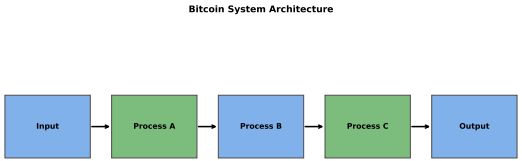
Lesson 18: Bitcoin Architecture

Mini-Lecture Version (30 min)

Digital Finance

Learning Objectives: Understand key concepts and applications

Bitcoin System Overview



Core Components:

- **P2P Network:** Decentralized node communication
- **Blockchain:** Immutable ledger of transactions
- **UTXO Model:** Unspent transaction outputs (like digital cash)
- **Script System:** Programmable transaction validation

This concept is fundamental to understanding Bitcoin Architecture.

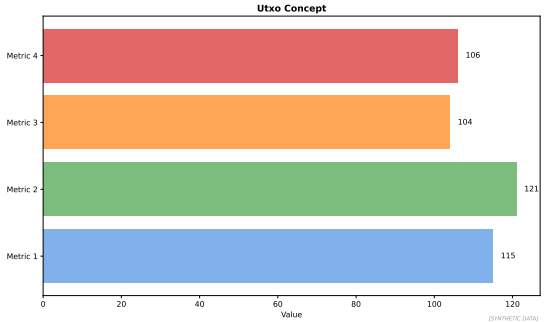
UTXO Model: Digital Cash Analogy

Physical Cash:

- Discrete bills and coins
- Cannot split a $20 bill
- Give exact amount or get change
- Destroyed when spent

UTXO Model:

- Discrete chunks of bitcoin
- Cannot partially spend UTXO
- Consume entirely, create change UTXO
- Marked as spent, new UTXO created



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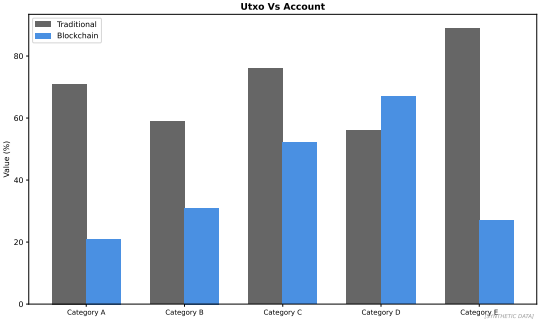
UTXO vs Account Model



UTXO (Bitcoin):

- Stateless
- Better privacy (addresses change)
- Parallel transaction validation
- No account balances

Account (Ethereum):

- Stateful (balance stored)
- Simple mental model
- Sequential nonces
- Easier for smart contracts

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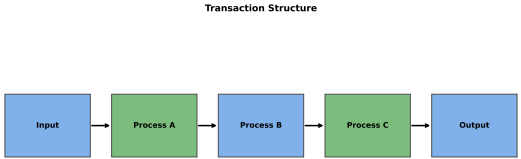
Transaction Structure: Inputs and Outputs



Components:

- **Inputs:** References to previous UTXOs (txid + output index) + signature
- **Outputs:** New UTXOs with amounts and locking scripts
- **Fee:** Sum(inputs) – Sum(outputs)

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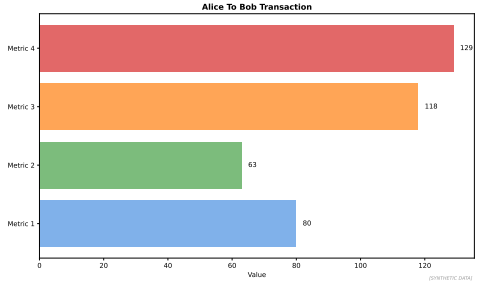
Example Transaction: Alice Pays Bob

Scenario: Alice has 0.5 BTC UTXO, wants to pay Bob 0.3 BTC

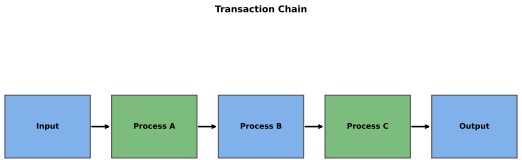
Transaction:

- **Input:** Alice's 0.5 BTC UTXO + Alice's signature
- **Output 1:** 0.3 BTC to Bob's address
- **Output 2:** 0.19 BTC change to Alice's new address
- **Fee:** 0.01 BTC (0.5 – 0.3 – 0.19)



Real-world examples demonstrate Bitcoin Architecture applications.

Transaction Chaining



Key Properties:

- Each transaction references previous outputs
- Creates directed acyclic graph (DAG)
- Double-spending prevented by UTXO tracking
- Validation traces back to coinbase transactions

This concept is fundamental to understanding Bitcoin Architecture.

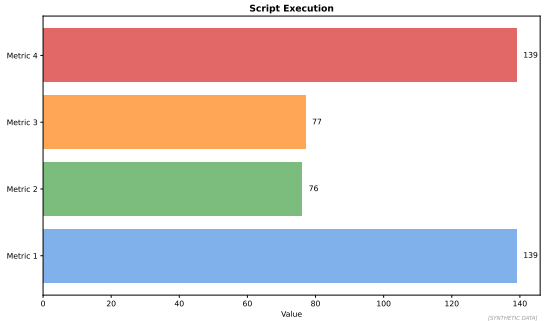
Bitcoin Script: Programmable Conditions

What is Script?

- Stack-based language
- Turing-incomplete (no loops)
- Defines spending conditions
- Executed by all nodes

Script Types:

- Pay-to-Public-Key-Hash (P2PKH)
- Pay-to-Script-Hash (P2SH)
- Pay-to-Witness-Public-Key-Hash (P2WPKH)
- Multisig



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P2PKH: Standard Bitcoin Transaction

Locking Script (scriptPubKey):

```
OP_DUP OP_HASH160 <PubKeyHash> OP_EQUALVERIFY OP_CHECKSIG
```

Unlocking Script (scriptSig):

```
<Signature> <PublicKey>
```

Execution:

1. Push signature and public key to stack
2. Duplicate public key
3. Hash duplicated public key
4. Compare hash to stored hash (EQUALVERIFY)
5. (See full lecture for details)

This concept is fundamental to understanding Bitcoin Architecture.

Key Takeaways

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

Bottom Line: Bitcoin Architecture is transforming how financial services operate and compete.

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

Bitcoin Architecture in Visual Perspective

Technology view

Application view

Future view

Visual representations help reinforce key concepts of bitcoin architecture.

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.