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Digital Evidence Chain of Custody:
Navigating New Realities of Digital Forensics

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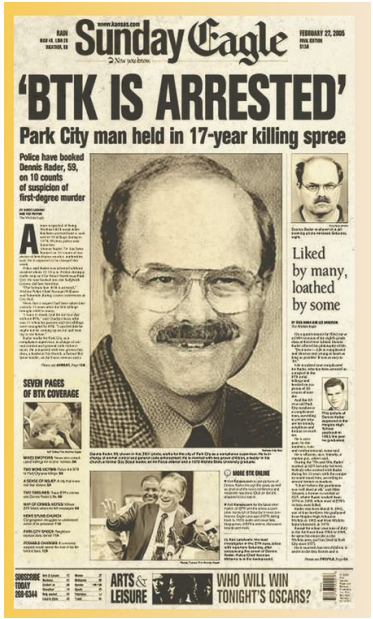
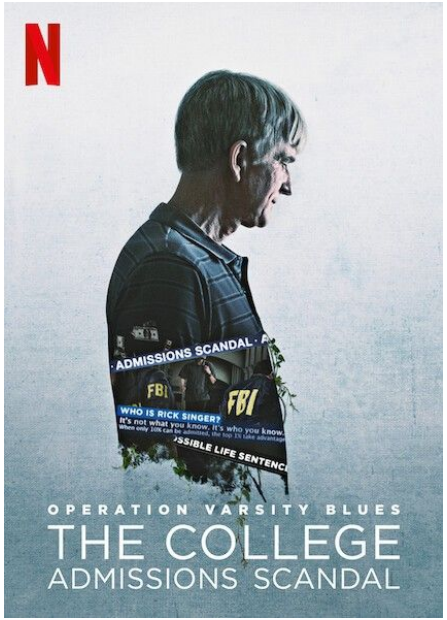
October 28, 2024

Motivation



Arrest of the
BTK killer, 2005

Boston Marathon
Bombing, 2013



College Admission
Scandal, 2019

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Digital Evidence Admissibility

- **Authenticity**
  - The digital evidence must be proven to originate from a credible source and not fabricated
  - E.g., *An email presented in court must be shown to have come from the defendant's verified account, confirming it as genuine evidence, and not maliciously fabricated.*

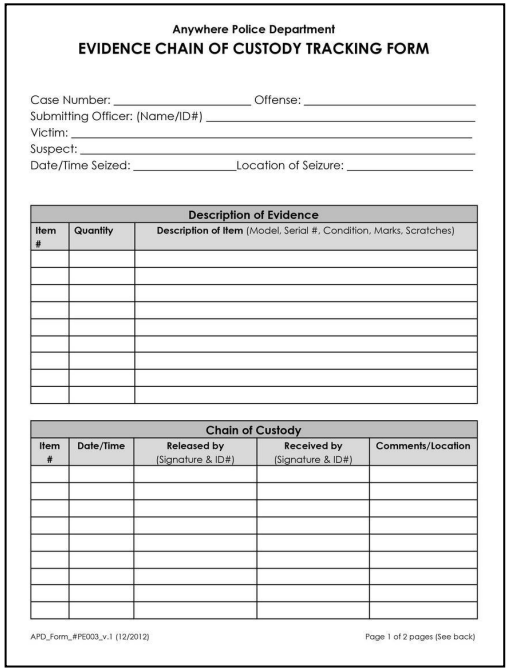
- **Integrity**
  - The digital evidence must remain unaltered from the time it was collected until it is presented in court
  - E.g., *A screenshot of a social media post must be preserved in its original form, with metadata intact, to ensure it has not been edited before being used as evidence in court.*

What is a Chain of Custody (CoC)?

A chronological history of the evidence throughout the life cycle of the case from its collection to presentation in the court.

The documentation must address the following queries:

- **WHAT?** What is the evidence?
- **HOW?** How was it collected and stored?
- **WHO?** Who took possession of it?
- **WHEN?** When was it collected/transferred/handled?
- **WHERE?** Where did the evidence travel?
- **WHY?** Why the evidence was transferred?



Anywhere Police Department

EVIDENCE CHAIN OF CUSTODY TRACKING FORM

Case Number: _____ Offense: _____
Submitting Officer: (Name/ID#) _____
Victim: _____
Suspect: _____
Date/Time Seized: _____Location of Seizure: _____

Description of Evidence		
Item #	**Quantity**	**Description of Item** (Model, Serial #, Condition, Marks, Scratches)

Chain of Custody				
Item #	**Date/Time**	**Released by** (Signature & ID#)	**Received by** (Signature & ID#)	**Comments/Location**

APD_Form_#PE003_v.1 (12/2012) Page 1 of 2 pages (See back)

NIST Template for CoC (2012)

Research Questions

- **RQ1:** What are the essential **security** and **operational** requirements for a digital evidence Chain of Custody?

- **RQ2:** What are the **existing frameworks** for Chain of Custody, as proposed in the academic literature and implemented in practice?

- **RQ3:** What **evaluative criteria** should be employed to assess the quality of a digital evidence Chain of Custody framework?

Methodology

(1) Literature Review

Scientific Literature Review

Grey Literature Review

- Blog Posts
- News Articles
- Product Documentation
- Guidelines and Reports

(2) Analysis and Modeling

Requirement Extraction

- Security Requirements
- Operational Requirements

Taxonomy Generation

- Commonalities Analysis
- Categorization of Frameworks

(3) Assessment

Comparative Analysis

- Assessment Framework Derivation
- Qualitative Comparison

Identifying Research Gaps

- Assessing Pros and Cons
- Proposing Research Directions

Research Outcomes

RQ1: Requirements → **RQ2:** Practices → **RQ3:** Quality Assessment

Chain of Custody Requirements

Security Requirements

- Comprehensiveness
- Completeness
- Security and Access Control
- Immutability
- Authentication and Non-repudiation
- Verifiability

Operational Requirements

- Usability and Applicability
- Complexity and Learnability
- Resource Needs (Computational and Non-Computational)
- Direct and Indirect Costs and Liability

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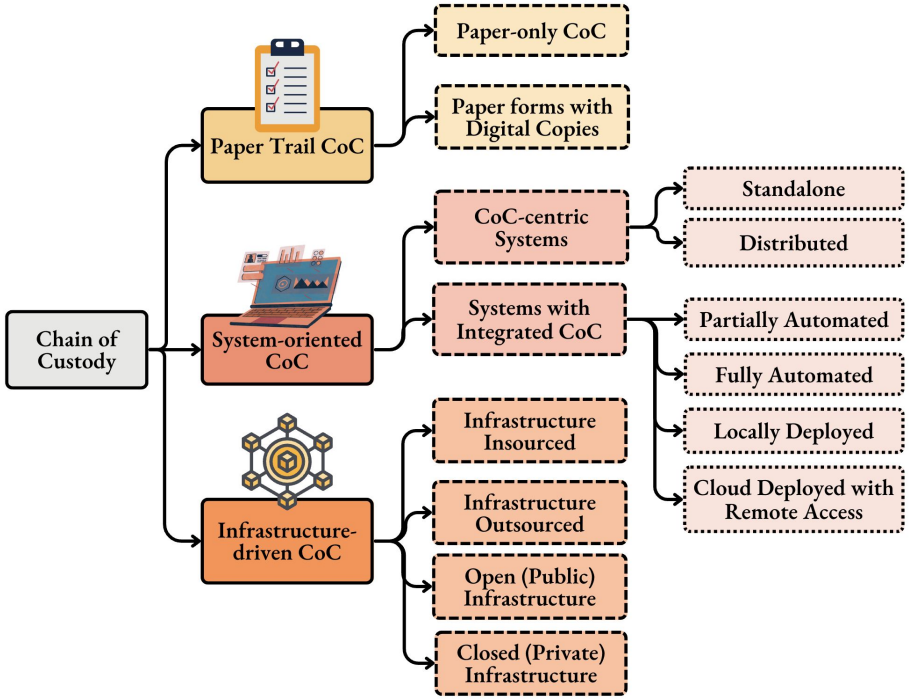
Chain of Custody Practices

We explore various CoC practices both from academic literature and real-world digital forensics applications

We categorize them into three distinct categories:

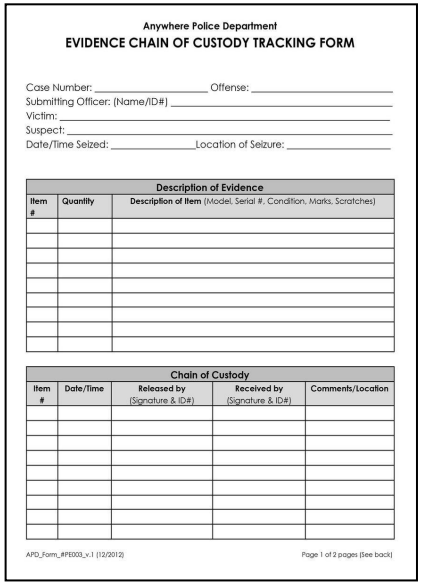
- Traditional Paper Trail CoC
- System-oriented CoC
- Infrastructure-driven CoC



Taxonomy of CoC Practices in Digital Forensics

Traditional Paper Trail Chain of Custody

- Paper forms to chronologically record every individual who handles the evidence and track its movement
- Offers a clear and traceable record of evidence interaction with accountability by requiring signatures from authorized personnels
- Simple, straightforward, transparent, and usable in resource-constrained environments



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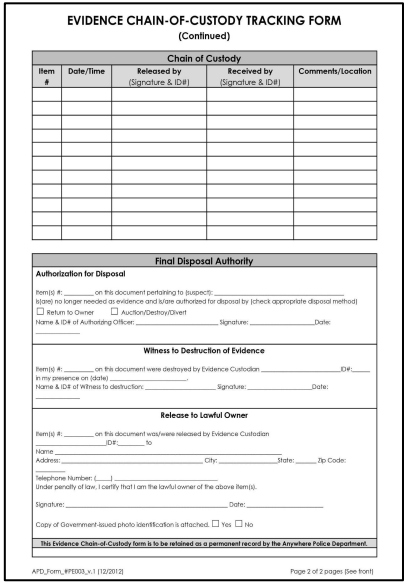


EVIDENCE CHAIN-OF-CUSTODY TRACKING FORM
(Continued)

Chain of Custody				
Item #	Date/Time	Released by (Signature & ID#)	Received by (Signature & ID#)	Comments/Location

Final Disposal Authority

Authorization for Disposal

Item(s) #: _____ on this document pertaining to (suspect): _____
is(are) no longer needed as evidence and is/are authorized for disposal by (check appropriate disposal method)
☐ Return to Owner ☐ Auction/Destroy/Divert
Name & ID# of Authorizing Officer: _____ Signature: _____Date: _____

Witness to Destruction of Evidence

Item(s) #: _____ on this document were destroyed by Evidence Custodian _____ID#:____
in my presence on (date) _____.
Name & ID# of Witness to destruction: _____ Signature: _____Date: _____

Release to Lawful Owner

Item(s) #: _____ on this document was/were released by Evidence Custodian _____ID#:_____ to
Name _____
Address: _____ City: _____State: _____ Zip Code: _____
Telephone Number: (_____) _____
Under penalty of law, I certify that I am the lawful owner of the above item(s).
Signature: _____ Date: _____
Copy of Government-issued photo identification is attached. ☐ Yes ☐ No

This Evidence Chain-of-Custody form is to be retained as a permanent record by the Anywhere Police Department.

APD_Form_#PE003_v.1 (12/2012) Page 2 of 2 pages (See front)

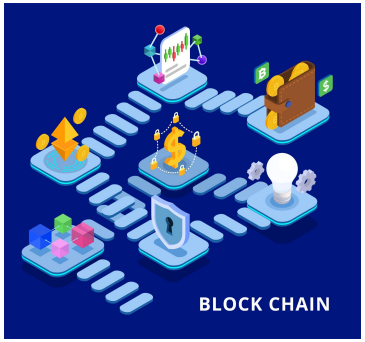
NIST Template for CoC (2012)

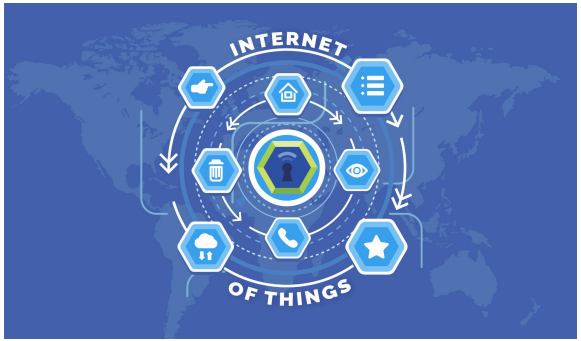
System-oriented Chain of Custody

- Systems that automate evidence tracking with metadata and digital signatures
- CoC-centric Systems vs. Systems with integrated CoCs
- Manual labour significantly reduced with the aid of automated evidence tracking and logging

Infrastructure-driven Chain of Custody

- Leveraging advanced technologies like Cloud Computing, Blockchain, and IoT for CoC and Digital Forensics ecosystem
- Distributed and Decentralized infrastructures to support more real-world forensic workflows
- Infrastructure outsourced vs. insourced
- Underlying infrastructure ensures immutability, transparency, and cryptographic security





Chain of Custody Quality Assessment

- **Documentation**
  - Manual Inputs
  - Data Redundancy
- **Legal Credibility**
  - Immutability
  - Transparency
  - Accountability
  - Verifiability
- **Applicability**
  - Complexity
  - Learnability
  - Usability
  - Cost
- **Resource Requirements**
  - Non-Computational
  - Computational

Criteria	Sub-criteria	Paper	System	Infra.
(C_1)	Manual Inputs	High	Medium	Low
	Data Redundancy	Low	Medium	High
(C_2)	Immutability	Medium	Medium	High
	Transparency	Low	Medium	High
	Accountability	Low	High	High
	Verifiability	Low	Low	High
(C_3)	Complexity	Low	High	High
	Learnability	High	Medium	Low
	Usability	High	Medium	Medium
	Cost	Low	Medium	High
(C_4)	Non-Computational	High	Low	Low
	Computational	Low	Medium	High

(C_1) Documentation, (C_2) Legal Credibility, (C_3) Applicability, (C_4) Resource Requirements

Qualitative Comparison of the CoC Practices

Key Findings

- **Paper Trail is easy-to-use but might not be the most secure option**
  - Straightforward approach integrates well with existing ecosystem
  - Highly practical due to simplicity, familiarity, and cost-effectiveness
  - Provides limited security, but highly adaptable

- **Infrastructure-driven CoCs are secure, but confined to academic research**
  - Underlying infrastructure meets the security requirements
  - Highly resource-intensive and lacks standardized practical implementation

- **System-oriented CoCs find a middle ground, but still limited in application**
  - Somewhat practical and adaptable, but still relies on manual obligation for compliance
  - Limited real-world application needs further investigation

Research Direction

- **Exploration of Tailored and Optimized Systems**
  - Need for Bespoke, optimized systems and infrastructures for practical and secure CoC
  - Careful selection of capabilities to remove unnecessary features and functionalities that add overhead without contributing to the core objectives of CoC

- **Actor-centric Design and Evaluation**
  - Actor-centric analysis during both the design and evaluation phases
  - Directly eliciting requirements from a diverse range of stakeholders to meet the varied needs and preferences of their end users

- **Context-aware Chain of Custody**
  - Incorporating contextual data to improve the traceability of evidence
  - Integration of AI to streamline anomaly detection and prevent tampering in real-time
  - Explore computational demands and privacy and legal concerns

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Thank you

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