Automatically Fixing Vulnerabilities in WebAssembly

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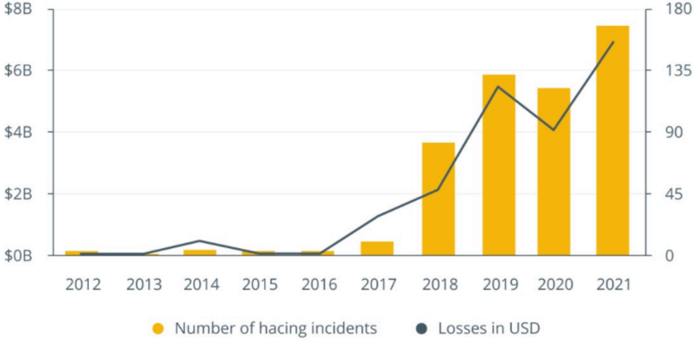
Agenda

- **Backgroud: the importance of contract security**
- Vulnerabilities in smart contracts
  - Reentrancy
  - Missing Input Validation
  - Unhandled Exception
  - Arithmetic Vulnerabilities
  - Fake EOS
  - Fake Receipt
  - Rollback
  - Missing Permission Check
- Vulnerabilities Detection
- Automatic Fixes
- Evaluation
- Reference

Backgroud: the importance of contract security



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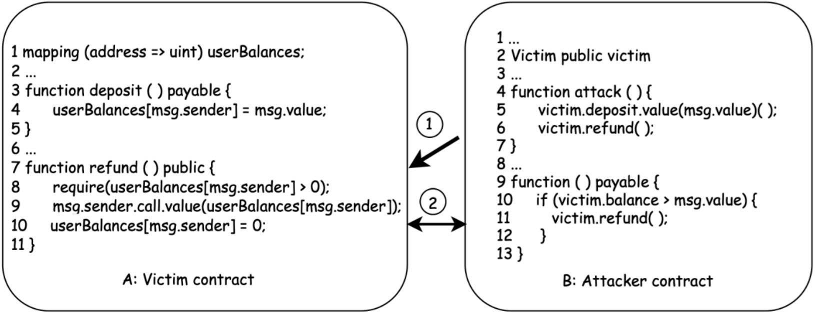
Reentrancy

- init
    - Attach account: $100
    - Employee A
    - Employee B
- attack
    1. Request a withdrawal of $60 from Employee A.
    2. Employee A gives $60 to the attacker
    3. Request a withdrawal of $60 from employee B. At this time, employee B does not know that the attacker has already withdrawn $60 from employee A.
    4. Employee gives $60 to the attacker.
    5. Employee B changes the balance of the attacker's bank account.
       Attacker's account:100 - 60 = 40
    6. Employee A changes the balance of the attacker's bank account.
       Attacker's account:40 - 60 = -20

Reentrancy



```
mapping (address => uint) userBalances;
...
function deposit ( ) payable {
    userBalances[msg.sender] = msg.value;
}
...
function refund ( ) public {
    require(userBalances[msg.sender] > 0);
    msg.sender.call.value(userBalances[msg.sender]);
    userBalances[msg.sender] = 0;
}
```

```
...
Victim public victim
...
function attack ( ) {
    victim.deposit.value(msg.value)( );
    victim.refund( );
}
...
function ( ) payable {
   if (victim.balance > msg.value) {
      victim.refund( );
   }
}
```

Figure: An exploit of Reentrancy vulnerability

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Vulnerabilities Detection

- Difference comparison
- Find control flow, data flow characteristics
- Fuzzing
- Using multiple existing tools, and seting thresholds to determine if it is a vulnerability

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Automatic Fixes

- Generates patches using template-based fix patterns and leverages static program analysis
- Binary rewriting. Binary rewriting has also been applied to retrofit security hardening techniques such as control-flow integrity, to compiled binaries, but also to dynamically apply security patches to running programs. For binary rewriting on traditional architectures two flavors of approaches have been developed: static and dynamic rewriting.

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Evaluation

- False Positives
- Runtime Performance
- Extra Gas

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Reference

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