Backdooring Cryptocurrencies

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.
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: CASH
  - Silver: nccgroup
- Thank you to our judges:
  - JP Aumasson
  - Gustavo Banegas
  - Eric Wustrow
The Winner

- Here it is:

  3LEETmEZWX9ULbsFQVgL2QgGCJHPZJVaJ

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

Winner: Jonas Nick
https://nickler.ninja
Bitcoin 101

Unspent Transaction Output (UTXO) Set
Bitcoin 101

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Bitcoin 101

Proof Script
(from transaction)

Verify Script
(from UTXO)

Yes/No
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
```
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).
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:

```java
uint256 SignatureHash(const CScript& scriptCode, const CTransaction& txTo, unsigned int nIn, int nHashType)
{
    static const uint256 one(uint256("0xffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff"));
    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!

- “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!