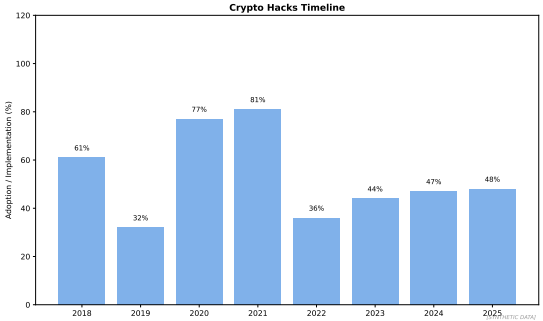
Lesson 23: Blockchain Security

Mini-Lecture Version (30 min)

Digital Finance

Learning Objectives: Understand key concepts and applications

The Stakes: Billions Lost to Hacks

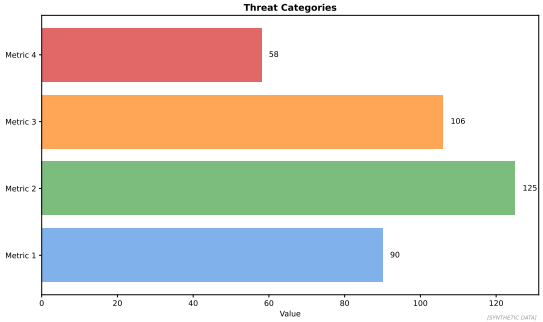


Major Incidents:

- **2016:** The DAO ($60M) – reentrancy
- **2021:** Poly Network ($611M) – access control (returned)
- **2022:** Ronin Bridge ($625M) – compromised keys
- **2022:** Wormhole Bridge ($325M) – signature verification
- **Total (2020–2024):** >$10 billion stolen

This concept is fundamental to understanding Blockchain Security.

Threat Landscape



Attack Vectors:

- **Smart Contract Bugs:** Logic errors, reentrancy, overflow
- **Bridge Vulnerabilities:** Cross-chain security weaknesses
- **Private Key Compromise:** Phishing, social engineering, malware
- **Oracle Manipulation:** Flash loan attacks on price feeds
- **Governance Attacks:** Token-based voting exploits

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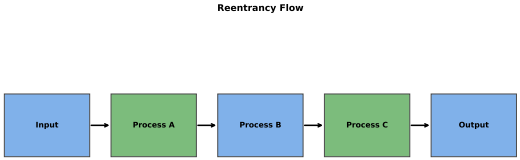
Reentrancy: The DAO Hack (2016)

Vulnerability:

- Contract sends ETH before updating balance
- Recipient contract calls back
- Recursive withdrawals drain funds

Impact:

- 3.6M ETH stolen ($60M)
- Led to Ethereum hard fork
- ETH/ETC split



[SYNTHETIC DATA]

Prevention: Checks-Effects-Interactions pattern, reentrancy guards (OpenZeppelin)

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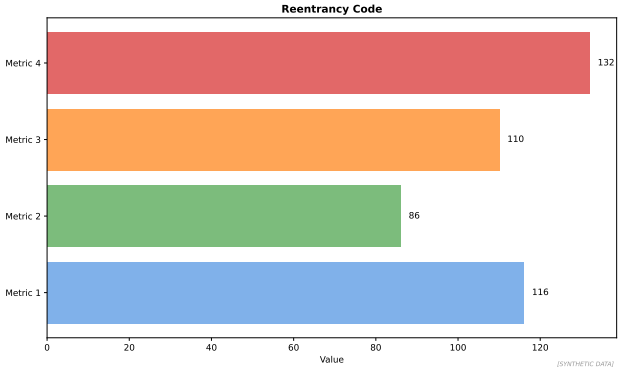
Reentrancy Code Example



Fix: Checks-Effects-Interactions

- **Checks:** Validate conditions (sufficient balance)
- **Effects:** Update state (subtract balance)
- **Interactions:** External calls (send ETH)

Modern Protection: OpenZeppelin `ReentrancyGuard` modifier

Real-world examples demonstrate Blockchain Security applications.

Integer Overflow/Underflow

Problem (Pre-Solidity 0.8):

- uint256 max: $2^{256} - 1$
- Overflow: max + 1 wraps to 0
- Underflow: 0 - 1 wraps to max
- Silent failures (no revert)

Example Attack:

- Balance: 100 tokens
- Transfer 200 (should fail)
- `balance - 200` underflows to huge number
- Exploit unlimited tokens

Overflow Visualization

[SYNTHETIC DATA]

Fix: Solidity 0.8+ has automatic overflow checks, or use SafeMath library

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Access Control Vulnerabilities

Common Mistakes:

- Missing `onlyOwner` modifiers on critical functions
- Default function visibility (public vs internal)
- Incorrect permission checks

Example: Parity Wallet Hack (2017)

- Multi-sig library had unprotected `initWallet()` function
- Anyone could call and become owner
- Attacker initialized, then called `kill()` (selfdestruct)
- $300M frozen permanently

Best Practice:

- Explicitly declare visibility (public, external, internal, private)
- Use OpenZeppelin `Ownable` and `AccessControl`
- Audit all privileged functions

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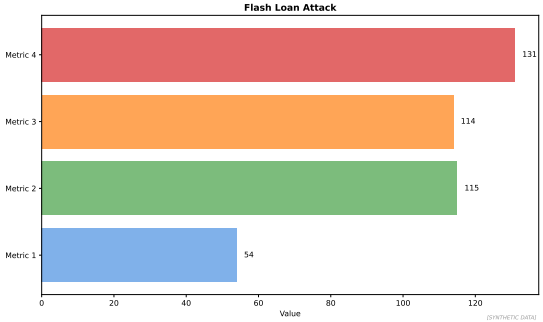
Oracle Manipulation: Flash Loan Attacks



Attack Pattern (e.g., Harvest Finance, $24M):

1. Flash loan large amount of Token A
2. Swap on low-liquidity DEX, manipulate price
3. Protocol using DEX price oracle now sees inflated price
4. Exploit: borrow over-collateralized or dump tokens at fake price
5. Repay flash loan, profit

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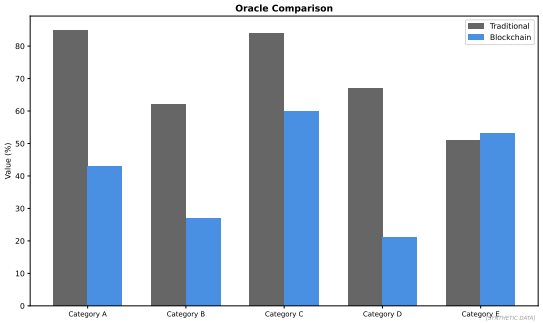
Oracle Security: Defense Mechanisms

Vulnerable:

- Single DEX as price source
- Spot price (current block)
- Low liquidity pools

Secure:

- Time-Weighted Average Price (TWAP)
- Multiple oracle sources (Chainlink)
- High liquidity requirements
- Price deviation limits



Chainlink: Decentralized oracle network, aggregates data from multiple providers

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Key Takeaways

1. Key concept 1 about Blockchain Security
2. Key concept 2 about Blockchain Security
3. Practical implication for financial services
4. Future outlook and trends

Bottom Line: Blockchain Security is transforming how financial services operate and compete.

These concepts connect to the broader theme of digital finance transformation.

Blockchain Security in Visual Perspective

Technology view

Application view

Future view

Visual representations help reinforce key concepts of blockchain security.

Concrete Examples: Making It Real

Technical Examples

- Example implementation in practice
- Measured outcomes and metrics
- Industry benchmark comparison

Case Study

- Real-world deployment scenario
- Quantifiable results achieved

Industry Leaders

- Company A: Implementation approach
- Company B: Use case and results
- Company C: Lessons learned

Market Data

- Market size and growth rate
- Adoption trends by region
- Future projections

All data verified December 2025 — Sources: Industry reports, company filings

Quiz Questions (1–5)

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A) Increase efficiency B) Reduce costs C) Improve access D) All of the above

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Answer: D – All these trends are interconnected.