Backdooring Cryptocurrencies

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The Underhanded Crypto Contest Winners

What is the Underhanded Crypto Contest?

- It's like the Underhanded C Contest.
- Add hard-to-spot backdoors to crypto.
  - Protocols.
  - Implementations.
- It's important because:
  - Makes us better at spotting backdoors.
    - And, by extension, unintentional bugs.
  - Predicts future classes vulnerabilities.
- This is the third year.

2014

- Winner: Tiny AES implementation for IoT devices.
  - It magically becomes vulnerable when you implement IPSec with it.
  - Re-uses the same buffer for the key and CTR-mode nonce.
  - Uses `typedef unsigned char boolean` for the “re-run the key schedule parameter.”
  - Encrypt something that’s not a multiple of 16 bytes => Key schedule gets re-run.
  - But... the buffer contains the nonce, so everything from then on is decipherable.
- Runner up: Stern’s Zero-Knowledge Identification Protocol
  - Hamming weight function has an integer bug.
  - Makes tricking the prover a lot easier.

2015

- Mini contest held during DEF CON 23.
- Category 1: GnuPG
  - GnuPG re-randomizes the top 32 bits of DSA nonces.
  - The patch makes it look like it's clearing the nonce when it's no longer needed.
  - But... now the nonce is all zero except those top 32 bits.
- Category 2: Password Hashing
  - User-enumeration side-channel defense.
  - Check the password against a hash of a random string.
  - But... the random string comes from `rand()`.

2016

- Cryptocurrency theme.
- Only one entry, but it's good!
- Thank you to our sponsors for the prize money:

Gold: 

Silver: 

- Thank you to our judges:
  - JP Aumasson
  - Gustavo Banegas
  - Eric Wustrow

Winner: Jonas Nick
https://nickler.ninja

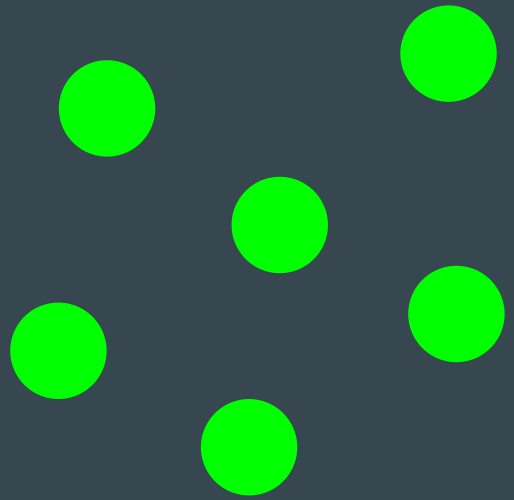
The Winner

- Here it is:

3LEETmEZWJX9ULbsFQVgL2QgGCJHPZJVaJ

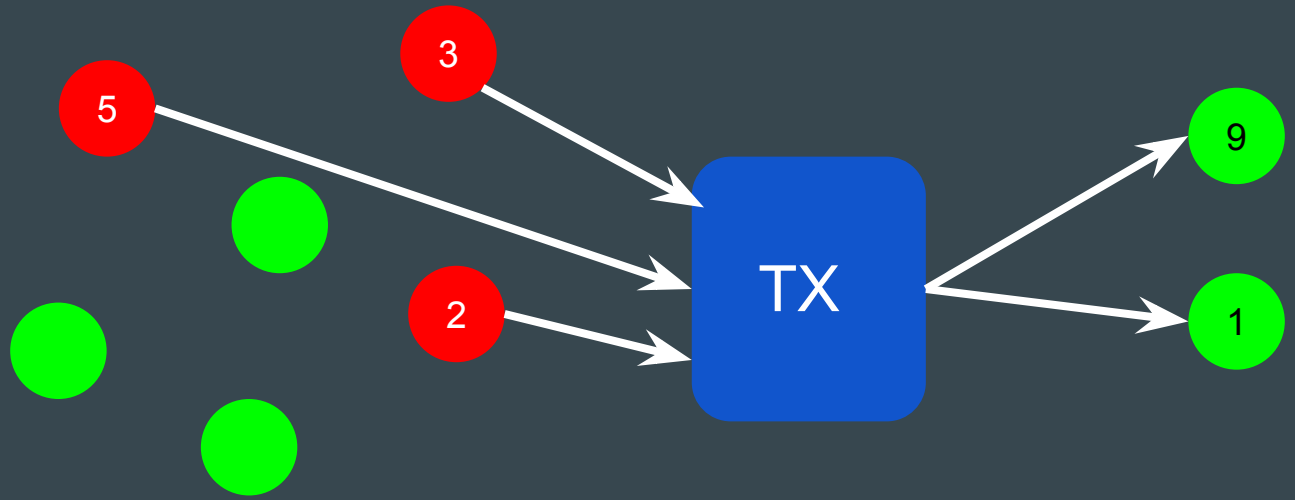
- It’s a Bitcoin address.
- Money sent there is “destroyed,” … *but not really.*
- Burn addresses are useful for...
  - Counterparty
  - Proof-of-Burn

Bitcoin 101



Unspent Transaction Output (UTXO) Set

Bitcoin 101



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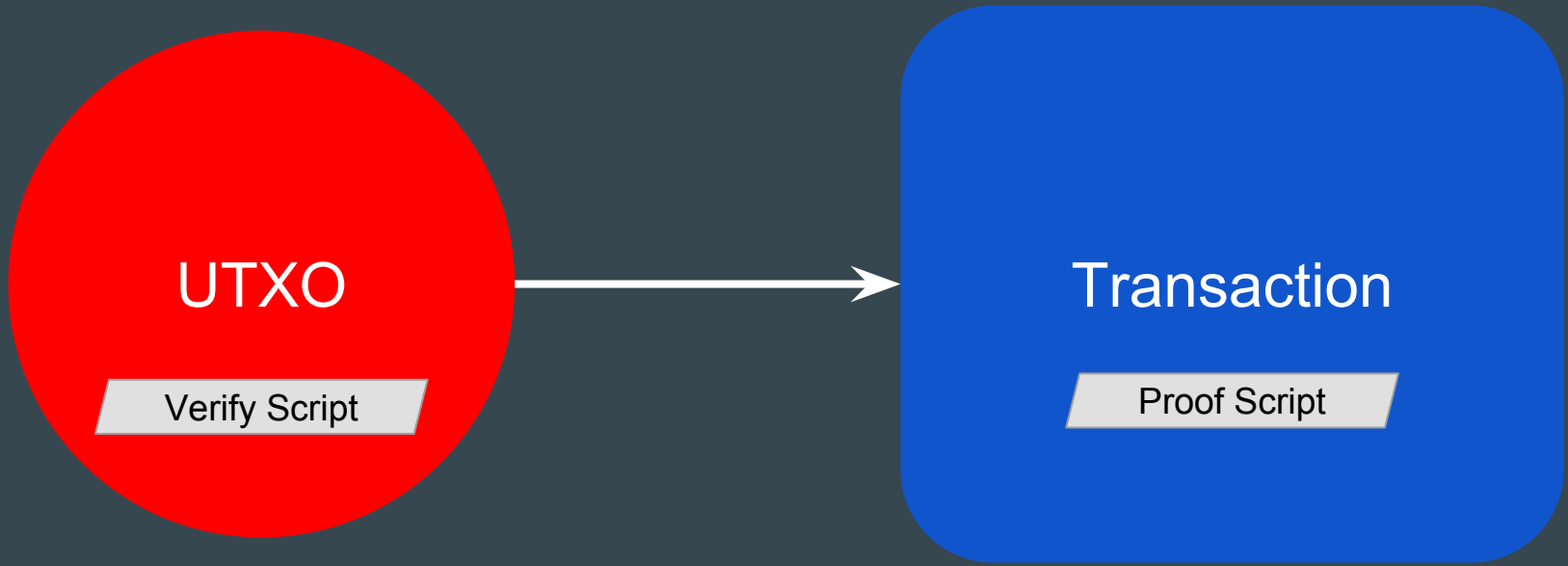

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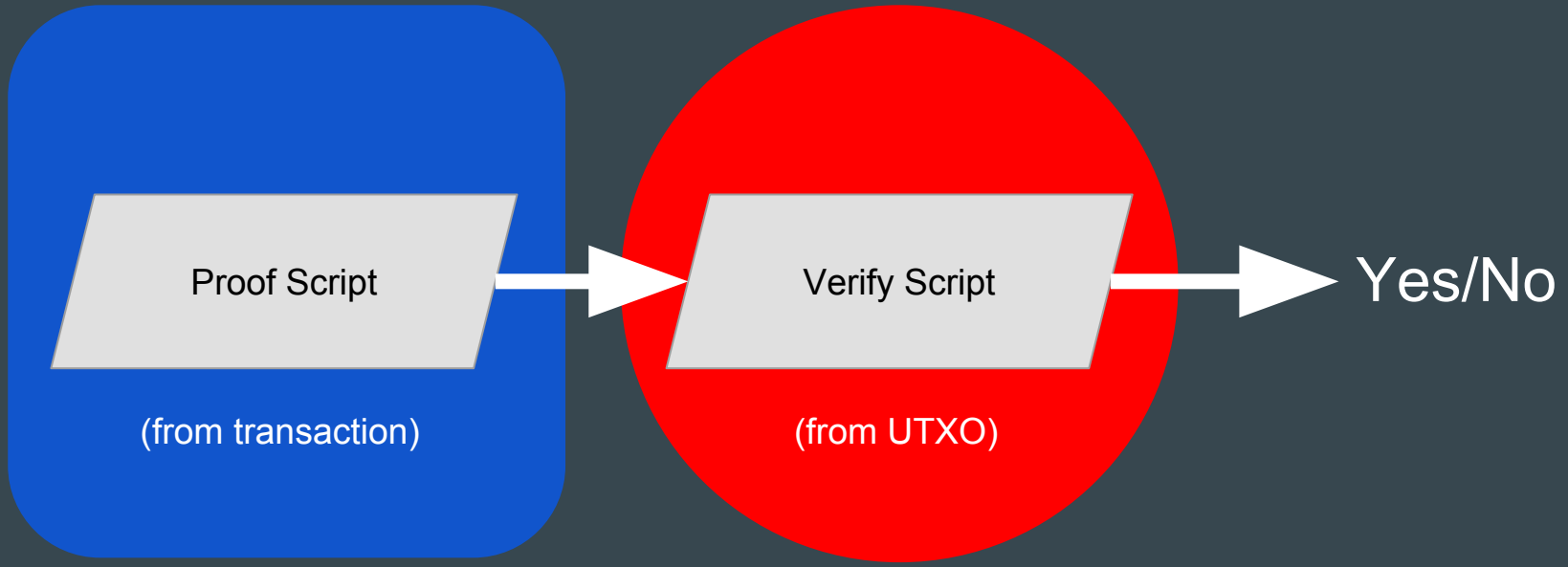
Proof Script
(from transaction)
Verify Script
(from UTXO)
Yes/No

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Why it's a Burn Address

To spend coins sent to 3LEETmEZWJX9ULbsFQVgL2QgGCJHPZJVaJ you must satisfy this Verify Script:

```
304402203c5288058306b3bf5cd8202413b867...   (signature)
2
023b439207c8a0a082a5c5a968632be9a363f5...   (public key 1)
0316b0dbf710b8739eec21a806e7142db1755a...   (public key 2)
2
OP_CHECKMULTISIG
```

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Why it's a Burn Address

To spend coins sent to 3LEETmEZWJX9ULbsFQVgL2QgGCJHPZJVaJ the transaction must satisfy this Verify Script:

1. The transaction's signature (by private key 1) must be 304402203c528...
2. You must provide a signature of the transaction (by private key 2).

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How to Spend Burnt Coins

- Problem: Burn address creator has to predict the spending transaction's hash.
- Not possible, but there's a convenient bug in bitcoin:

```
uint256 SignatureHash(const CScript& scriptCode, const CTransaction& txTo, unsigned int nIn, int nHashType)
{
    static const uint256 one(uint256S("0000000000000000000000000000000000000000000000000000000000000001"));
    if (nIn >= txTo.vin.size()) {
        //  nIn out of range
        return one;
    }

    // Check for invalid use of SIGHASH_SINGLE
    if ((nHashType & 0x1f) == SIGHASH_SINGLE) {
        if (nIn >= txTo.vout.size()) {
            //  nOut out of range
            return one;
        }
    }
```

- Yes, that 304402203c5288058306b3bf... is just a signature of 1.

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How to Spend Burnt Coins

1. Create a transaction to spending the burnt UTXO.
2. Make it trigger the SIGHASH_SINGLE bug, so its hash is 1.
3. Sign it with private key 2.

It's NOBUS!

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- "Nobody But Us" can exploit the backdoor.

1. The transaction's signature (by private key 1) must be 304402203c528...
2. You must provide a signature of the transaction (by private key 2).

Only the burn address creator knows that private key!

Drawing Conclusions

- Specific: In-band signalling is bad!
- General: Baked-in bugs increase mental burden.
  - Maybe fork more often to fix consensus bugs.
  - We were convinced by reasoning at the protocol level, but an easy-to-forget implementation detail brought our logic crashing down.

The Future of Underhanded Crypto

- There will be a 2017 contest.
- Broader scope, more like the 2014 one.
- Feedback: contact@underhandedcrypto.com

Thank you!

nccgroup

freedom from doubt