Ethereum

Recall: Bitcoin scripting:

- non Turing-complete
- limited/limiting

Solutions:

- Add application-specific functionality in scripting of altcoin
- Create altcoin with Turing-complete scripting

Smart Contracts Programming Model

Smart Contract (Nick Szabo 1994):

"... is a computerized transaction protocol that executes the terms of a contract."

Classical example of mechanized contract:

Vending Machine

In Ethereum, contracts are stored in the blockchain.

Written in Solidity programming language

Users can make procedure calls to the contract.

Example: Namecoin in Ethereum

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

Namecoin in Ethereum - Improvements

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

1. Add more data with mapping.
2. Require periodic re-registration
   - "last-updated" field
3. Add function to withdraw funds
   - Ethereum suppors security features

Example: Simple Currency

```
contract MyToken {
    /* This creates an array with all balances */
    mapping (address => uint256) public balanceOf;

    /* Initializes contract with initial supply tokens to the creator of the contract */
    function MyToken(
        uint256 initialSupply
        ) {
        balanceOf[msg.sender] = initialSupply;       // Give the creator all initial tokens
    }

    /* Send coins */
    function transfer(address _to, uint256 _value) {
        if (balanceOf[msg.sender] < _value) throw;       // Check if sender has enough
        if (balanceOf[_to] + _value < balanceOf[_to]) throw; // Check for overflows
        balanceOf[msg.sender] -= _value;                     // Subtract from the sender
        balanceOf[_to] += _value;                          // Add the same to the recipient
    }
}
```

Some more basic Information

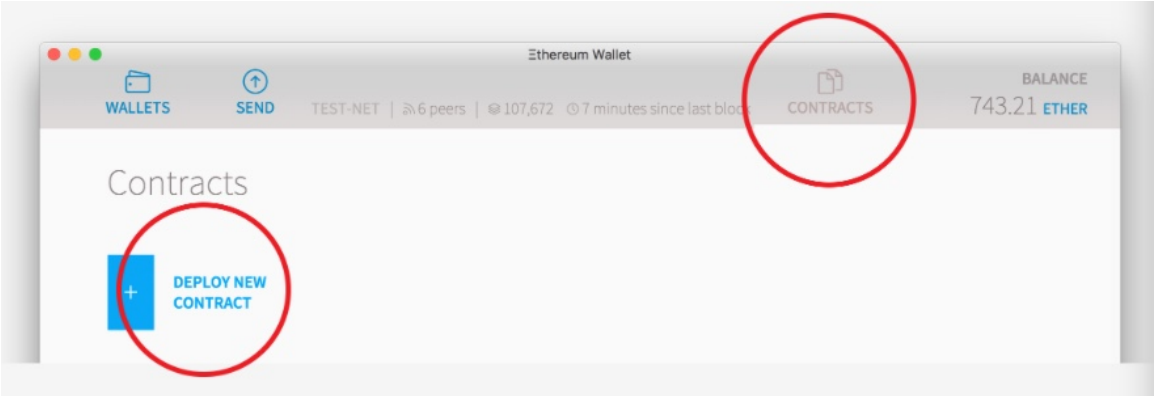
```
/* Initializes contract with initial supply tokens to the creator of the contract */
function MyToken(uint256 initialSupply,
                 string  tokenName,
                 uint8   decimalUnits,
                 string  tokenSymbol) {
    balanceOf[msg.sender] = initialSupply;  // Give the creator all initial tokens
    name     = tokenName;                   // Set the name for display purposes
    symbol   = tokenSymbol;                 // Set the symbol for display purposes
    decimals = decimalUnits;                // Amount of decimals for display purposes
}
```

Events

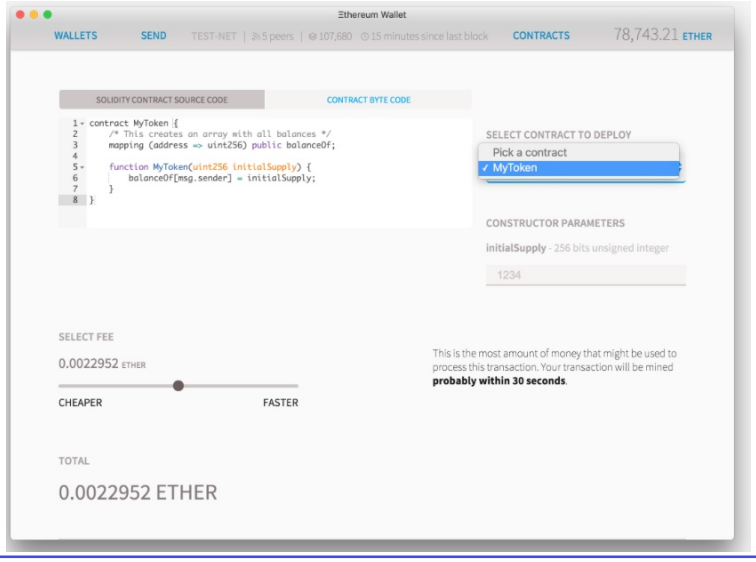
```
/* This generates a public event on the blockchain that will notify clients */
event Transfer(address indexed from, address indexed to, uint256 value);

/* Send coins */
function transfer(address _to, uint256 _value) {
    if (_to == 0x0) throw;             // Prevent transfer to 0x0 address
    if (balanceOf[msg.sender] < _value) throw; // Check if sender has enough
    if (balanceOf[_to] + _value < balanceOf[_to]) throw; // Check for overflows
    balanceOf[msg.sender] -= _value;   // Subtract from the sender
    balanceOf[_to] += _value;          // Add the same to the recipient
    Transfer(msg.sender, _to, _value); // Notify anyone listening that this
transfer took place
    }
```

Ethereum Wallet



Deploying a Contract



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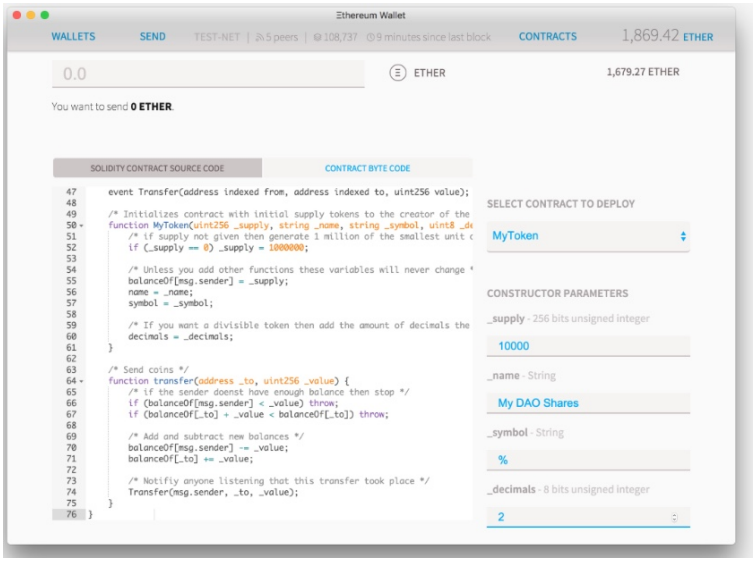
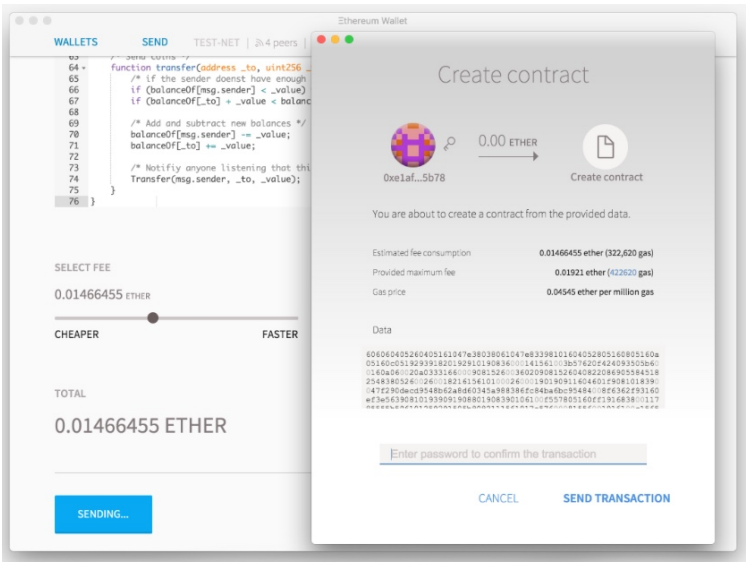
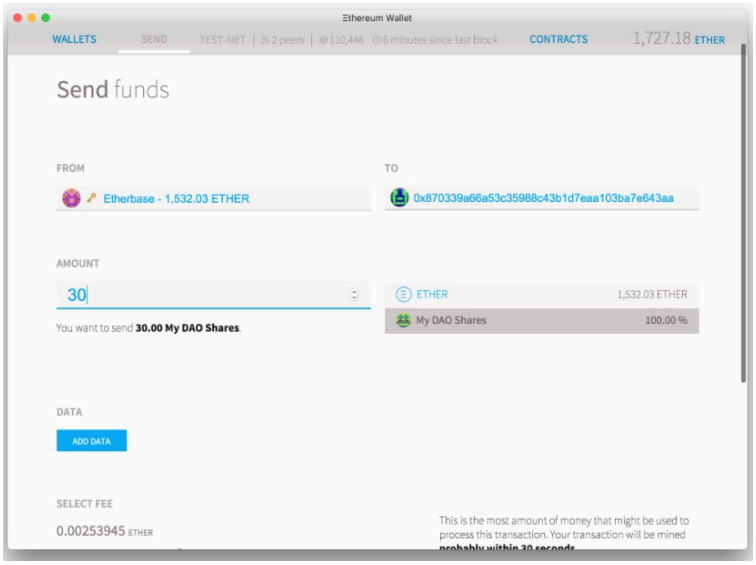


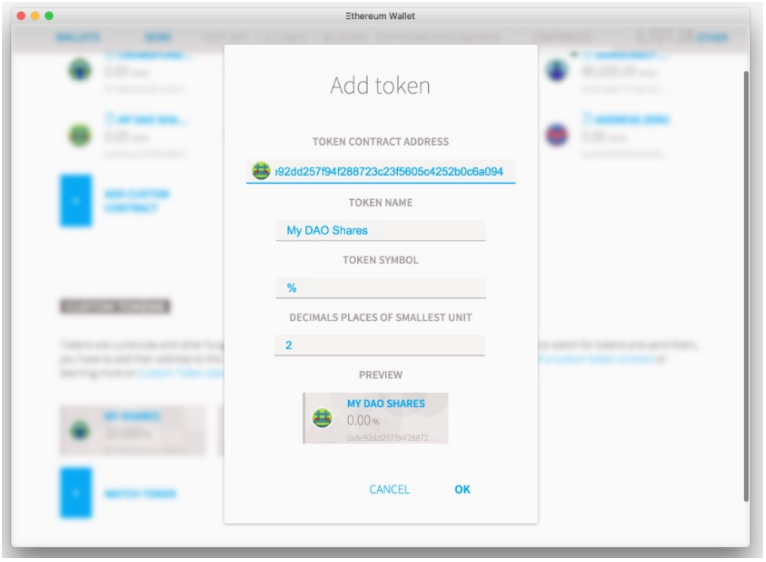
Deploying a Contract



Using the Contract



Watch Token...



Improvement: Add Central Administrator

```
contract owned {
    address public owner;

    function owned() {
        owner = msg.sender;
    }

    modifier onlyOwner {
        if (msg.sender != owner) throw;
        _;
    }

    function transferOwnership(address newOwner) onlyOwner {
        owner = newOwner;
    }
}
```

Adding Central Administrator

```
contract MyToken is owned {
    /* Rest of the contract as usual */
}
```

Adding Central Administrator

```
contract MyToken is owned {
    /* This creates an array with all balances */
    mapping (address => uint256) public balanceOf;

    /* Initializes contract with initial supply tokens to the creator of the contract */
    function MyToken(
        uint256 initialSupply
        ) {
        balanceOf[msg.sender] = initialSupply;       // Give the creator all initial tokens
    }

    /* Send coins */
    function transfer(address _to, uint256 _value) {
        if (balanceOf[msg.sender] < _value) throw;       // Check if the sender has enough
        if (balanceOf[_to] + _value < balanceOf[_to]) throw; // Check for overflows
        balanceOf[msg.sender] -= _value;                     // Subtract from the sender
        balanceOf[_to] += _value;                          // Add the same to the recipient
    }
}
```

Central Mint

```
function mintToken(address target, uint256 mintedAmount) onlyOwner
{
    balanceOf[target] += mintedAmount;
    totalSupply += mintedAmount;
    Transfer(0, owner, mintedAmount);
    Transfer(owner, target, mintedAmount);
}
```

```
contract owned {
    ...
    modifier onlyOwner {
        if (msg.sender != owner) throw;
        _;
    }
    ...
}
```

Improvement: Freezing Assets

```
mapping (address => bool) public frozenAccount;
event FrozenFunds(address target, bool frozen);

function freezeAccount(address target, bool freeze) onlyOwner {
    frozenAccount[target] = freeze;
    FrozenFunds(target, freeze);
}


function transfer(address _to, uint256 _value) {
    if (frozenAccount[msg.sender]) throw;
    ...
}
```

Improvement: Automatic Selling and Buying

```
uint256 public sellPrice;
uint256 public buyPrice;

function setPrices(uint256 newSellPrice, uint256 newBuyPrice) onlyOwner {
    sellPrice = newSellPrice;
    buyPrice = newBuyPrice;
}
```

Automated Selling and Buying

```
function buy() payable returns (uint amount){
    amount = msg.value / buyPrice;       // calculates the amount
    if (balanceOf[this] < amount) throw; // checks if it has enough to sell
    balanceOf[msg.sender] += amount;     // adds the amount to buyer's balance
    balanceOf[this] -= amount;           // subtracts same from seller's bal.
    Transfer(this, msg.sender, amount);  // execute an event about the change
    return amount;                       // ends function and returns
}
```

Automated Selling and Buying

```
function sell(uint amount) returns (uint revenue){
    if (balanceOf[msg.sender] < amount ) throw; // checks if the sender has enough to sell
    balanceOf[this] += amount;                  // adds the amount to owner's balance
    balanceOf[msg.sender] -= amount;            // subtracts amount from seller's balance
    revenue = amount * sellPrice;
    if (!msg.sender.send(revenue)) {            // sends ether to the seller: it's important
        throw;                                  // to do this last
                                                // to prevent recursion attacks
    } else {
        Transfer(msg.sender, this, amount);     // executes event reflecting on the change
        return revenue;                         // ends function and returns
    }
}
```

Improvement: Autorefill

```
uint minBalanceForAccounts;

function setMinBalance(uint minimumBalanceInFinney) onlyOwner {
     minBalanceForAccounts = minimumBalanceInFinney * 1 finney;
} // 1 finney = 0.001 ether

/* Send coins */
function transfer(address _to, uint256 _value) {
  ...
  if(_to.balance<minBalanceForAccounts)
    _to.send(sell((minBalanceForAccounts-_to.balance)/sellPrice));
}
```

Improvement: Proof-of-Work

```
function giveBlockReward() {
    balanceOf[block.coinbase] += 1;
}
```

Example: Crowdfunding

```
contract token { function transfer(address receiver, uint amount){  } }

contract Crowdsale {
    address public beneficiary;
    uint public fundingGoal; uint public amountRaised; uint public deadline;
    uint public price;
    token public tokenReward;
    mapping(address => uint256) public balanceOf;
    bool fundingGoalReached = false;
    event GoalReached(address beneficiary, uint amountRaised);
    event FundTransfer(address backer, uint amount, bool isContribution);
    bool crowdsaleClosed = false;

    /* data structure to hold information about campaign contributors */
    ...
}
```

Crowdfunding

```
/*  at initialization, setup the owner */
    function Crowdsale(
        address ifSuccessfulSendTo,
        uint fundingGoalInEthers,
        uint durationInMinutes,
        uint etherCostOfEachToken,
        token addressOfTokenUsedAsReward
    ) {
        beneficiary = ifSuccessfulSendTo;
        fundingGoal = fundingGoalInEthers * 1 ether;
        deadline = now + durationInMinutes * 1 minutes;
        price = etherCostOfEachToken * 1 ether;
        tokenReward = token(addressOfTokenUsedAsReward);
    }
```

Crowdfunding: Raise Funds

```
/* The function without name is the default function
   that is called whenever anyone sends funds to a contract */
    function () payable {
        if (crowdsaleClosed) throw;
        uint amount = msg.value;
        balanceOf[msg.sender] = amount;
        amountRaised += amount;
        tokenReward.transfer(msg.sender, amount / price);
        FundTransfer(msg.sender, amount, true);
    }
```

Crowdfunding: Deadline

```
modifier afterDeadline() { if (now >= deadline) _; }

/* checks if goal / time limit has been reached; ends the campaign */
function checkGoalReached() afterDeadline {
        if (amountRaised >= fundingGoal){
            fundingGoalReached = true;
            GoalReached(beneficiary, amountRaised);
        }
        crowdsaleClosed = true;
}
```

Closing Crowdfunding Round (1)

```
function safeWithdrawal() afterDeadline {
       if (!fundingGoalReached) {
            uint amount = balanceOf[msg.sender];
            balanceOf[msg.sender] = 0;
            if (amount > 0) {
                if (msg.sender.send(amount)) {
                    FundTransfer(msg.sender, amount, false);
                } else {
                    balanceOf[msg.sender] = amount;
                }
            }
        }

        if (fundingGoalReached && beneficiary == msg.sender) {
            ...
        }
    }
```

Closing Crowdfunding Round (2)

```
function safeWithdrawal() afterDeadline {
        if (!fundingGoalReached) {
            ...
        }

        if (fundingGoalReached && beneficiary == msg.sender) {
            if (beneficiary.send(amountRaised)) {
                FundTransfer(beneficiary, amountRaised, false);
            } else {
                //If we fail to send the funds to beneficiary, unlock funders balance
                fundingGoalReached = false;
            }
        }
    }
```