Smart Contract Security

Assessing Solidity smart contracts

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About Me

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- Certs: OSCE, OSCP, OSWP

Positive
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- Blockchain Basics
- Front Running
- Reentrancy
- External Calls
- Integer Overflow
- tx.origin
- Gas limit

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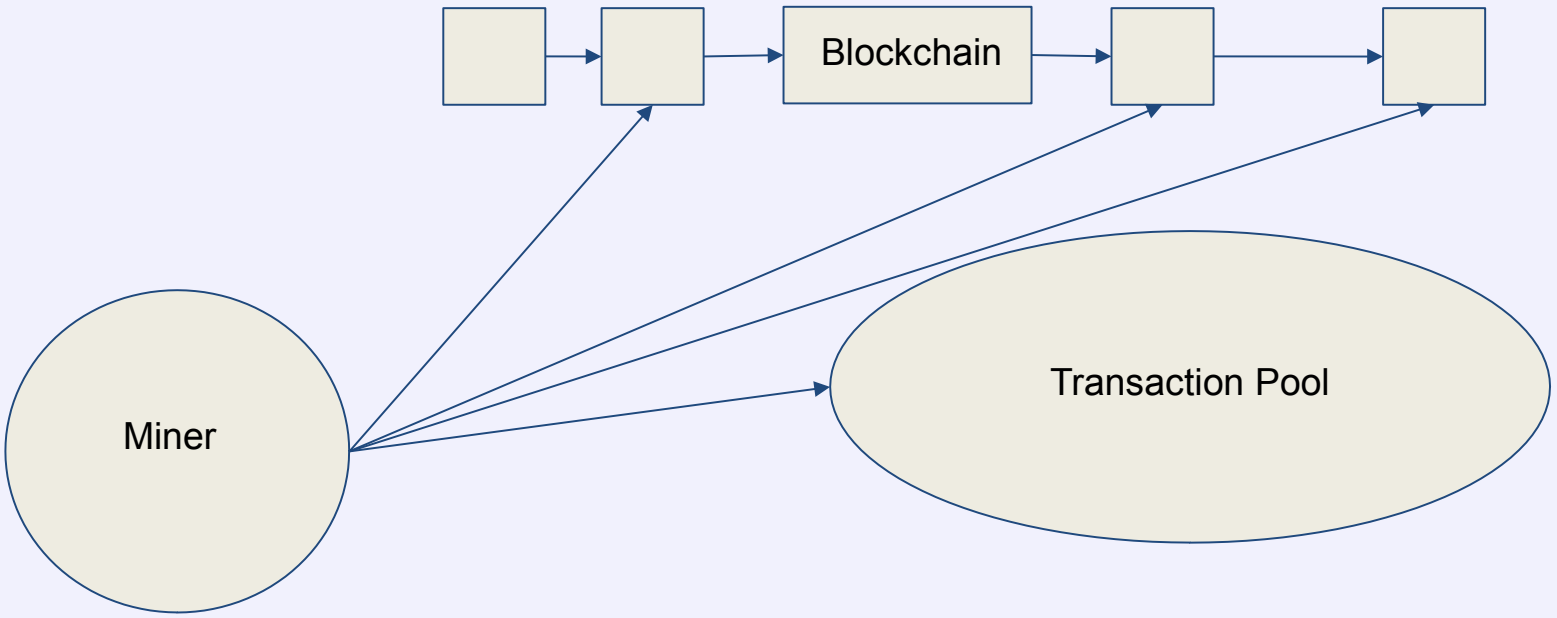
Ethereum Gas

- Introduced to reduce abuse
- transaction cost (EVM operation)
- gas price (in eth)

Miner receives estimated gas spent* gas price

Remainder of gas cost is returned to the sender

Blockchain Transactions



Frontrunning

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- aka Timing attacks
- Affecting: First In First Out Contracts
- Miner frontrunning
- User frontrunning

Frontrunning

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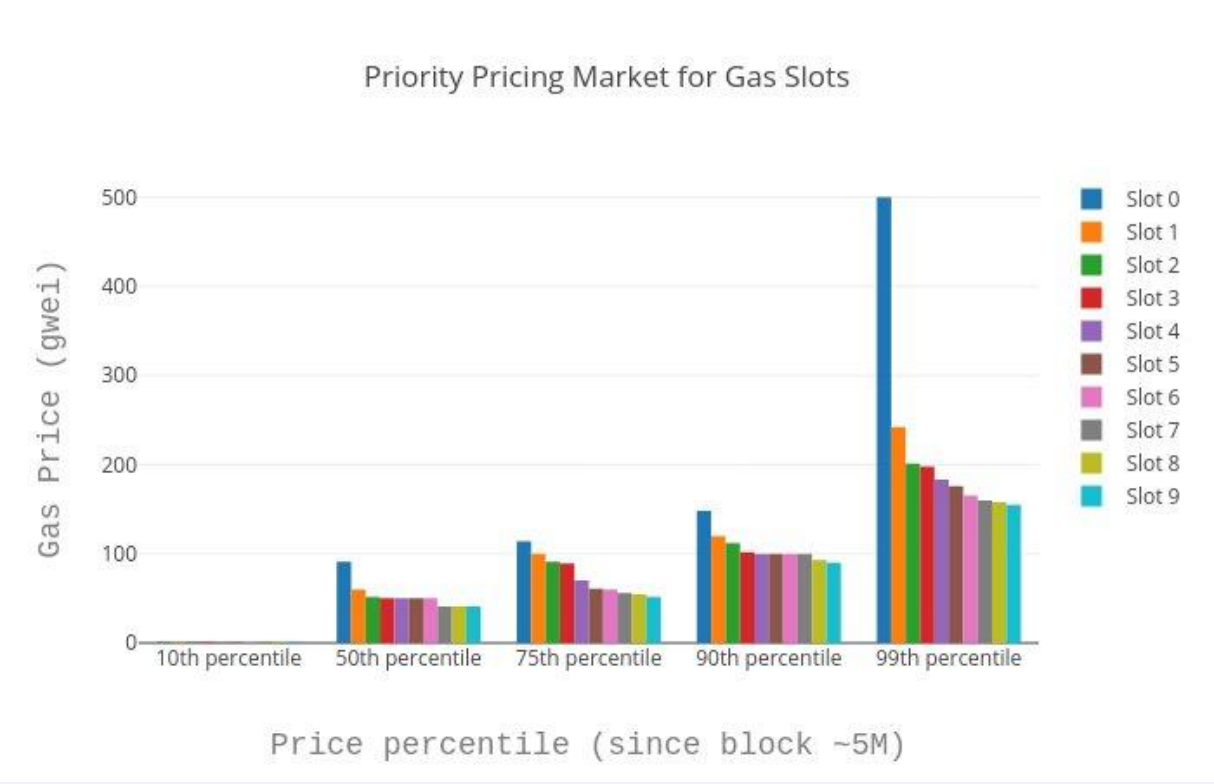
- Examples: DEX, Bancor, random ICOs

```
1   function freeEth(){
2       msg.sender.transfer(1000 ether);
3   }
```

Reference: https://hackernoon.com/front-running-bancor-in-150-lines-of-python-with-ethereum-api-d5e2bfd0d798

Frontrunning



Reference: https://twitter.com/phildaian/status/1032679149960355840

Frontrunning - Mitigation

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- Set upper gas limit
- Set a fixed gas limit
- tx.gasprice
- gasleft()

```
1  function () payable {
2      require(tx.gasprice <= max_gas_price);
3      require(gasleft() <= max_gas_limit);
4      //...
5  }
```

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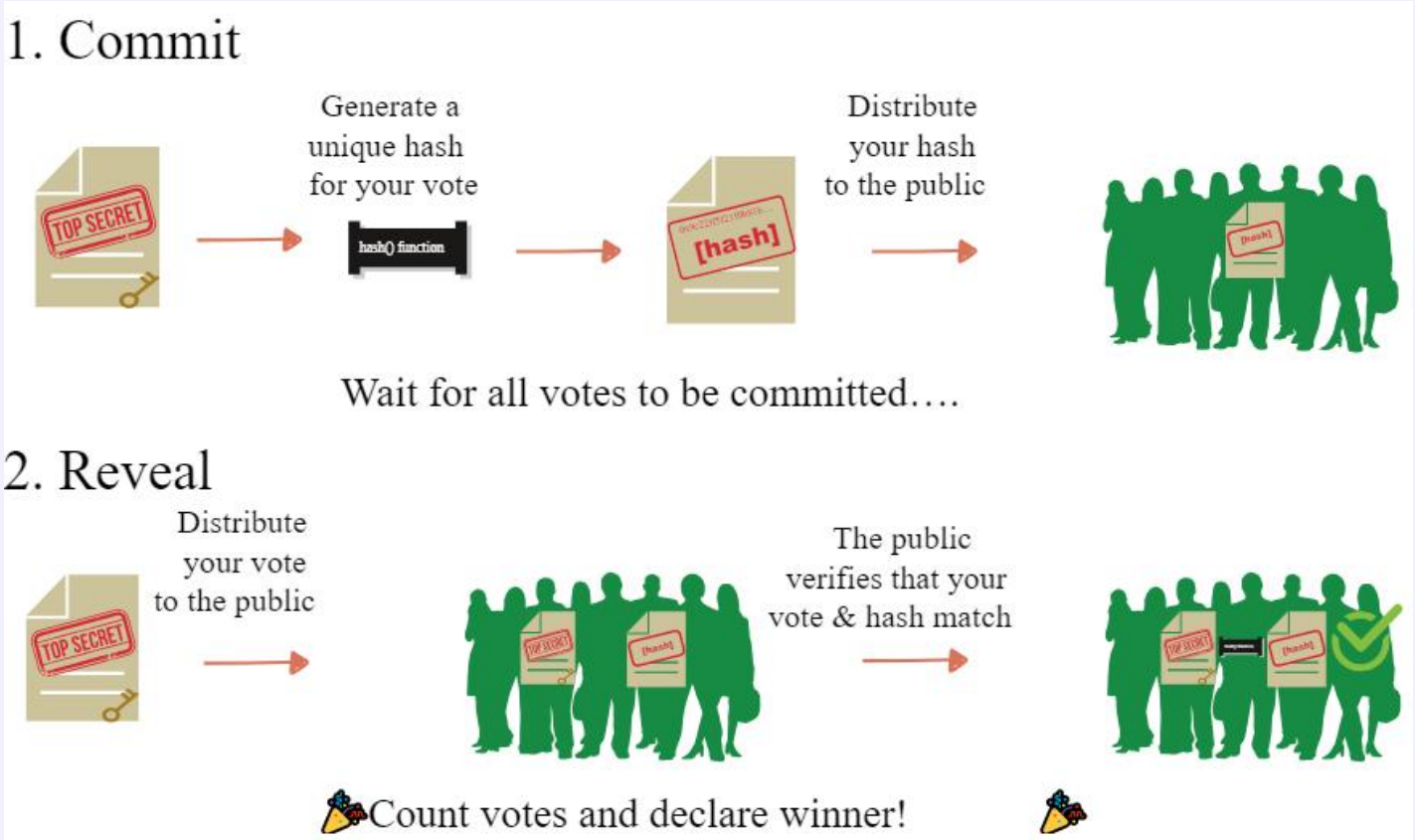
Commit/Reveal approach



Reference: https://karl.tech/learning-solidity-part-2-voting/

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Payable functions

```
1  function deposit() public payable {
2      balances[msg.sender] += msg.value;
3  }
4
5  function () payable {
6      balances[msg.sender] += msg.value;
7  }
```

Reentrancy

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150$ mil stolen

DAO & numerous other contracts

Reentrancy - Vulnerable Contract

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```
1  function deposit() public payable {
2      balances[msg.sender] += msg.value;
3  }
4
5  function withdraw(uint256 _withdraw) public {
6      require(balances[msg.sender] >=  withdraw);
7      require(msg.sender.call.value(_withdraw)());
8      balances[msg.sender] -= _withdraw;
9  }
```

Reentrancy - Attack Contract

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```
function deposit() public payable {
    balances[msg.sender] += msg.value;
}

function withdraw(uint256 _withdraw) public {
    require(balances[msg.sender] >= _withdraw);
    require(msg.sender.call.value(_withdraw)());
    balances[msg.sender] -= _withdraw;
}
```

```
function attack(address target) payable {
  c = VictimContract(target);
  c.deposit.value(0.1 ether)();
  c.withdraw(0.1 ether);
}
function() payable {
  c.withdraw(0.1 ether);
}
```

Reentrancy - Mitigation

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- Always use transfer()
- Use sensitive operations before calls to other contracts
- ReentrancyGuard by OpenZeppelin

Reference: https://github.com/OpenZeppelin/openzeppelin-solidity/blob/master/contracts/ReentrancyGuard.sol

Reentrancy - Bridges

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- Reentrancy is not really obsolete
- “A bridge to connect all bridges”
- Connects ERC20 tokens

Reentrancy - Bridges

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Not reentrancy per se

```
function gift(ERC20 _token, uint256 _amount, address _receiver){
    require(_token.transfer(_receiver, _amount);
    nativetoken.mint(msg.sender, reward);
}
```

```
function transfer(address _adress, uint _amount) {
    vuln_contract.gift(_attack_contract, _amount, _attack_contract);
}
```

More like call to the unknown

External Contracts

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- Trust that called function will succeed
- Trust that you know what the called function do

```
1  function destroy(){
2      require(!destroyed);
3      msg.sender.send(1000 ether);
4      destroyed = true;
5  }
6
```

External Contract - Mitigation

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- Ensure external contract returns expected value
- Perform sensitive operations before calling external contract
- Never assume external contract functionality

Integer Overflow

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- Proof of Weak Hands Coin - 866 Eth
- BatchOverflow

Age	From		To	Value	Token
2 hrs 8 mins ago	0x3f2dd0cb25bbf89...	OUT	0x521c526d5b50de...	57,896,044,618,658,100,000,000,000...	Erc20
2 hrs 8 mins ago	0x3f2dd0cb25bbf89...	OUT	0x4473c6396eba3d...	57,896,044,618,658,100,000,000,000...	Erc20
2 hrs 54 mins ago	0x3f2dd0cb25bbf89...	OUT	0x66f471fd1c471bb...	57,896,044,618,658,100,000,000,000...	Erc20
2 hrs 54 mins ago	0x3f2dd0cb25bbf89...	OUT	0x4473c6396eba3d...	57,896,044,618,658,100,000,000,000...	Erc20

Reference: https://medium.com/@peckshield/alert-new-batchoverflow-bug-in-multiple-erc20-smart-contracts-cve-2018-10299-511067db6536

Integer Overflow

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- Integer only
- Conversions (Unsigned -> Signed)

```
1  function transfer(int _amount) {
2      require(_amount >= 0);
3      balances[msg.sender] -= _amount;
4      msg.sender.transfer(balances[msg.sender]);
5  }
```

More overflow cases:

https://github.com/ethereum/solidity/issues/796#issuecomment-253578925

Integer Overflow - Mitigation

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- Perform operations within boundaries
- SafeMath library

```
51      function add(uint256 _a, uint256 _b) internal pure returns (uint256) {
52        uint256 c = _a + _b;
53        require(c >= _a);
54
55        return c;
56      }
```

Reference: https://github.com/OpenZeppelin/openzeppelin-solidity/blob/master/contracts/math/SafeMath.sol

tx.origin

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- Blockchain CSRF?
- tx.origin vs msg.sender

```
1 function withdraw(uint _amount) {
2     require(tx.origin == owner);
3     msg.sender.transfer(1000 ether);
4 }
```

tx.origin

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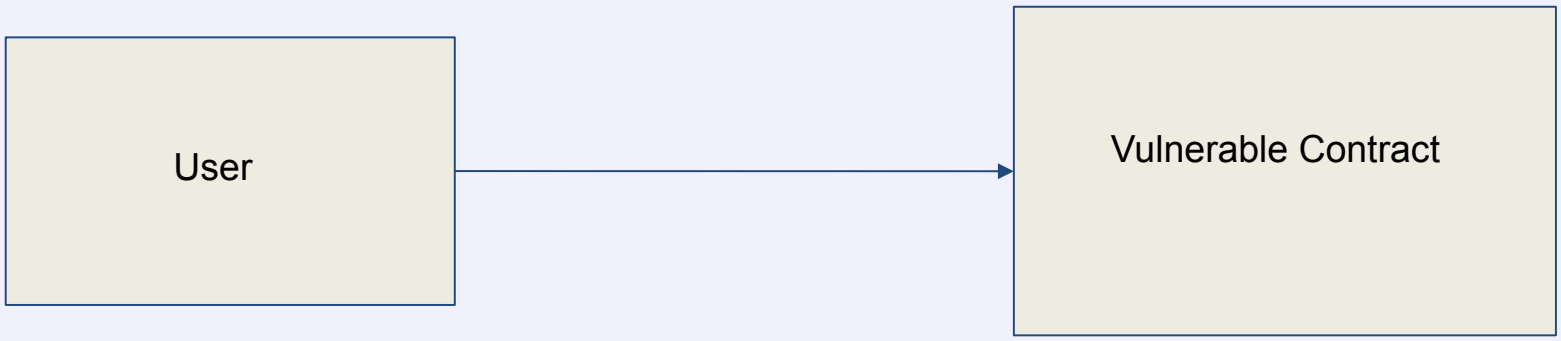
call()	For Vulnerable Contract
tx.origin	User
msg.sender	User



tx.origin

call()	For Malicious Contract	For Vulnerable Contract
tx.origin	User	User
msg.sender	User	Malicious Contract

tx.origin - Mitigation

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- call vs delegatecall
- Caution when using tx.origin

Gas limit attacks

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- Looping over unknown arrays
- Leads to denial of service

```
1  function distribute() public {
2      for(uint i = 0; i < investors.length; i++) {
3          // Important administrative tasks
4          // ...
5      }
6  }
```

Gas limit attacks - Mitigation

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- Avoid looping over arrays of unknown length
- Set an upper limit for the array length
- Control the loop by checking gasleft()

```
1  function distribute() public {
2      while(i < investors.length && gasleft() > 20000) {
3          // Important administrative tasks
4          // ...
5      }
6  }
```

Things we didn't cover

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- Randomness (is hard)
- Visibility (Function, secret)
- Unexpected ether (contract-suicide)
- Delegatecall (3rd party libraries)
- Storage

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Questions?