# Basic Pentesting on Ethereum Blockchain

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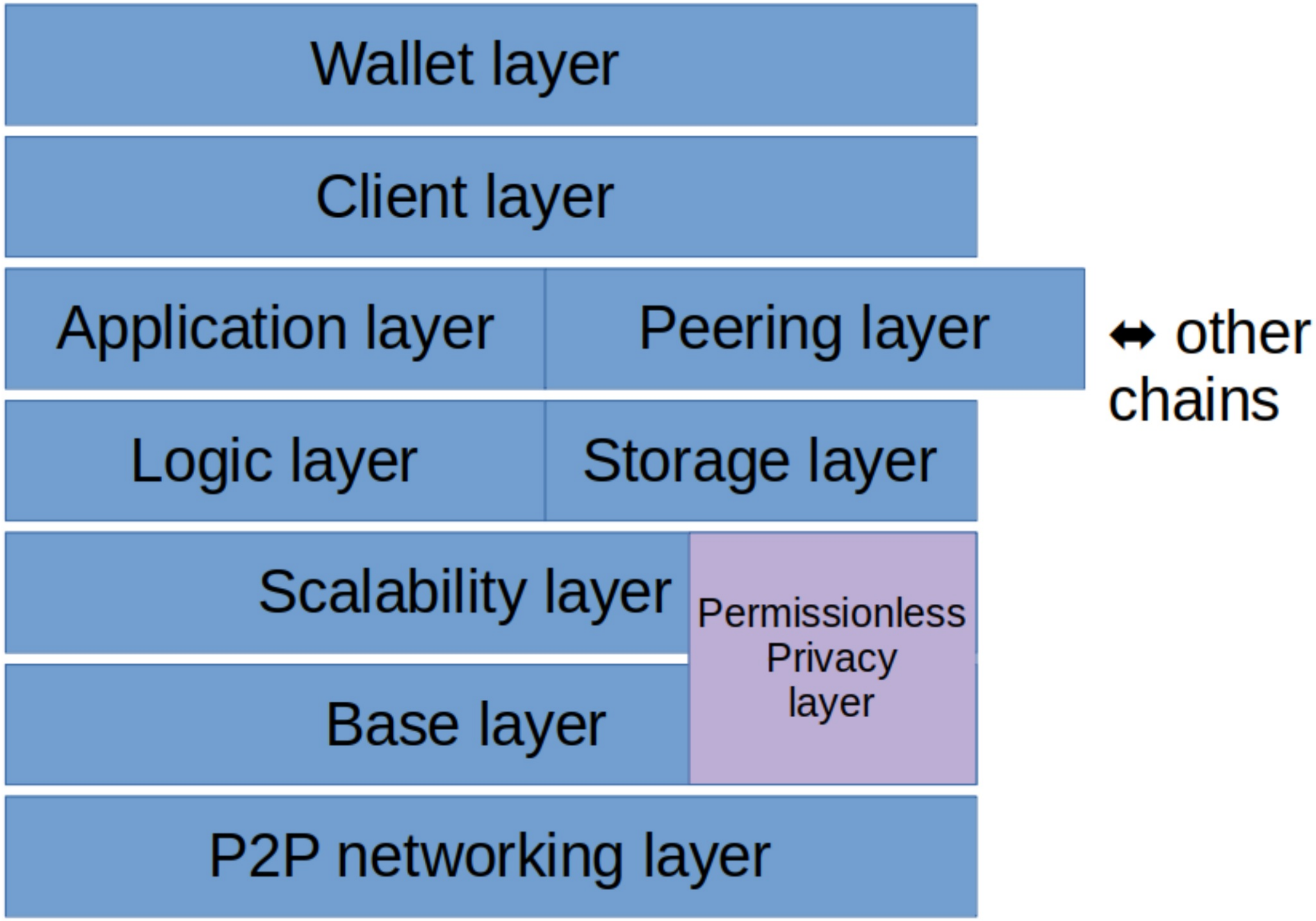
# Understanding the stack

# Blockchain as a stack



# P2P Networking Layer - attacks

- **networking and connectivity layer**, similar to P2P overlay networks
  - node discovery (dynamic list of nodes to connect to)
  - secure connection between nodes

- Can be **attacked by DoS**
  - Protect against network level attacks such as man-in-the-middle https://en.wikipedia.org/wiki/Man-in-the-middle_attack and
    eclipse attacks https://www.radixdlt.com/post/what-is-an-eclipse-attack
  - eclipse attack can be serious, if consensus(base layer) inherently assumes sufficient randomness of peer list or peer connections

# Base layer attack

- Base consensus mechanism(eg. PoW, PoS)

- **51% attack**, attack on consensus protocol
  - means the majority collude to attack other participants
  - affects everyone in network, *including decentralized exchanges, autonomous smart contracts, etc*
- ⬆network size, ⬇risk of 51% attack

# Scalability layer - challenges

- improve overall scalability of chain (throughput, may have side-effect on latency or commit time)
- using a '**divide and conquer**' approach to split base consensus in 2(or more) layers

- Techniques: DPoS, Sharding
  - Challenges – maintaining **atomicity across layers and shards**

# Privacy layer

- Known privacy techniques
  - Mixing / Ring signatures
  - Secure Multi-party computation
  - Zero Knowledge proofs
- Weakness of ZKP techniques
  - Snark – **“Toxic waste” issue**
  - Other parameters: **proof size, proof/verify speed**

# Logic layer - smart contract security

- non-turing complete language
  - lesser features
  - ↓ risk of security bug
- turing complete
  - more features
  - ↑ risk fo security bug (eg. infinite loop)
  - need more security checking tools

# Client layer

- full vs light node
  - **full node keeps all data**
  - light node only keep hash of all blocks and not content of block
- light node
  - **pulls data on-demand from full nodes**
  - light node is able to verify TX if data provided by full node

# Smart Contract – pentesting: Notable security holes

# Why Smart Contract pentesting?

- Bytecode (optionally contract mode) is public
- Code execution (by miners) is remote, decentralized and anonymous
- Hackers are remote and anonymous
- Security flaw has big loss (direct financial loss) and no recourse (no centralized authority to address loss, eg. police, bank, court)

# Some concepts

- GAS – transaction fee paid per transaction. Calculated based on computation and storage opcodes
- Fallback function – allows a smart contract to ‘accept’ eth payment like a normal wallet address and act upon it.

```
function () public external { … }
```

# Reentrancy Attacks

- Early ethereum startup, bug in DAO (decentralized autonomous organization) smart contract
- Caused 150M USD loss in ether
- Deployed a hard fork to roll-back the attack

# Reentrancy Attacks

Dangers of calling external contracts – can take over control flow.

```
mapping (address => uint) public balances;
function withdraw() public {
    bool success;
    bytes memory data;
    //send ether back to sender address/callback fn.
    (success, data) =
      msg.sender.call.value(balances[msg.sender])("");
    if (!success) {
      revert("Withdraw failed");
    }
    //vulnerable-balance update is behind transfer call
    balances[msg.sender] = 0;
}
```

# Reentrancy Attacks

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      revert("Withdraw failed");
    }
    //vulnerable-balance update is behind transfer call
    balances[msg.sender] = 0;
}
```

```
//------------ attacker.sol
function () public external {
  msg.sender.withdraw();
}
```

# Integer overflow/underflow

Dangers of calling external contracts – can take over control flow.

```
mapping (address => uint256) public balanceOf;
function transfer(address _to, uint256 _value) {
  require(balanceOf[msg.sender] >= _value);
  balanceOf[msg.sender] -= _value; //can overflow
  balanceOf[_to] += _value;        //can overflow
}
```

# Parity Bug – poor deployment

- Parent contract owner was uninitialized
  - Allowed for random user to re-init

```
modifier only_uninitialized { if (m_numOwners > 0) throw; _; }
function initWallet(address[] _owners, uint _required, uint _daylimit)
  only_uninitialized {
  initDaylimit(_daylimit);
  initMultiowned(_owners, _required);
}
```

  - `selfdestruct()` was accidentally called

**The $280M Ethereum's Parity bug.**

A critical security vulnerability in Parity multi-sig wallet got triggered on 6th November—paralyzing wallets created after the 20th July.

# Other know attacks, tools

- Other attacks
  - https://consensys.github.io/smart-contract-best-practices/known_attacks/
  - Other reentrancy attacks
  - Front-running (loss of market information)
  - DoS attacks (network layer)
- Security tools:
  - https://consensys.github.io/smart-contract-best-practices/security_tools/
  - Code analyzers: mythril, oyente, etc
  - Code coverage, linting

# Smart Contract – pentesting: Some help & tips

# Check-effect-interaction rule

- Do conditional <u>checks</u> first (eg. `require()`
- <u>Effect</u> changes to your variables & data
- <u>Interact</u> with external contracts
- General rule for preventing re-entrancy attack
- Do not rely on gas depletion to prevent re-entrancy

# openzeppelin

- battle-tested library of reusable smart contracts
- install using npm
  `npm install openzeppelin-solidity`

Can be integrated easily with `truffle`

```
import "openzeppelin-
  solidity/contracts/token/ERC20/ERC20Mintable.sol";

contract SMUToken is ERC20Mintable {
  string public constant name = "SMU Token";
  string public constant symbol = "SMU";
  uint8 public constant decimals = 18;
}
```

# openzeppelin

- Modules:
  - Token (ERC20, ERC721, ERC777)
    - Crowdsale
  - Payment, escrow
  - Math (prevent integer over/underflow)
  - Introspection (ERC165, ERC1820)
  - Cryptographic primitives
  - etc

# Published Code is not 100%

- External ABI of bytecode is not verified on etherscan

# Smart Contract – pentesting: Hands-on

# Re-entrancy hands-on

- pentest_target.sol
  http://bit.ly/pentest_solidity
- Pentest_attack_template.sol
  http://bit.ly/pentest_attack_template

# Solidity hints

Call function:

```
<contr var>.<mtd name>.value(<eth val>)(<mtd params);
```

Call function with payable eth:

```
<contr var>.<mtd name>(<mtd params>);
```

Get eth balance:

```
address(<contr var>).balance
```

Sender(tx caller) address:

```
msg.sender
```

Sender(tx caller) payable value:

```
msg.value
```

# Re-entrancy hands-on (solution)

- pentest_attacker.sol
  http://bit.ly/pentest_attacker