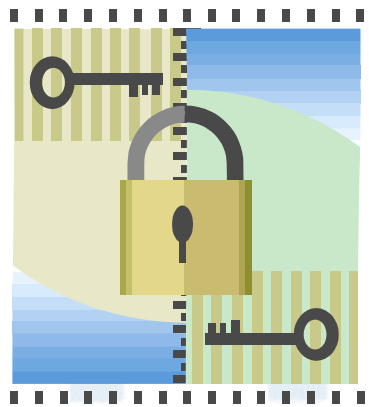
CKM® System Architecture

- System Owner Creates a CKM Domain
  - Domains Contain:
    - Domain Value (Shared Symmetric Key)
    - Maintenance Value (Shared Symmetric Key)
    - Credentials
  - Roles Are Mapped to Credentials
- Members Are Enrolled Into the System and Assigned a Domain
  - Members Can Belong to Multiple Domains
  - Members Are Assigned Roles
  - Token Created for Each Member



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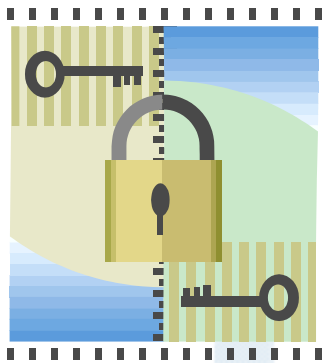
How Does CKM® Work?

- CKM Produces a Unique Working Key That Is Used to Encrypt Data.
- After the Data Is Encrypted, the Working Key Is **Destroyed!**
- What Remains Are the Components Used to Create the Working Key.
- Credentials Are Used to Encrypt the Sensitive Components, So That Only Authorized Users Will Be Able to Recreate the Working Key.



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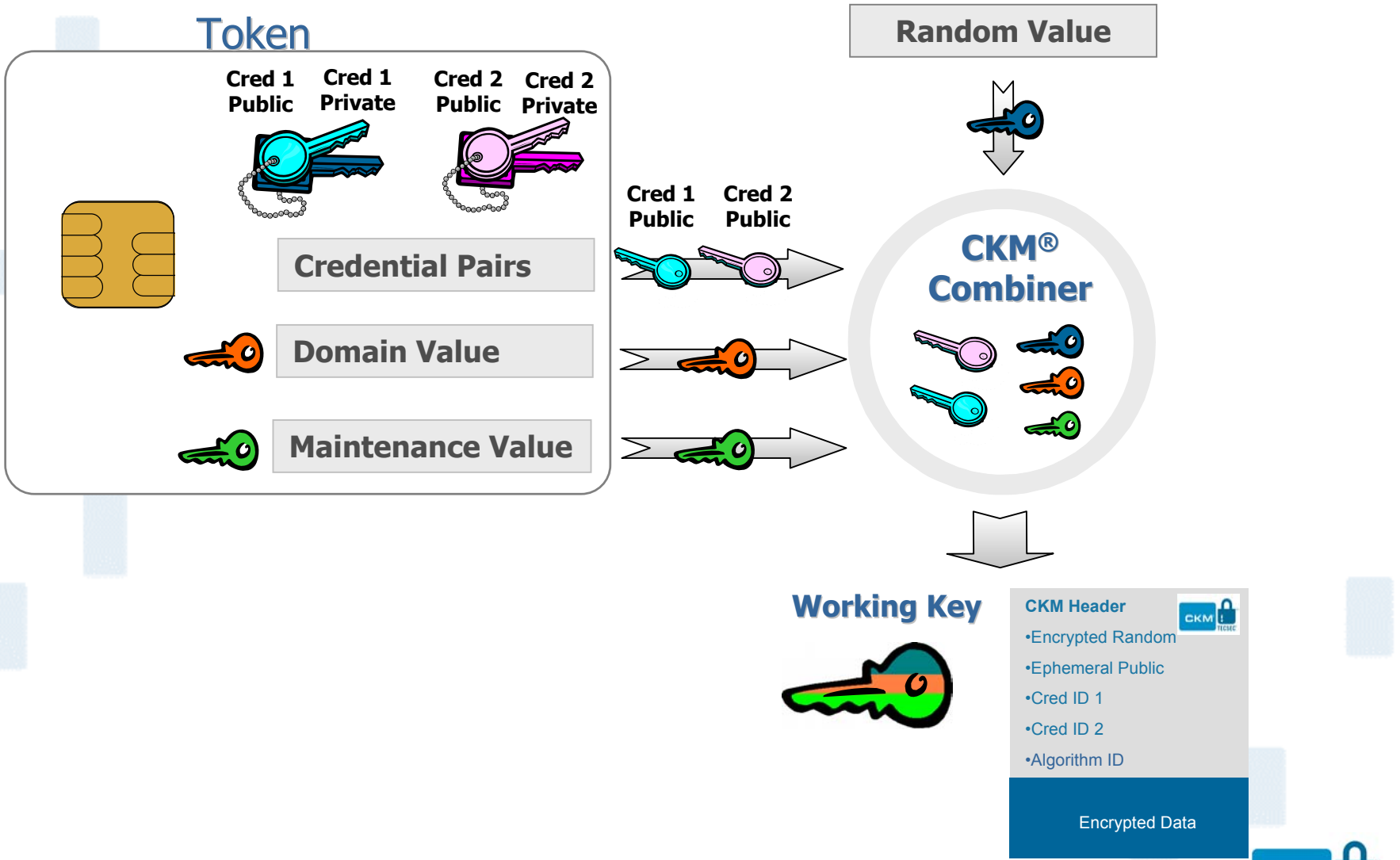
Encryption (Key Generation) – Logical View



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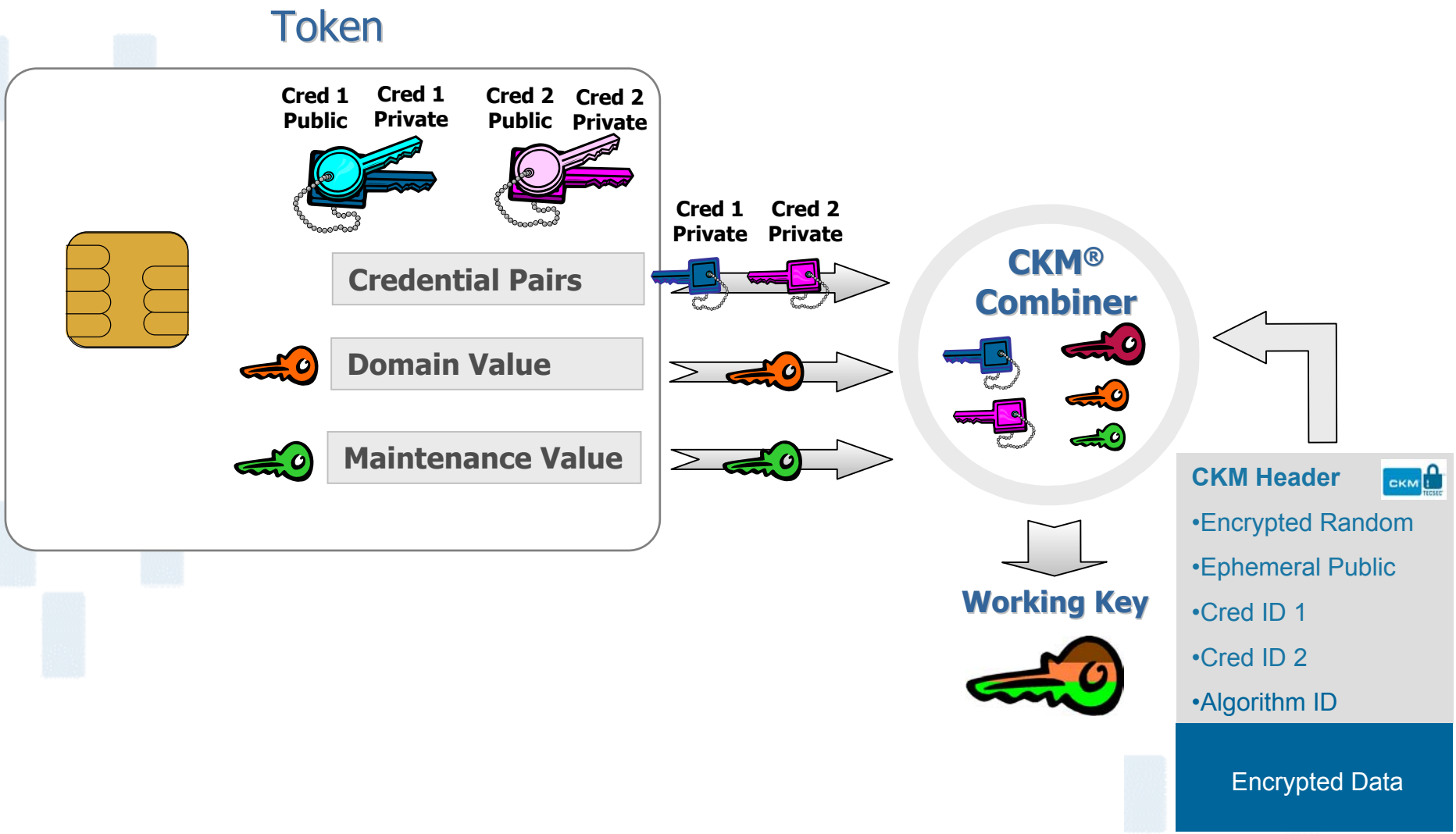
Decryption (Key Regeneration) – Logical View



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Review of CKM®

- The CKM Combiner Produces
  - Working Key and Header
- CKM Header
  - Describes How to Regenerate the Working Key
  - Credentials Define the Protection Components
  - Working Key Cannot Be Regenerated Without Knowledge of All Necessary Key Material

Cryptographically Enforced Role Based Access Control is Achieved

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Advanced CKM® Concepts

- Credentials Can Be Supplied to the Combiner to Produce Multiple Encrypted Random Values - Each Protected With a Different Set of Credentials
  - Logical AND / Logical OR
  - Multiple Calls to Combiner Creates Nesting
- X.509 Certificates can be used to Protect the Working Key
  - CKM Header can Include Entries which Specify Individuals Using PKI and Groups Using CKM

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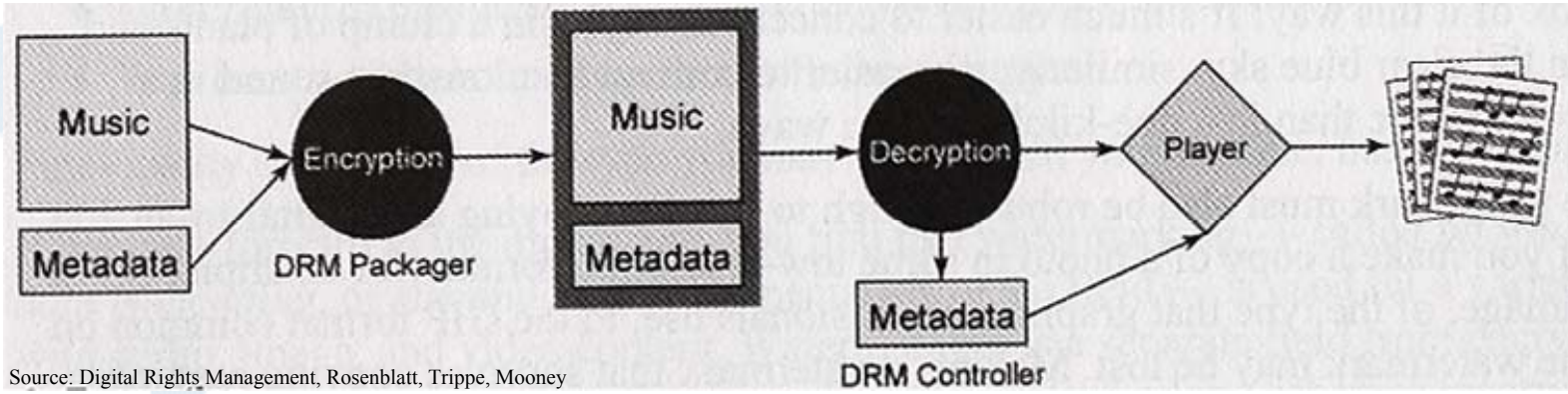
General DRM



Source: Digital Rights Management, Rosenblatt, Trippe, Mooney

- Most Systems Depend on an External Evaluation of a Digital Rights Environment (DRE)
  - Distributed or Shared Key
  - DRE Enforcement – Done Through Software
  - Misuse & Re-use of Key to Other Copies & Instances of Essence
- Key Distribution With Essence Is Also a Challenge

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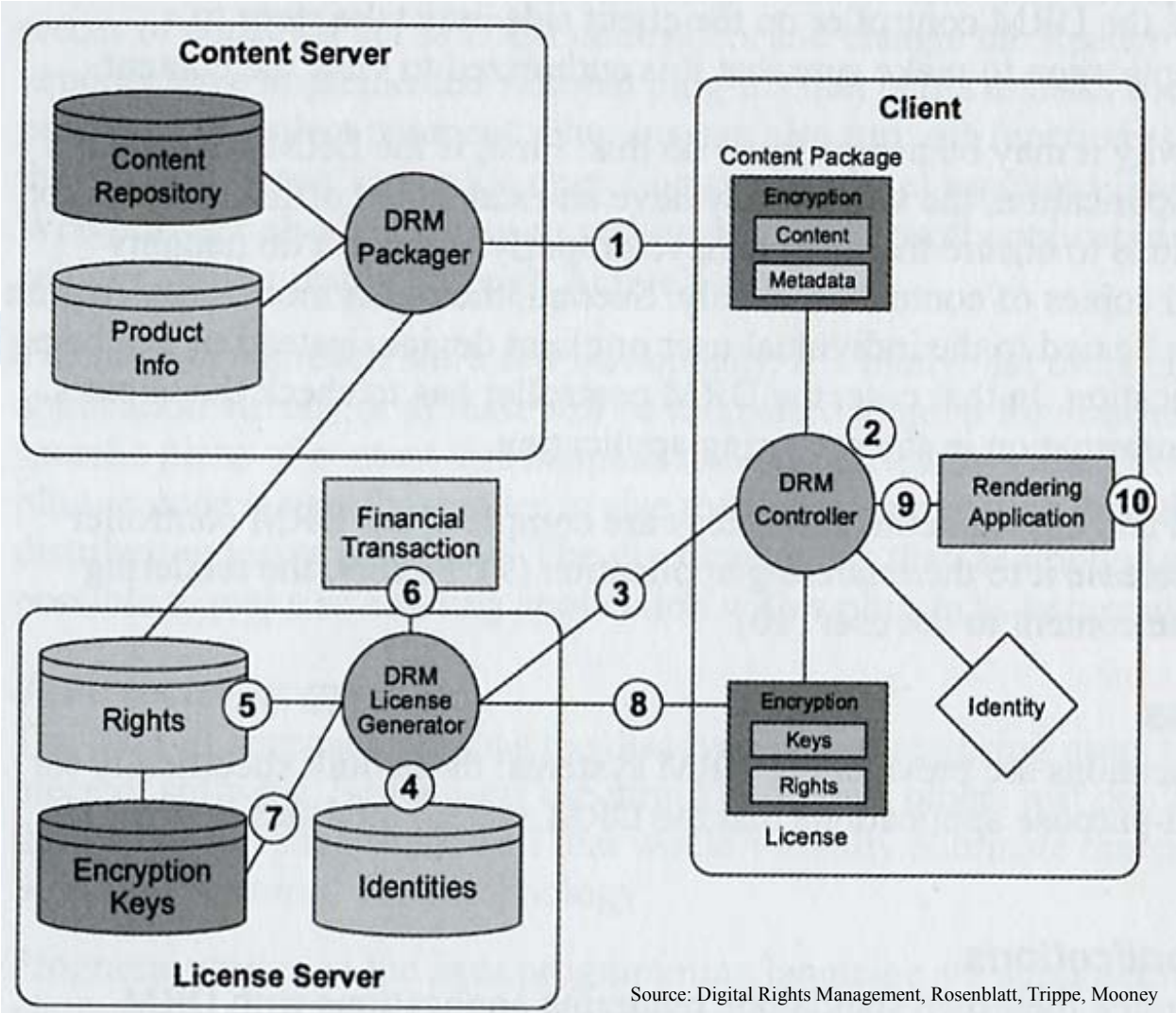
Reference DRM Architecture



Source: Digital Rights Management, Rosenblatt, Trippe, Mooney

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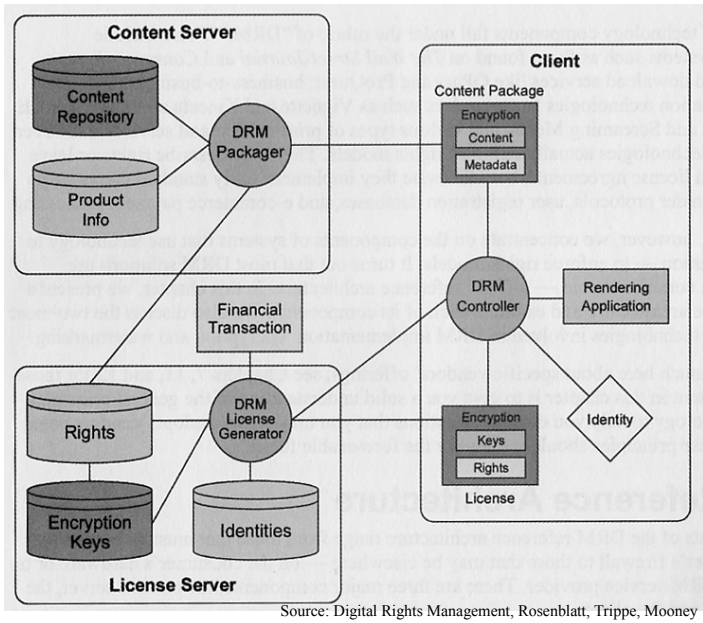
DRM Ref Architecture – Issues

- Approaches
  - Describe Rights and Leave in Written Contract
  - Control Distribution With Rights Enforcement Models
- Classical Model of “Mother May I”?
  - Scalability, On-line
- DRM License & Rights Packaging
  - Binding Content, Rights, User
  - Protection Method, Mobility
  - Key Sharing, Escrow, Distribution
  - Key Mis-use, Tamper Resistant



Source: Digital Rights Management, Rosenblatt, Trippe, Mooney

How to Bind Content and License Rights to an Indivisible Unit

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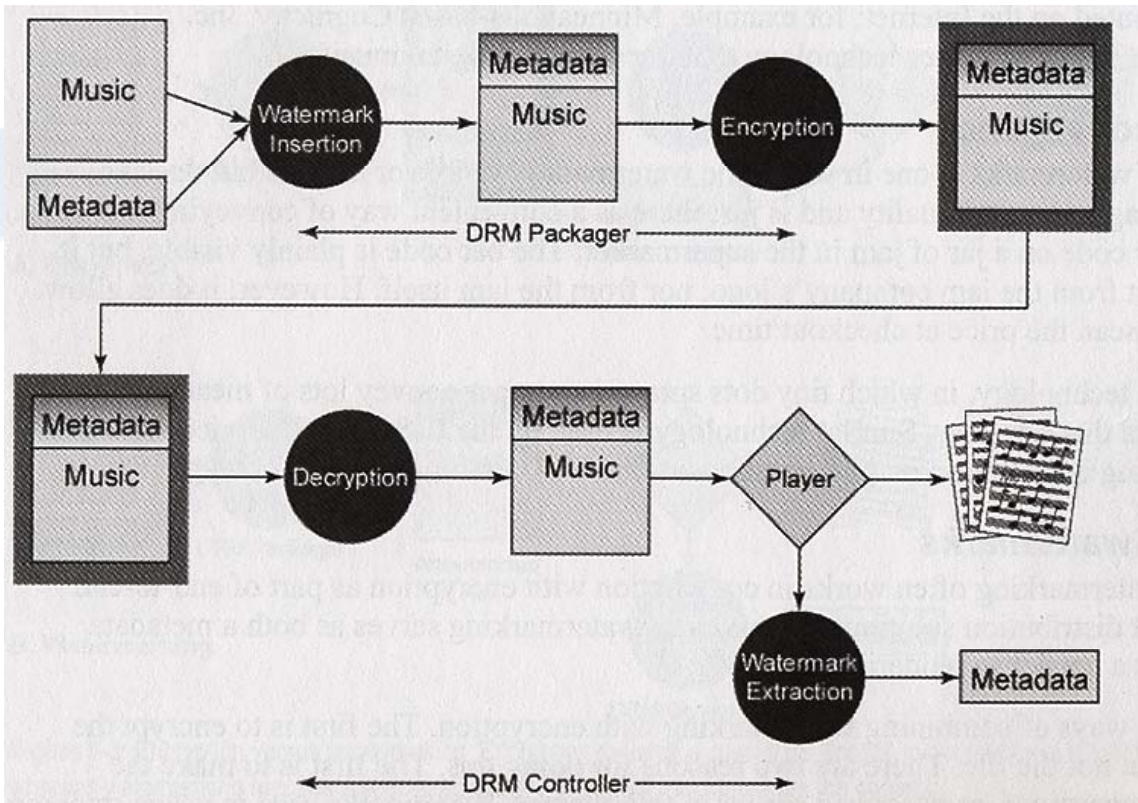
Application of Encryption to DRM

- Considered and Advanced Approach
- Goal: Prevent Content Form Being Accessible in Native Format Except When DRM Controller Permits



Source: Digital Rights Management, Rosenblatt, Trippe, Mooney

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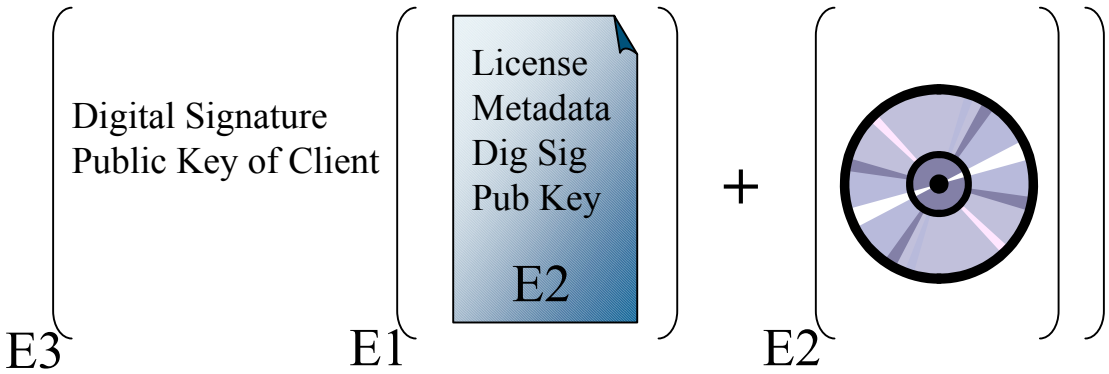
Crypto Embedded Watermark



- E3 – Key Used to Deliver Licensed & Bound Package (AKA Transport Key)
- E2 – Classical Message or Content Key – Protects Actual Essence (Contained or Embedded in License)
- E1 – Distributed Key – Obtained by Purchasing Content

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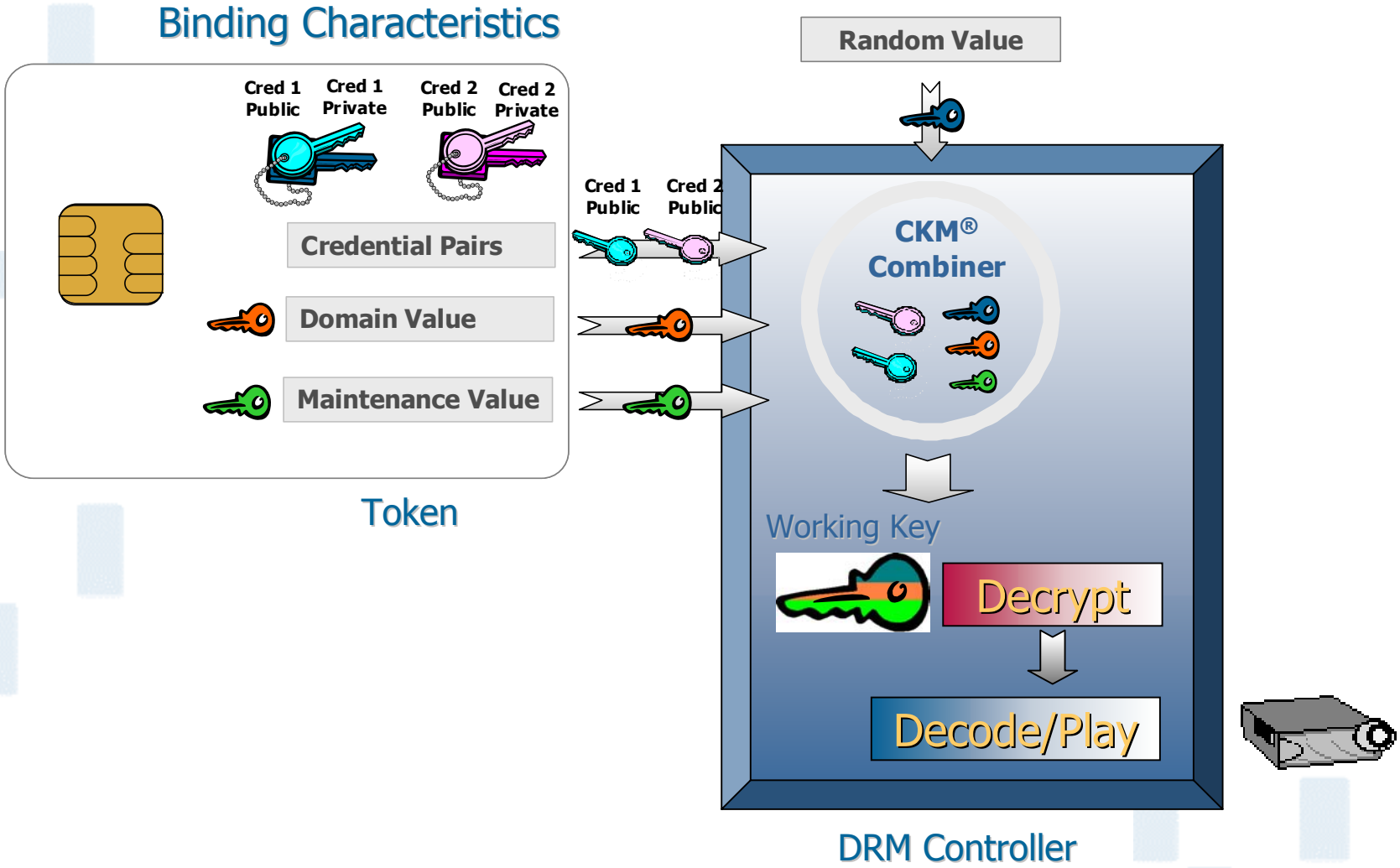
DRM Binding With CKM®



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DRM Binding Characteristics

- Cryptographic Binding of Rights Licensing
  - Access Content Delivery Chain
  - Hierarchical, Relational, Boolean Logic
  - Distributed Management
- Multi-factor Crypto Tokens
  - Distribution Channel/license, Sublicense
  - Theatre Ownership, Subscription Service
  - Exhibition Facility (Projector/system/device) Location Dependent
  - Format/content Program Material
  - Time Window for Valid Crypto Key
  - XrML Models
- Contract Relationship Flexibility
- End-to-end Content Protection
- No System Re-key Required to Support Changes in Delivery Contract
- Authenticate User and Device to Exhibition Event

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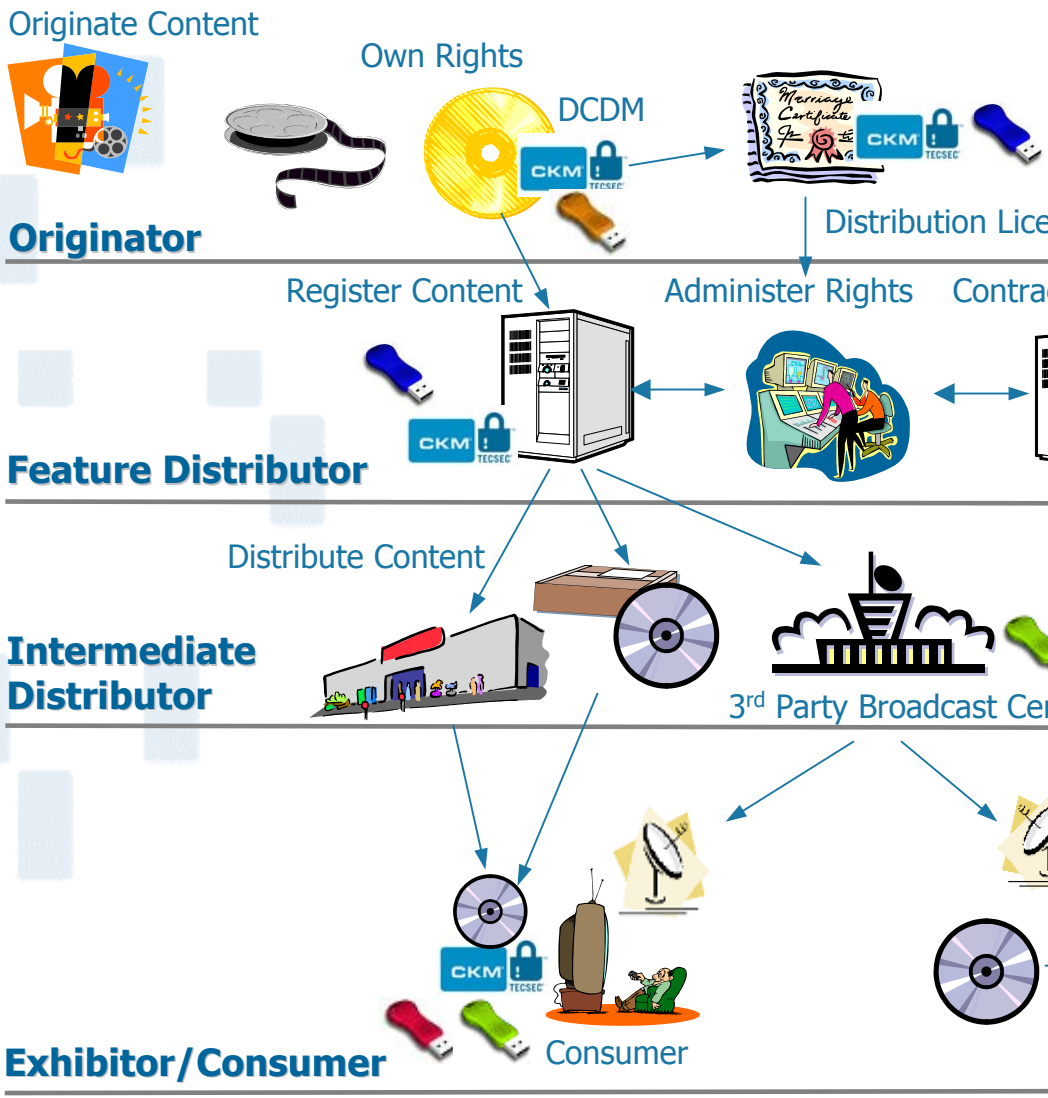
Feature Release Example



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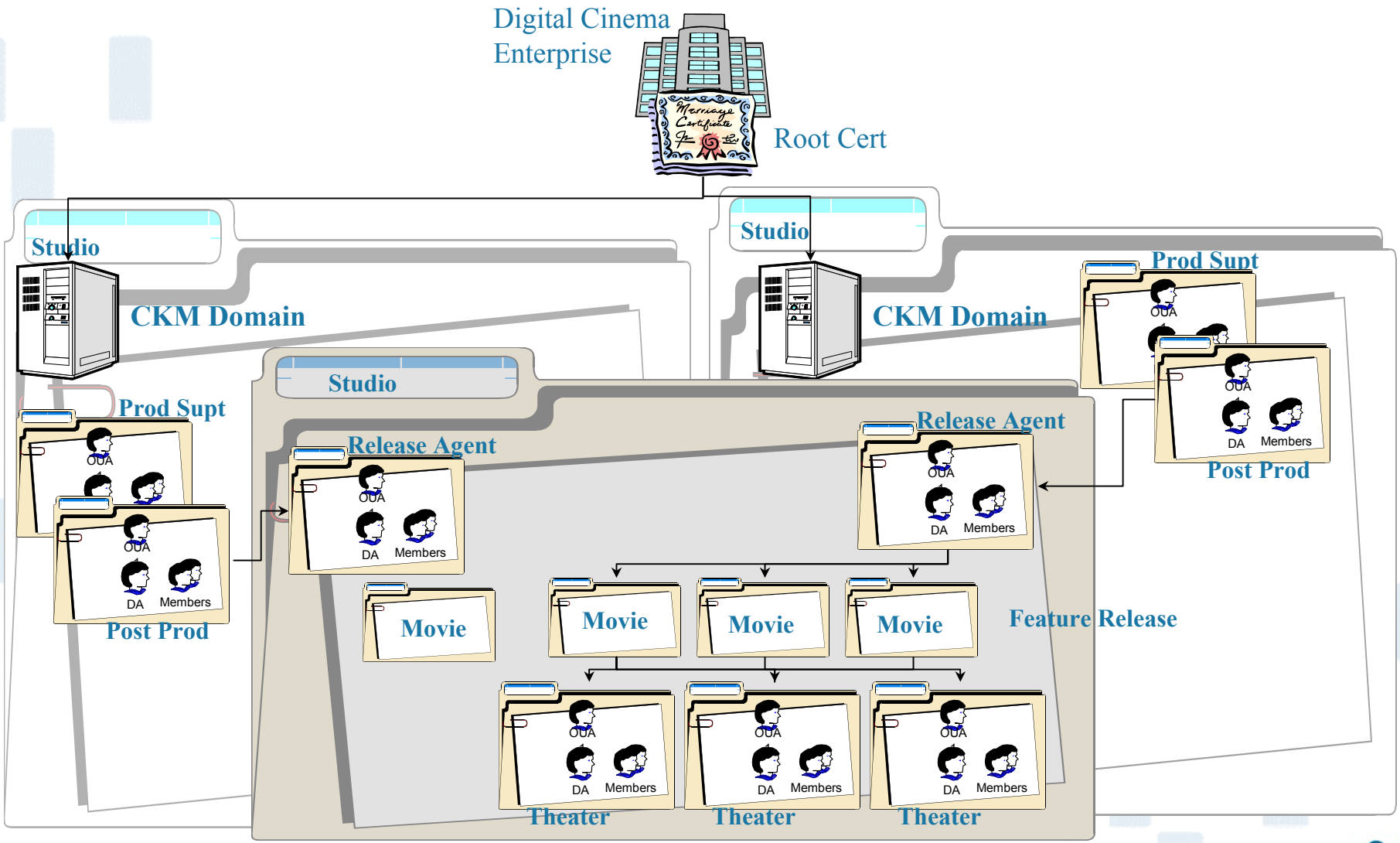
CKM Credentials in Digital Cinema



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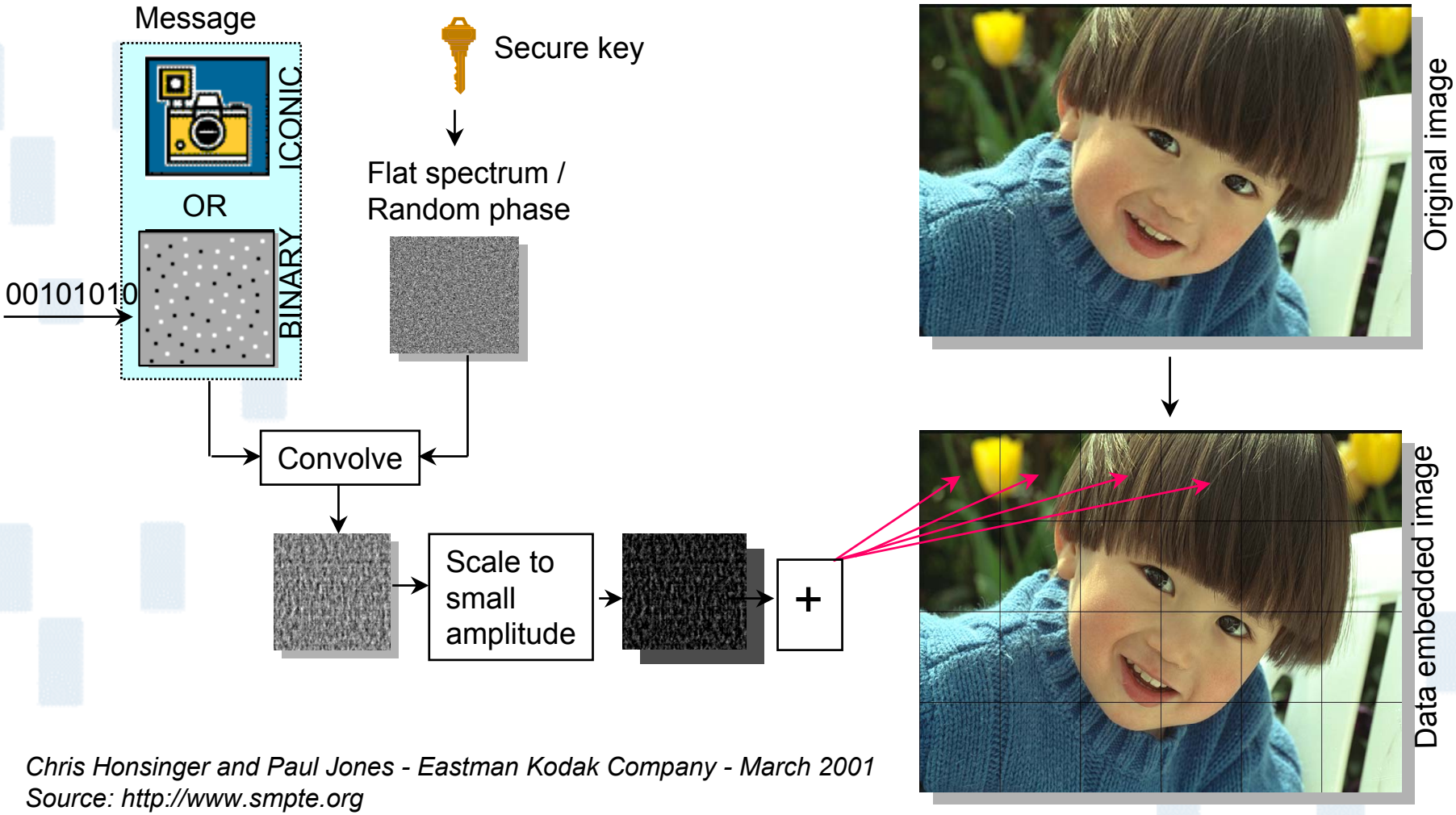
Kodak Algorithm – Embedding Messages



Chris Honsinger and Paul Jones - Eastman Kodak Company - March 2001
Source: http://www.smpte.org

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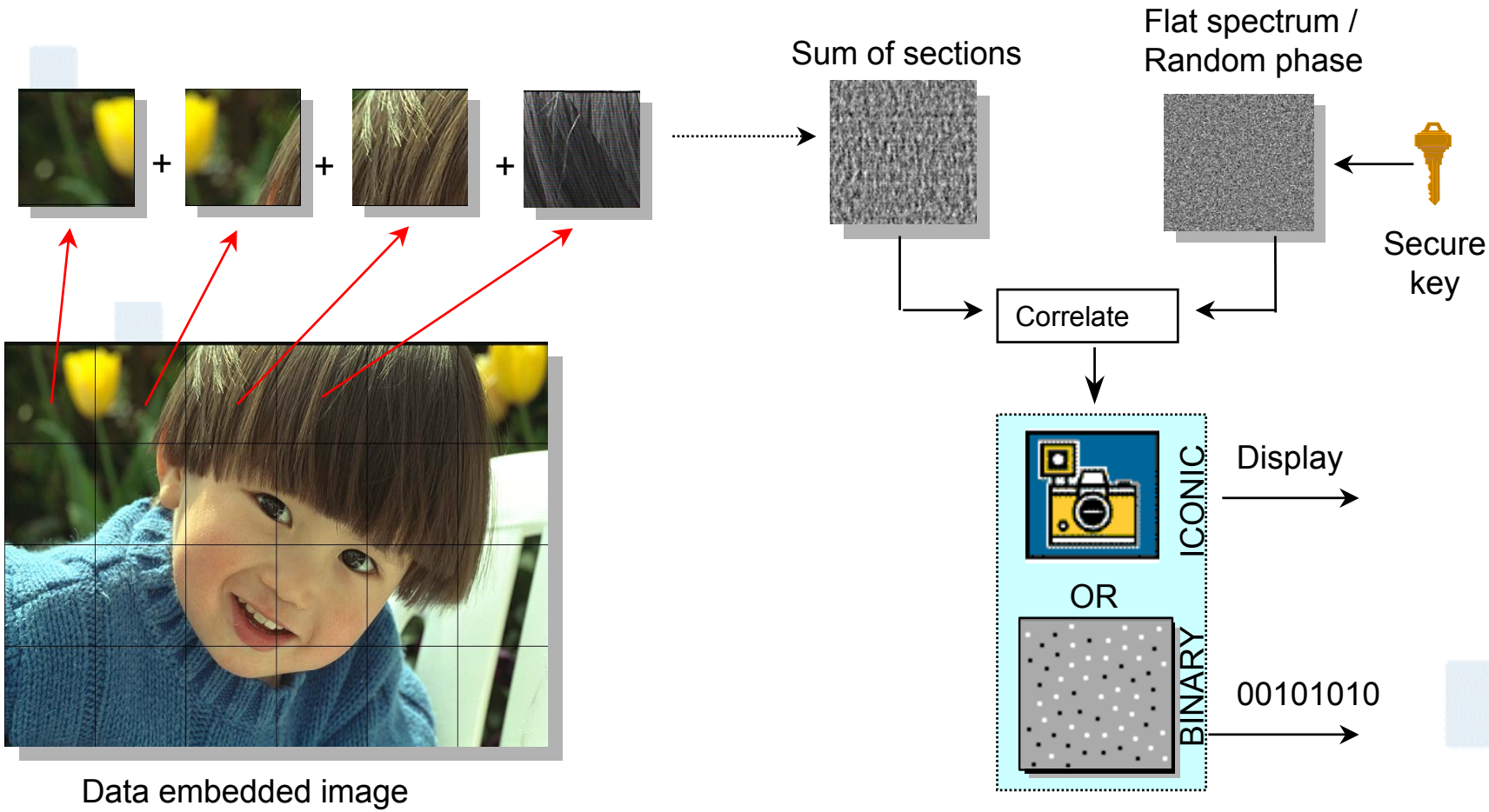
Kodak Algorithm – Extracting Messages



Chris Honsinger and Paul Jones - Eastman Kodak Company - March 2001

Source: http://www.smpte.org

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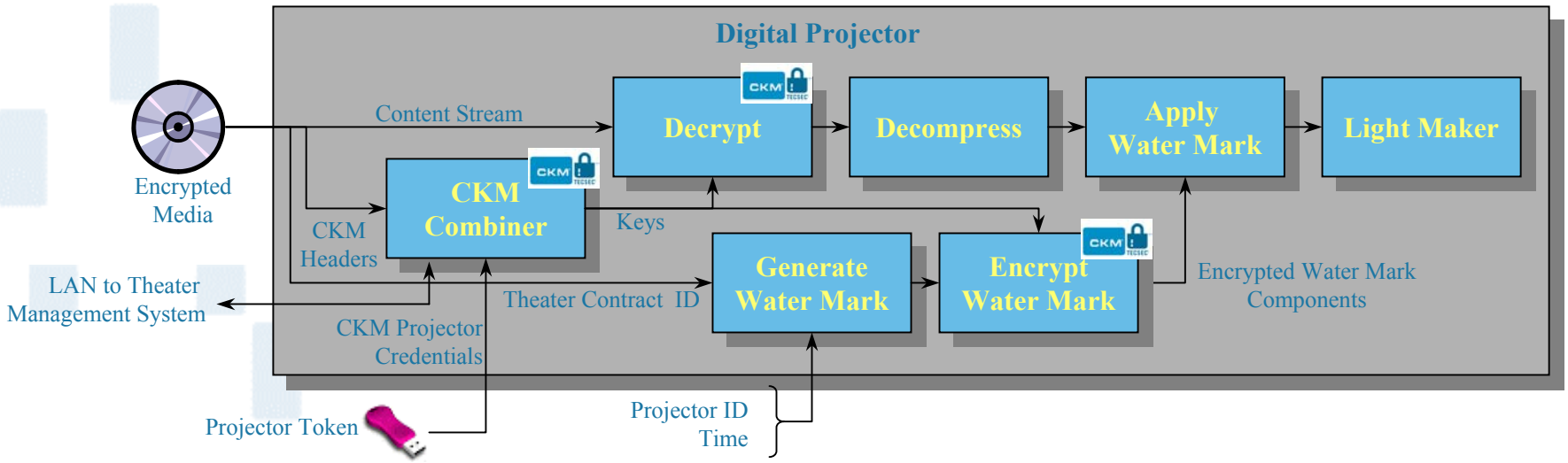
Watermark Application



- Encrypted Watermark
  - Cryptographically Interlocked With Exhibition Projector
  - Projector Token Cryptographically Interlocked With Projector H/W
- Watermark Exposure Forensics Use Higher Level Media Distribution or Studio Release Credential
- Common Credentials Used for Decryption of Media, Generation of Water Mark
  - Cryptographically Binds Exhibition Event to License & Projector Device

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info@tecsec.com

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Backup Slides

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Encryption Process

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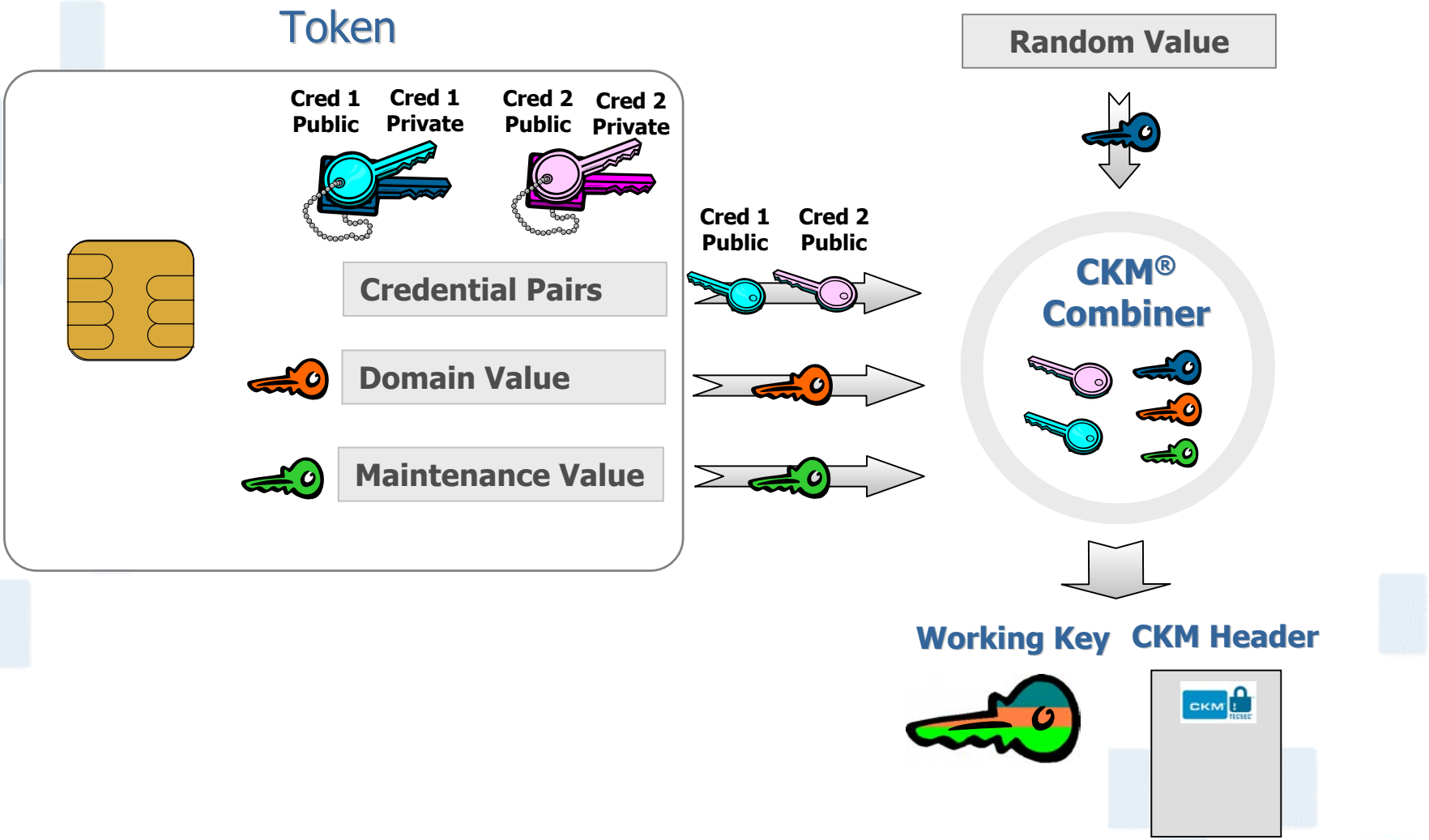
Encryption (Key Generation) – Logical View



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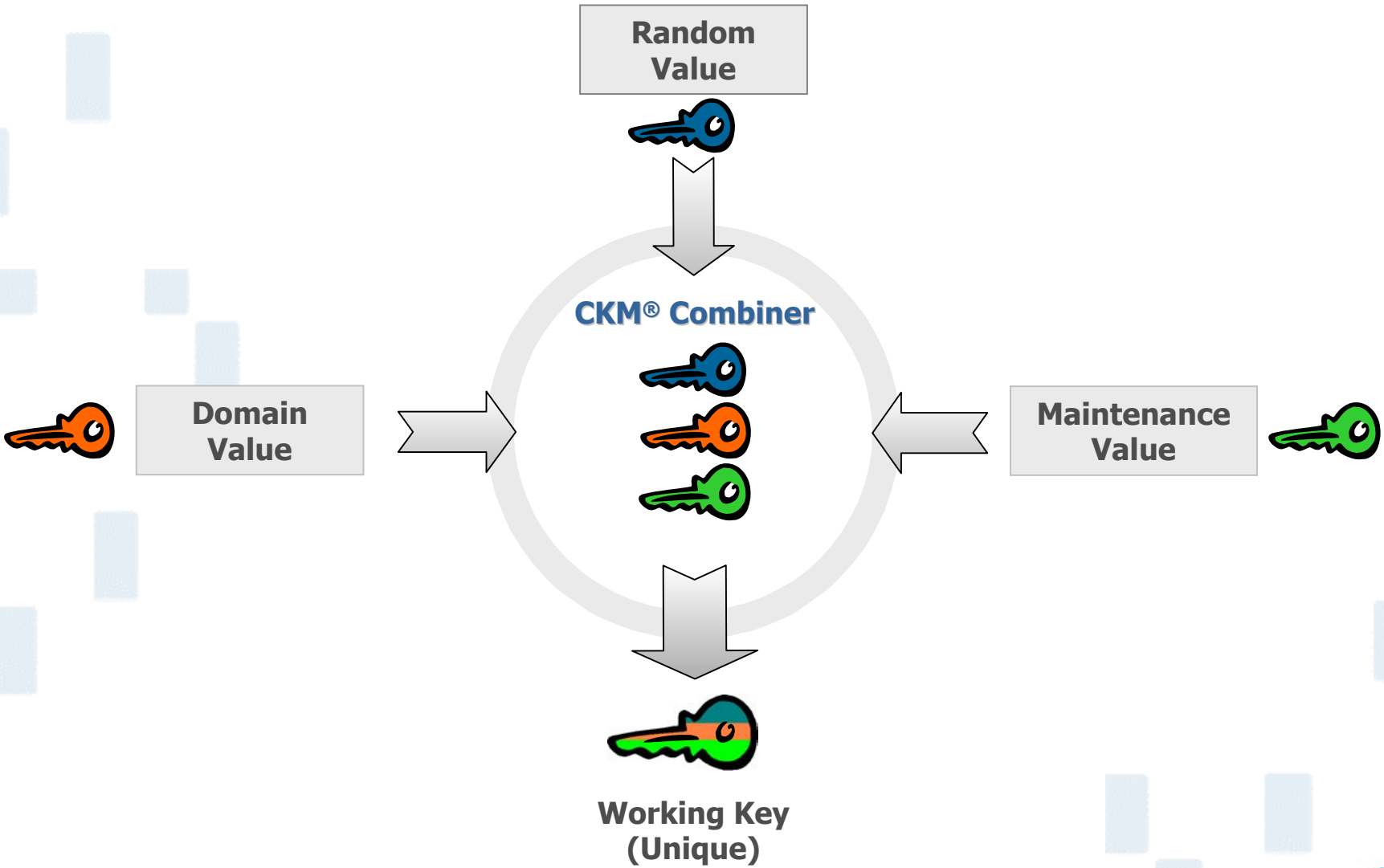
Encryption Functional View
Phase I - Working Key Generation



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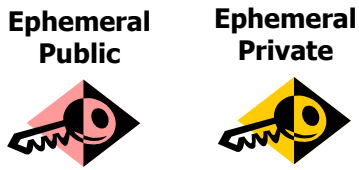
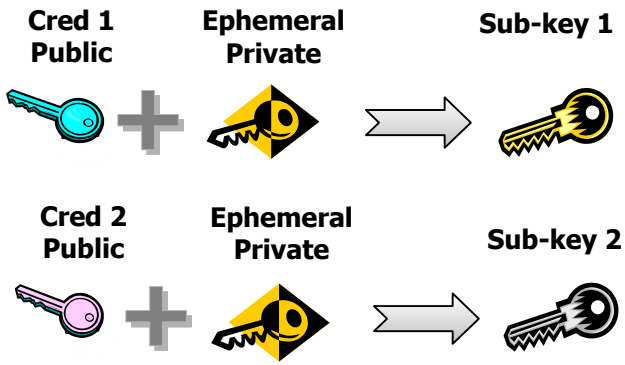
Encryption Functional View
Phase II – Protecting the Random

Ephemeral Key Pair is generated



Each supplied Credential's Public Key & the Ephemeral Private Key are used to produce a Sub-key.



Sub-keys are combined to produce a key to encrypt the Random

Random destroyed

Ephemeral Private destroyed

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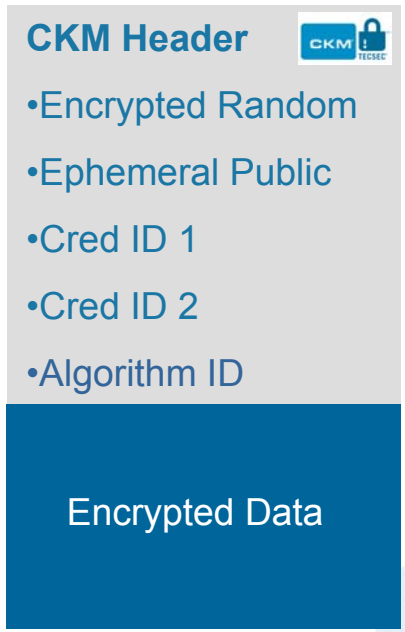
Encrypting the Data

- Once the Working Key and CKM® Header Have Been Created, the Following Steps Occur:

1. The Working Key Is Truncated to the Desired Length Based on the Selected Encryption Algorithm.
2. The CKM Header Has the Algorithm ID Included in it.
3. The Data Is Encrypted With the Working Key and the Header Is Attached to the Encrypted Data.
4. The Working Key Is Destroyed.



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Decryption Process

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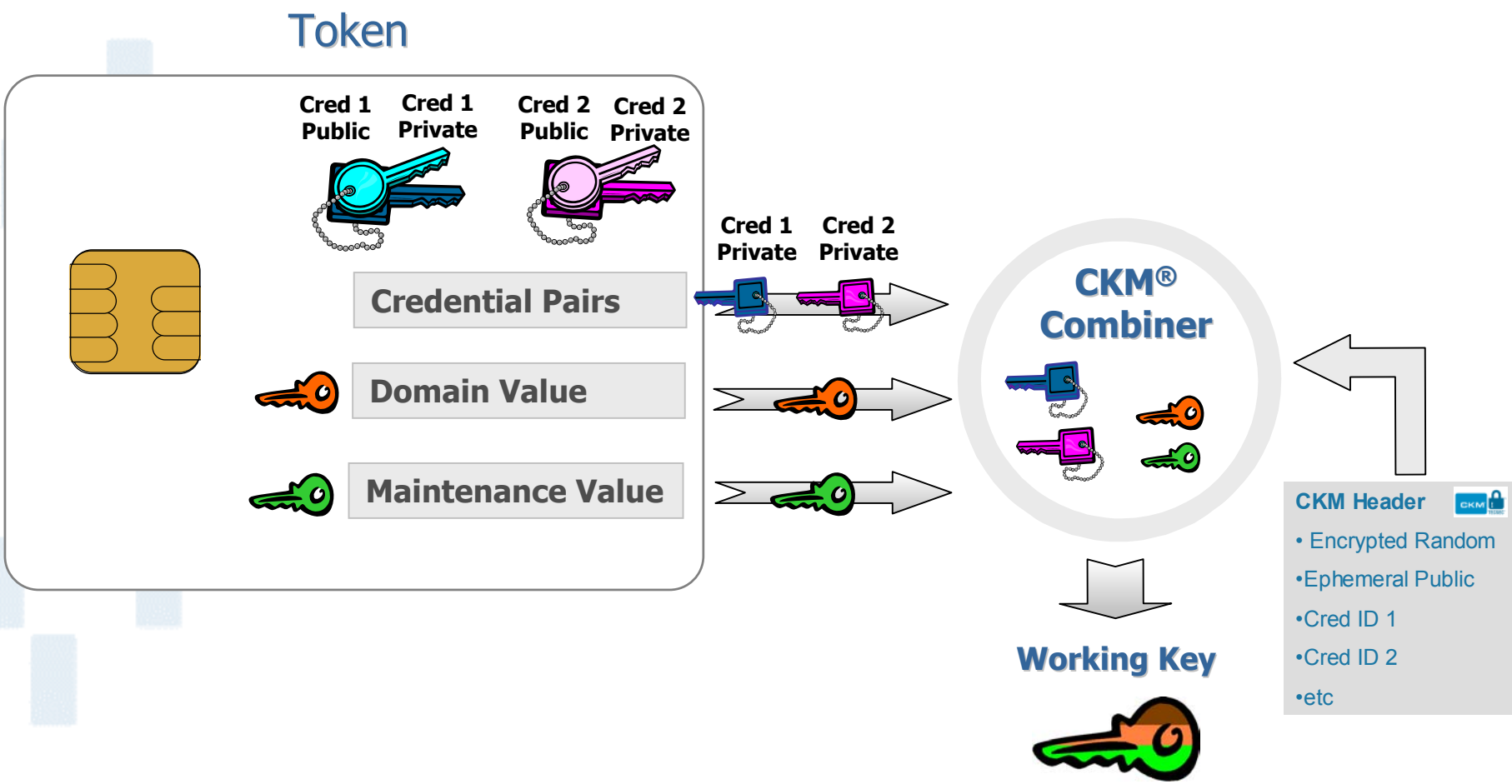
Decryption – Logical View



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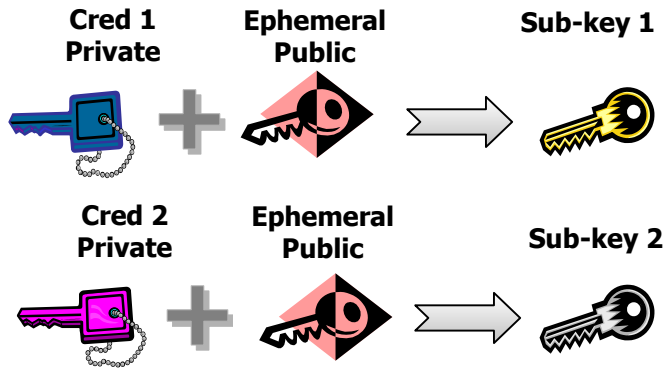
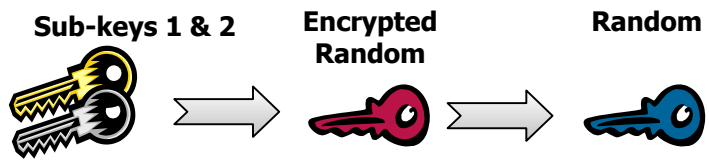
Decryption Functional View
Phase II – Recovering the Random

Each supplied Credential's Private Key & the Ephemeral Public Key are used to produce a Sub-key.



Sub-keys are combined to produce a key to decrypt the Random



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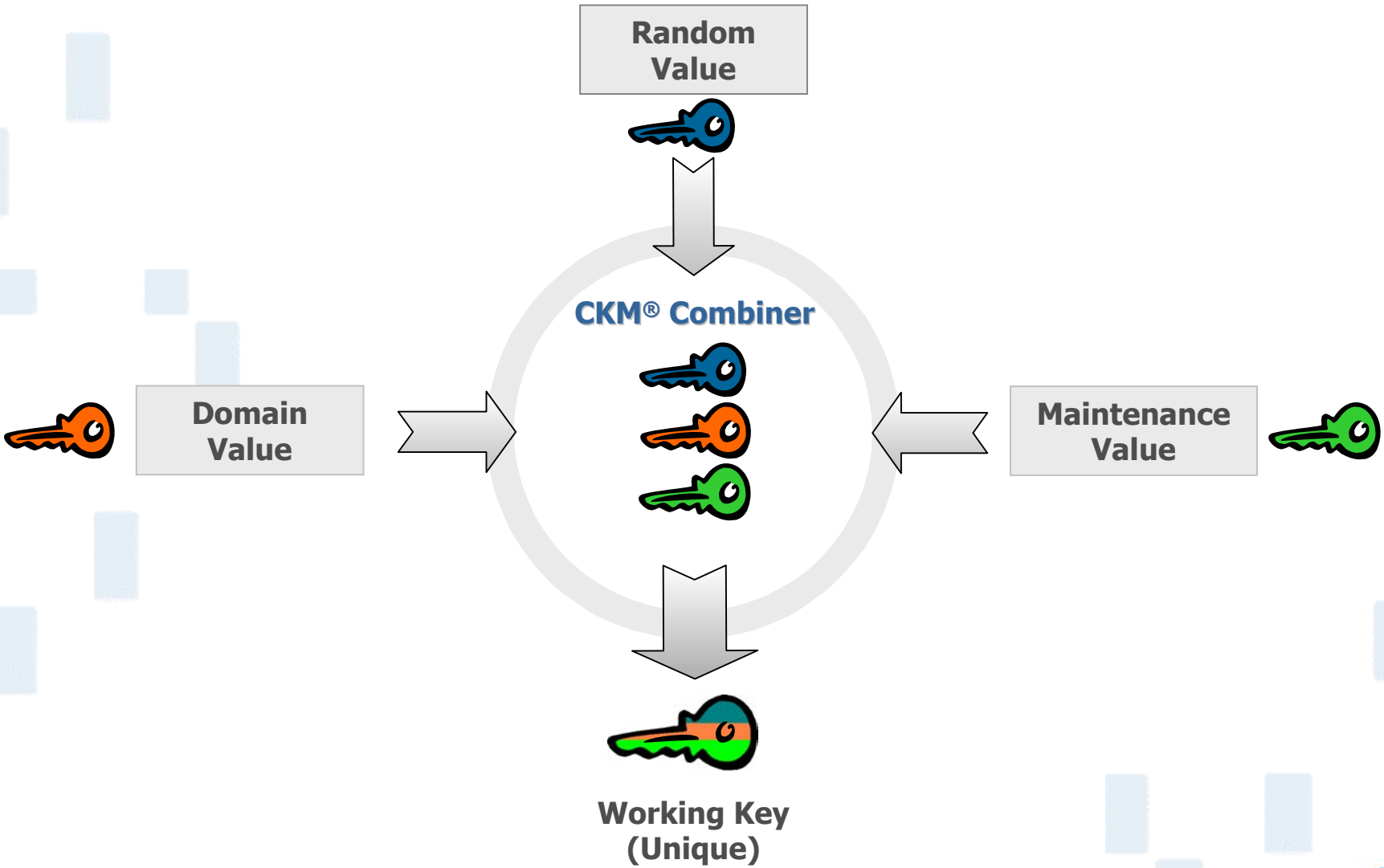
Decryption Functional View
Phase I - Working Key Generation



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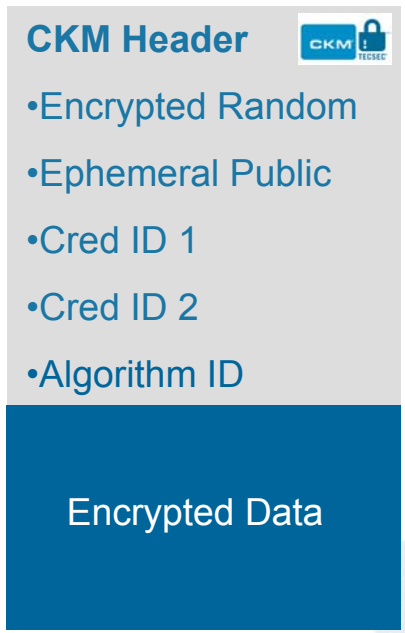
Decrypting the Data

- Once the Working Key Has Been Created, the Following Steps Occur:

1. We Look in the CKM® Header to Determine the Correct Algorithm to Use Based on the Algorithm Id
2. The Working Key Is Then Truncated to Conform to the Algorithm Specified
3. The Data Is Decrypted With the Working Key and the Header Is Discarded
4. The Working Key Is Destroyed



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Comparison of CKM® and PKI

CKM

- One-to-many Key Management
- Role Based Access Control
- Centralized Key Creation

PKI

- One-to-one Key Management
- Identification & Authentication
- Distributed Key Creation

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Combining CKM® and PKI

- One-to-one Key Management
- One-to-many Key Management
- Identification & Authentication
- Role Based Access Control

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Other Example Applications of CKM®

- Workflow
- Collaborative Development
- Broadcasting Encrypted Information

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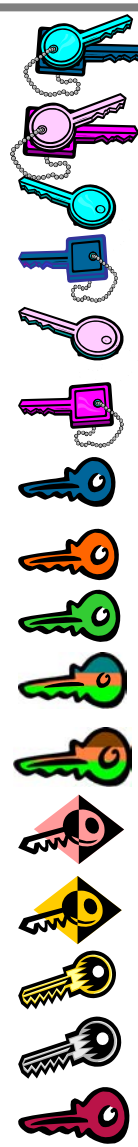
Key Legend

- Credential 1 Key Pair
- Credential 2 Key Pair
- Credential 1 Public
- Credential 1 Private
- Credential 2 Public
- Credential 2 Private
- Random Value
- Domain Value
- Maintenance Value
- Working Key (Encryption)
- Working Key (Decryption)
- Ephemeral Public
- Ephemeral Private
- Sub-key 1
- Sub-key 2
- Encrypted Random



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