# Ethereum and smart contracts

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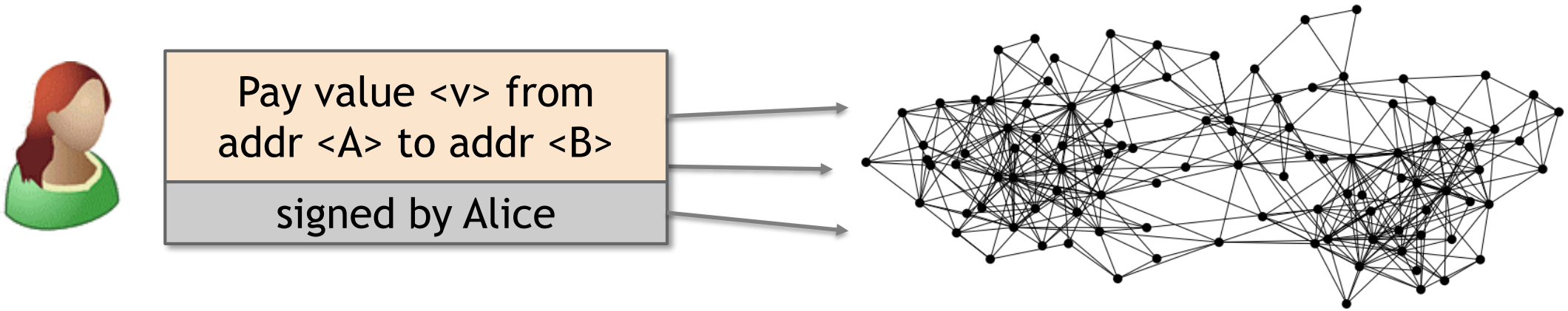
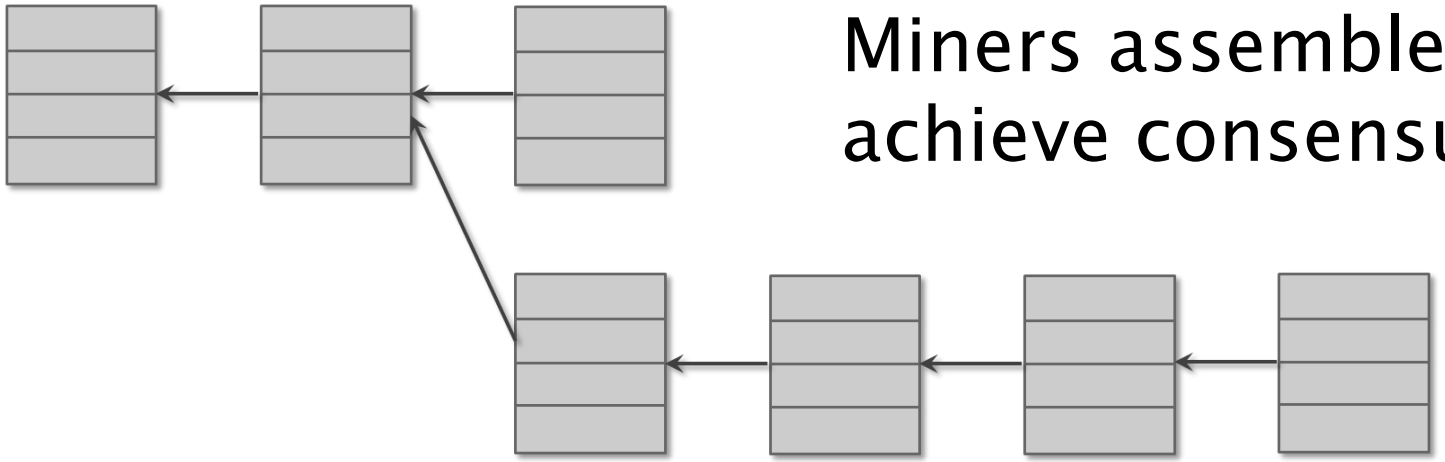
# Goals

- Understand smart contract platforms
  (without getting bogged down in Ethereum details)
- Appreciate why smart contracts are powerful
- Learn their current limitations and open problems

# Bitcoin

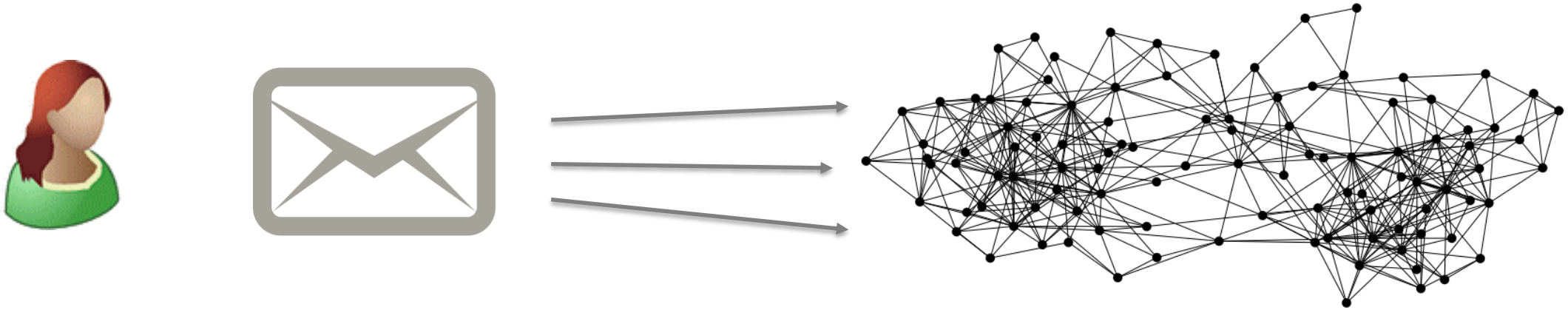



Users broadcast transactions to the network

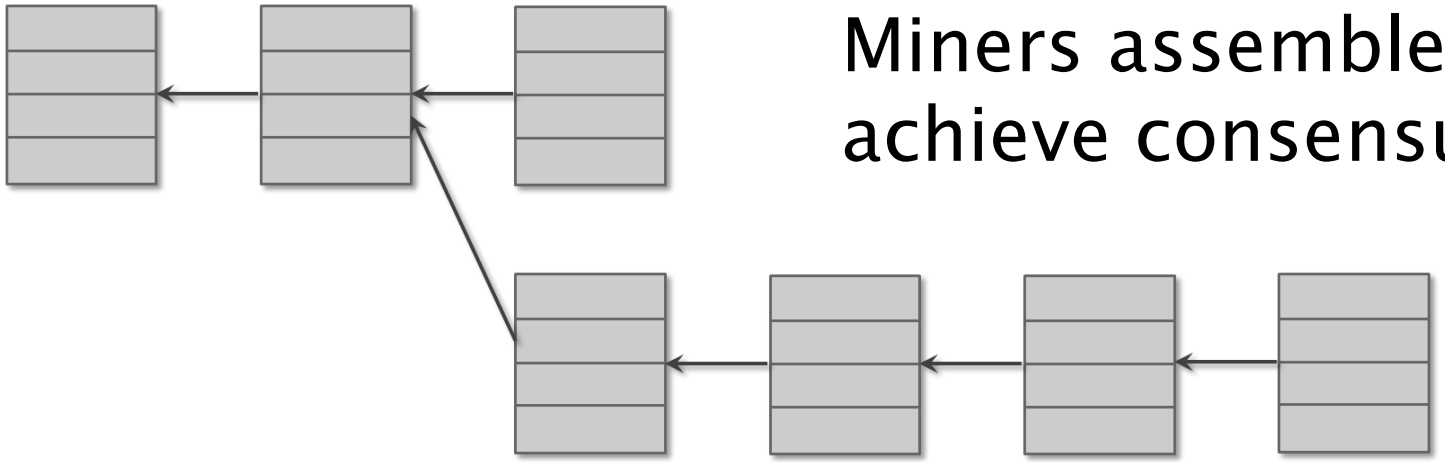


Miners assemble them into blocks, achieve consensus

# Extension 1

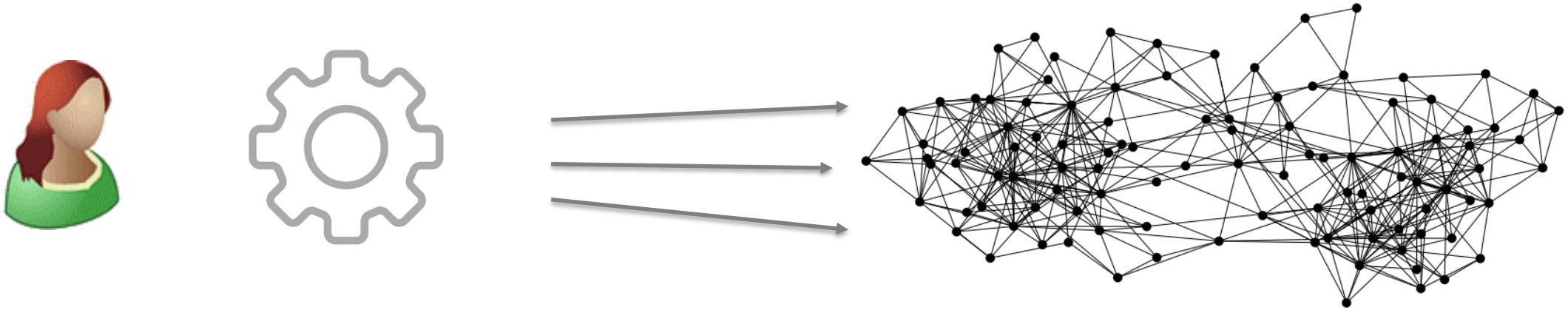


Users broadcast arbitrary messages to the network

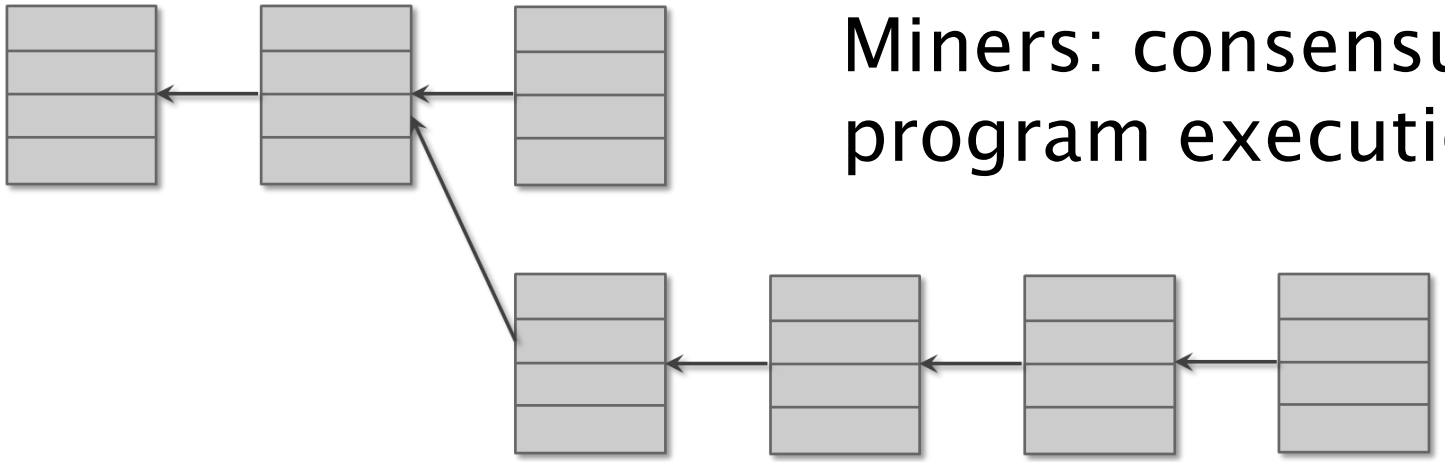


Miners assemble them into blocks, achieve consensus

# Extension 2: state machine replication

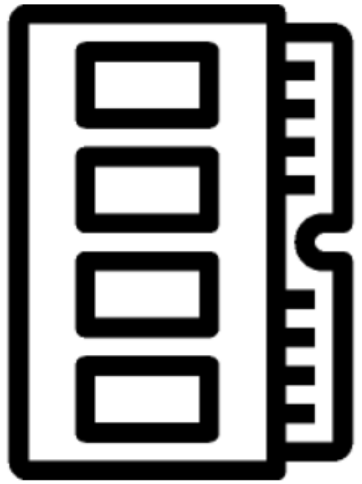


Users broadcast <u>programs</u> to the network



Miners: consensus + program execution

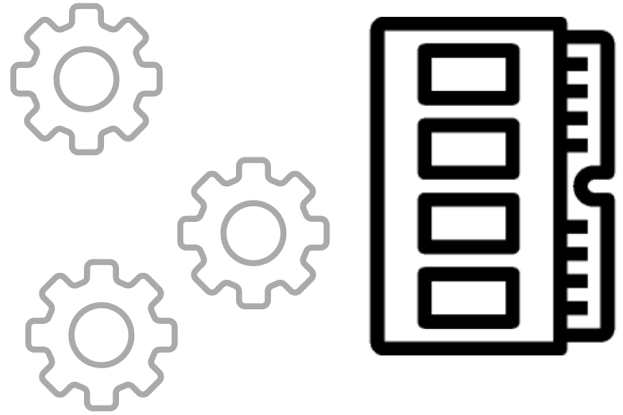
Global state



# Extension 3: smart contract platform

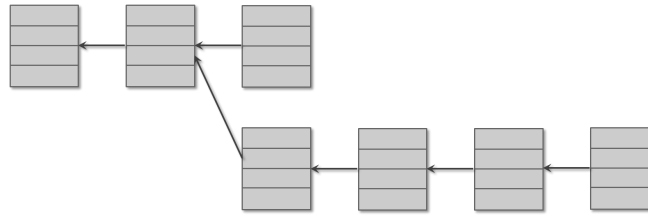
Access control for writes to global state

- Not for reads: everything is public



Designate some variables as tokens/money

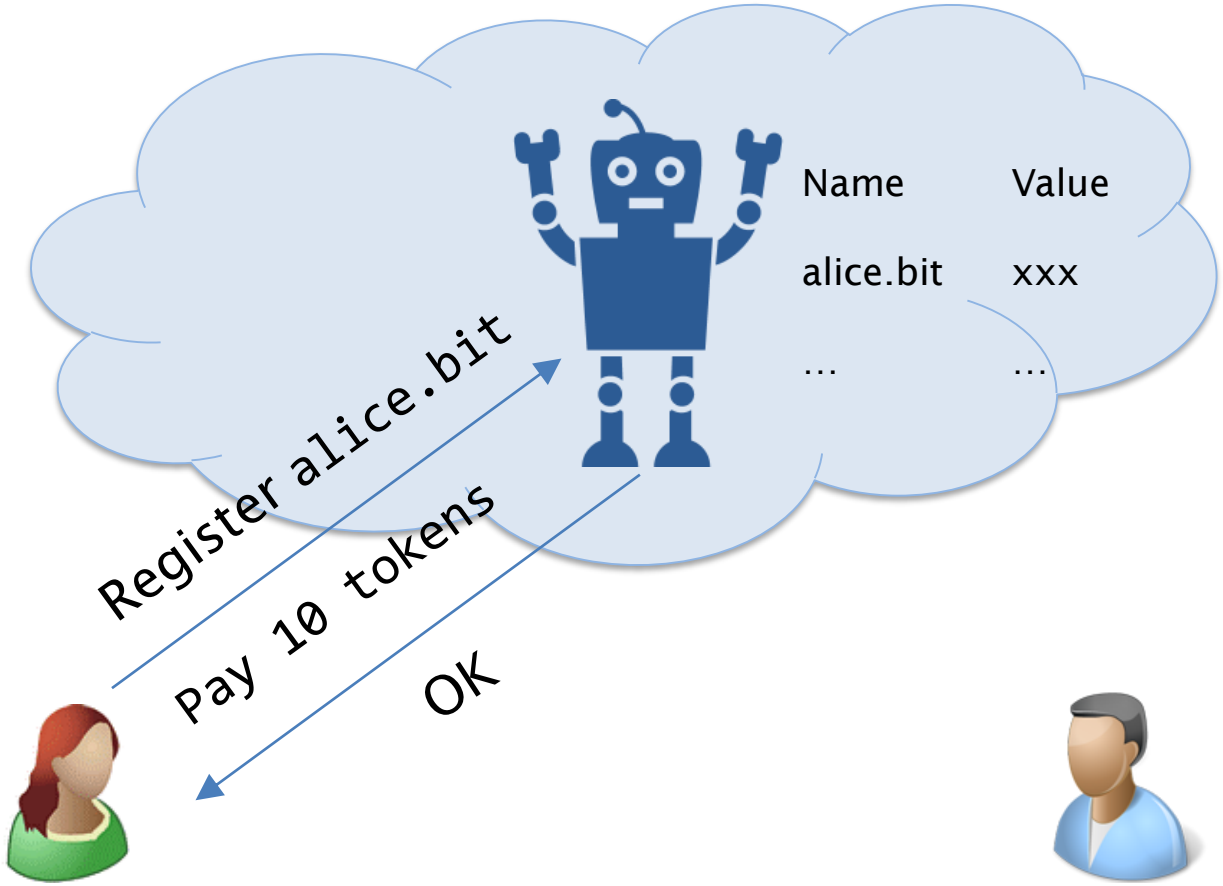
- Native instructions to send/receive money
- Virtual machine enforces usual rules of money



Programs are long-lived, pass messages to other programs

Consequence: programs are agents!

# A smart contract is an algorithmic agent




Agent's actions algorithmically specified, fixed

Decentralized — no one controls it

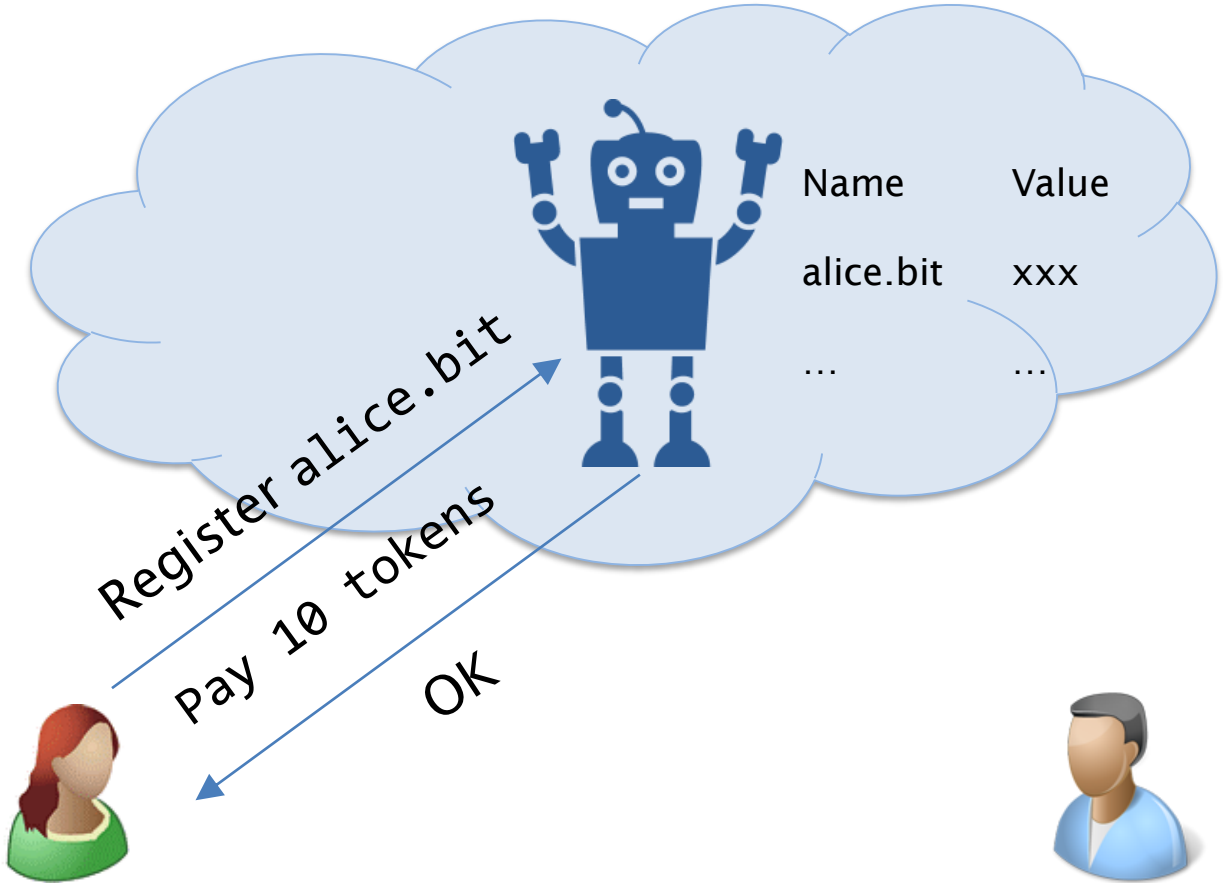
No private memory, communication channels

# Ethereum code for above smart contract

```
contract NameRegistry {
      mapping(bytes32 => address) public registryTable;
      function claimName(bytes32 name) {
            if (msg.value < 10) {
                  throw;
            }
            if (registryTable[name] == 0) {
                  registryTable[name] = msg.sender;
            }
      }
}
```

(This version uses sender's address as the value)

# Puzzle: how to look up a domain name?

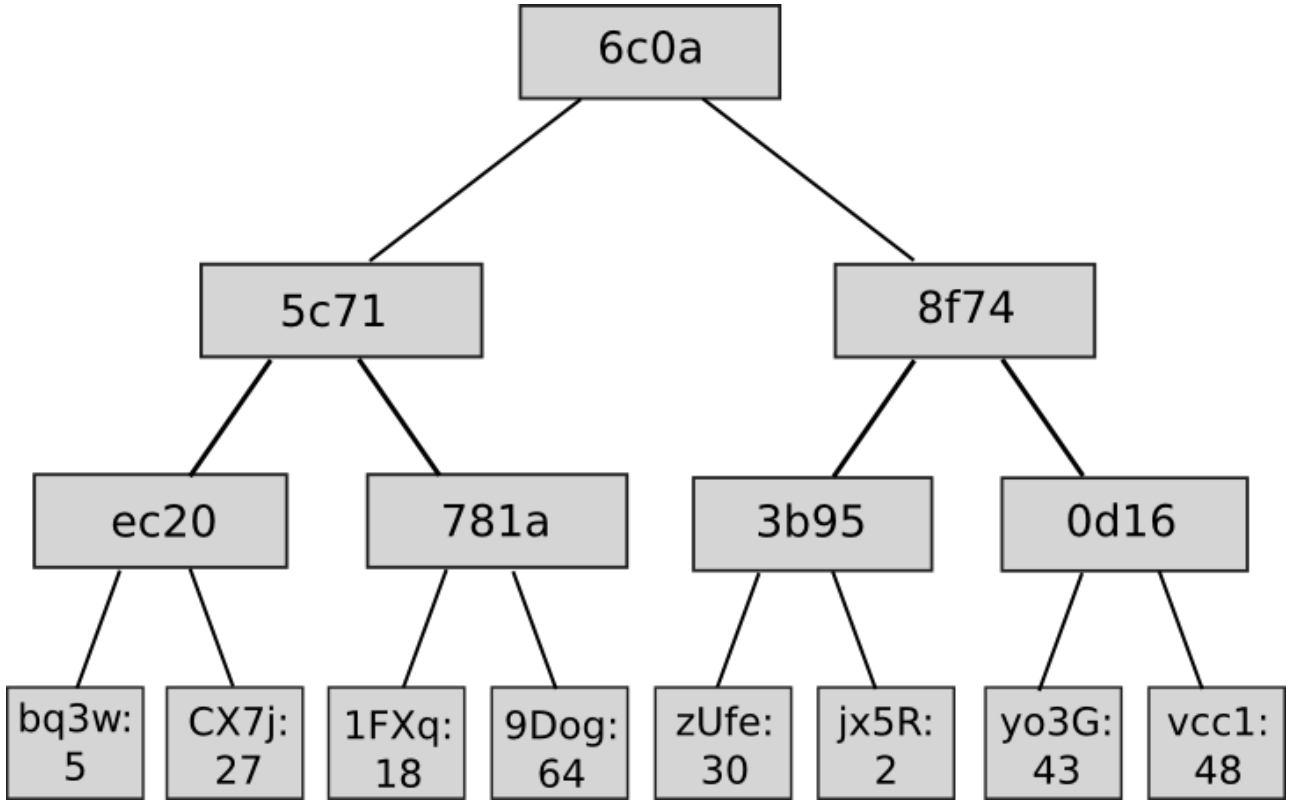



Can't download entire blockchain – too inefficient

Can't simply ask a miner – no one is trusted

Hint: in Bitcoin, how to confirm that you've received a payment w/o downloading blockchain?

# Solution: store a succinct snapshot of smart contract execution in the blockchain




Blockchain contains hash tree of all current key-value pairs in the system

User stores root hash

User queries key

Miner returns value, hash chain to root

# Vision: markets/commerce without gatekeepers

# Honest Ponzi scheme

# Limitations of today's smart contract platforms

1. Verifier's dilemma (see reading)
2. Data feeds
3. Scaling & sharding (see reading)
4. Endpoint security
5. Contract security (next slide)

# Ethereum: poor design choices w.r.t. security

1. No handling of race conditions
2. No random number generator
3. Poor exception handling
4. Reentrancy is unsafe

Paper: *Making smart contracts smarter*

# A note of caution

Many smart contract applications are attempts to solve social problems using technology

Example:

a land registry smart contract won't help against a corrupt gov't:
they have all the guns and can come take your land anyway

Example:

healthcare smart contracts "solve" the "problem" of patients
not trusting their doctors (!!)