grincon0
18.11.09 // c-base berlin

Cross-chain atomic swaps with Grin

Jasper van der Maarel

Introduction

Grin is fast approaching mainnet!

An economy will form around Grin

A need to change between Grin and other cryptocurrencies

Variety of exchanges, with different technologies

Centralized

Decentralized

Centralized

Decentralized

Central exchanges

BINANCE kraken

BITTREX POLONIEX

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- Instant trades
- High liquidity, advanced options
- Surrender control of coins
- KYC
- Regulations / censorship

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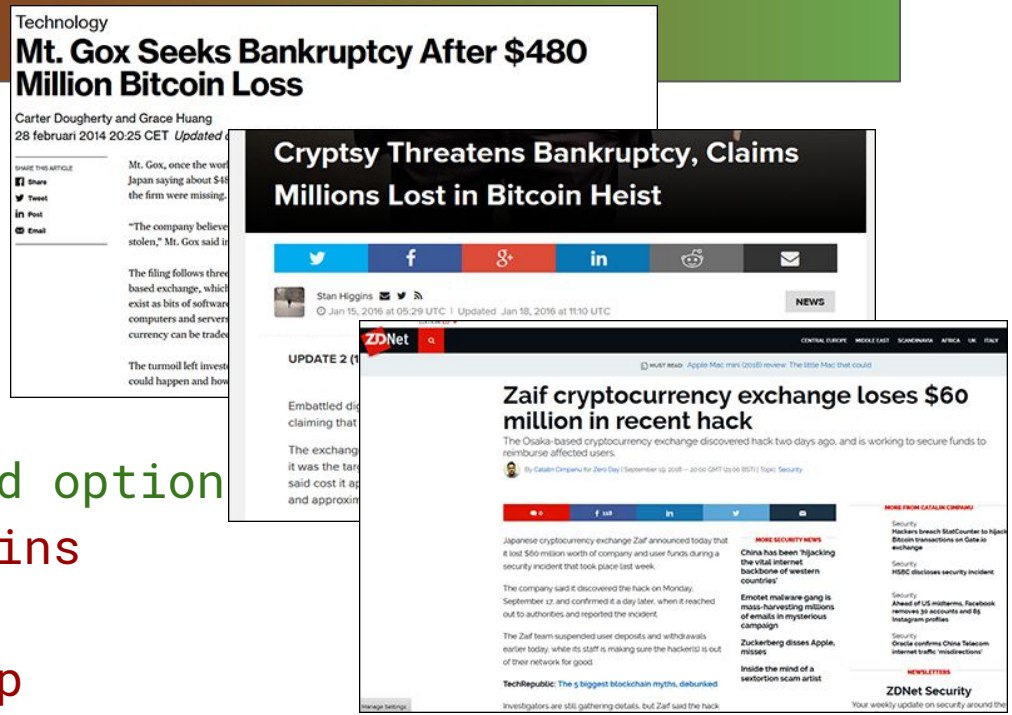


Centralized

Decentralized

Non-custodial exchanges

ShapeShift changelly

- Greater control of funds
- KYC
- Regulations

Centralized

Decentralized

On-chain decentralized exchanges

0x

EtherDelta

- Full control of funds
- “Anonymity”
- Trades are slow
- Poor scaling
- Single chain

Centralized

Decentralized

Cross-chain atomic swaps

- Full control of funds
- Can be fully p2p
- Anonymity
- Trades are slow

What is a cross-chain atomic swap?

Swap: trade without intermediary trusted party

Atomic: all-or-nothing. Either both parties complete the swap or neither of them does

Cross-chain: between currencies (here: Grin + BTC/ETH)

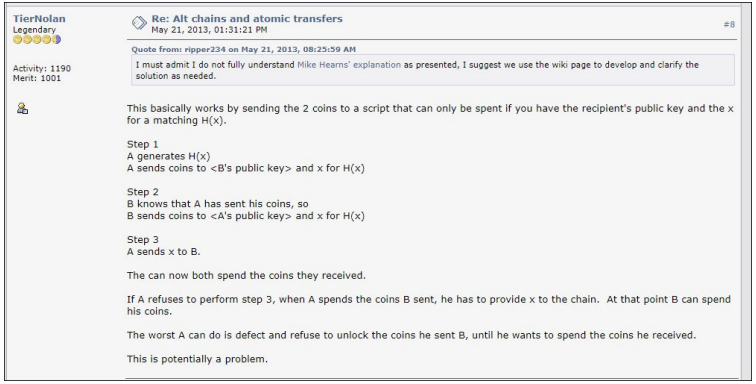
Atomic swap history

First proposal: 2013 by Tier Nolan on Bitcointalk

Weakness: no refunds

OP_CLTV soft fork

First BTC atomic swaps ~1y ago



HTLC atomic swaps

- Alice generates secret **q**
- Alice locks BTC with **H(q)**, unlockable by
  - Bob if he knows **q**
  - Alice if sufficient time has passed
- Bob locks altcoin with **H(q)**, unlockable by
  - Alice by revealing **q**
  - Bob if sufficient time has passed
- Relative time of the locks is important

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  - Alice by revealing **q**
  - Bob if sufficient time has passed
- Relative time of the locks is important
- Requires timelocks
- Requires hash pre-images
- Both sides of swap are linkable (use the same hash)

Grin swaps: in theory

MW atomic swaps

High level overview:

1. Bob generates secret **q**. Locks BTC/ETH in a 2-of-2 multisig using Alice’s key and **q**. Refund to Bob after 24h
2. Alice locks grins (with help of Bob) in a 2-of-2 multisig using Alice’s and Bob’s keys. Refund to Alice after 12h
3. Alice and Bob cooperate to send grins to Bob. When Bob finalizes the transaction, he automatically reveals **q**
4. Alice claims the BTC/ETH

1 - Bob locks BTC/ETH

Bitcoin: P2SH address

- Bob deposits agreed amount
- Output can be spent by
  - Alice, if she knows **q**
  - Bob, if 24 hours have passed

Ethereum: similar, but smart contract

```
OP_IF
  <now+24h>
  OP_CLTV
  OP_DROP
  <Bob's pubkey>
  OP_CHECKSIG
OP_ELSE
  OP_2
  <Alice's pubkey>
  <q pubkey>
  OP_2
  OP_CHECKMULTISIG
OP_ENDIF
```

2 - Alice (and Bob) lock grins

Remember: no scripts, interactive transactions

Outputs are Pedersen commitments

$$C = x*G + v*H$$

2 - Alice (and Bob) lock grins

How do we make a multisignature?

Create a new output

$$O = (x_A + x_B) * G + v * H$$

Complication: building rangeproof requires knowledge of blinding factor → replaced by interactive process

2 - Alice (and Bob) lock grins

Second complication: holding coins hostage

Once tx is final, neither party has full control of the output

If Bob refuses to cooperate, Alice’s coins will be stuck

Solution: build a refund back to Alice, before finalizing the multisignature

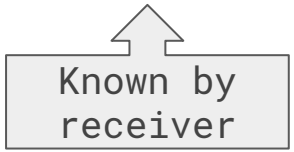
This transaction has a 12h timelock, it can not be mined in a block before its expiration

3 - Build tx to spend grins

In general, transactions have to balance out

For example, 1 input -> 2 output transaction:

$$O_R + O_{ch} - I_S = (x_R + x_{ch} - x_S) * G + 0 * H$$



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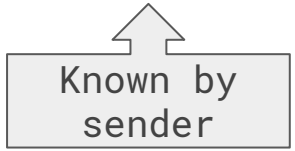

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In general, transactions have to balance out

For example, 1 input -> 2 output transaction:

$$O_R + O_{ch} - I_S = (x_R+x_{ch}-x_S)*G + 0*H$$

Schnorr signature for excess: both parties can generate a partial signature for their own contribution to the tx

Total signature is sum of parts:

$$(s,k*G) = (s_S+s_R, k_S*G+k_R*G)$$

3 - Build tx to spend grins

In our case, Alice and Bob build a tx to spend the multisig

$$I = (x_A+x_B)*G + v*H$$

And create a new output solely controlled by Bob

Trick: adaptor signature

Bob will calculate his partial signature s_B, but instead send $s_{adap} = s_B + q$ to Alice

3 - Build tx to spend grins

Alice can cryptographically verify that she in fact did receive $\mathbf{s_B + q}$

She can now safely send $\mathbf{s_A}$ to Bob

Bob will publish the transaction with total signature $\mathbf{s = s_A + s_B}$ to the Grin network, claiming the coins

4 - Claim BTC/ETH

Alice monitors the Grin chain for the transaction

From this she learns the total signature **s**

She performs simple arithmetic to find **q**:

$$q = s_{adap} + s_A - s$$

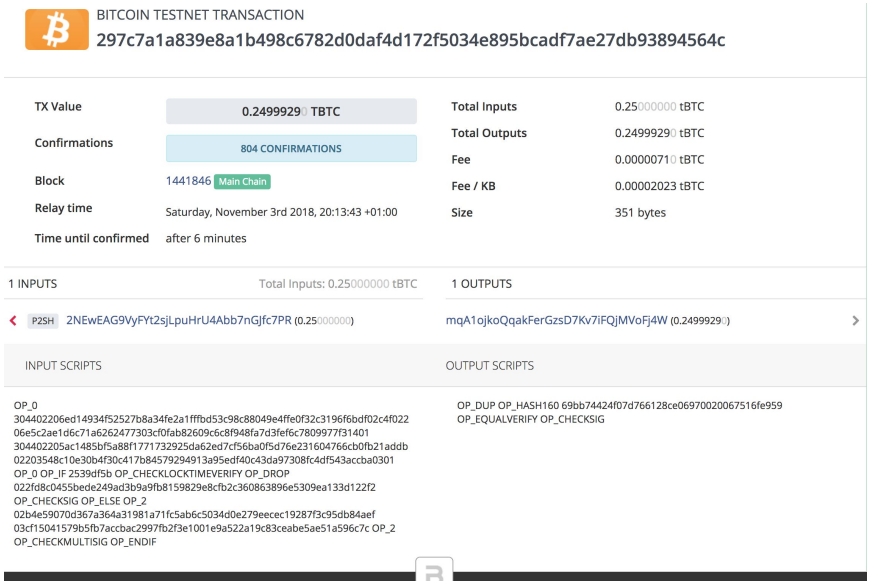
This allows her to spend the multisig on the BTC/ETH chain

The swap is now complete!

Grin swaps: in practice

Atomic swaps on testnet

T4: first Grin-tBTC swap



BITCOIN TESTNET TRANSACTION

297c7a1a839e8a1b498c6782d0daf4d172f5034e895bcadf7ae27db93894564c

TX Value	0.2499929 TBTC	Total Inputs	0.25000000 tBTC
Confirmations	804 CONFIRMATIONS	Total Outputs	0.24999290 tBTC
		Fee	0.00000710 tBTC
Block	1441846 Main Chain	Fee / KB	0.00002023 tBTC
Relay time	Saturday, November 3rd 2018, 20:13:43 +01:00	Size	351 bytes
Time until confirmed	after 6 minutes		

1 INPUTS — Total Inputs: 0.25000000 tBTC

P2SH 2NEwEAG9VyFYt2sjLpuHrU4Abb7nGJfc7PR (0.25000000)

1 OUTPUTS

mqA1ojkoQqakFerGzsD7Kv7iFQjMVoFj4W (0.24999290)

INPUT SCRIPTS

OP_0
304402206ed14934f52527b8a34fe2a1fffbd53c98c88049e4ffe0f32c3196f6bdf02c4f022
06e5c2ae1d6c71a6262477303cf0fab82609c6c8f948fa7d3fef6c7809977f31401
304402205ac1485bf5a88f1771732925da62ed7cf56ba0f5d76e231604766cb0fb21addb
02203548c10e30b4f30c417b84579294913a95edf40c43da97308fc4df543accba0301
OP_0 OP_IF 2539df5b OP_CHECKLOCKTIMEVERIFY OP_DROP
022fd8c0455bede249ad3b9a9fb8159829e8cfb2c360863896e5309ea133d122f2
OP_CHECKSIG OP_ELSE OP_2
02b4e59070d367a364a31981a71fc5ab6c5034d0e279eecec19287f3c95db84aef
03cf15041579b5fb7accbac2997fb2f3e1001e9a522a19c83ceabe5ae51a596c7c OP_2
OP_CHECKMULTISIG OP_ENDIF

OUTPUT SCRIPTS

OP_DUP OP_HASH160 69bb74424f07d766128ce06970020067516fe959
OP_EQUALVERIFY OP_CHECKSIG

Block 03e889de

Height	23,882
Hash	03e889de4c2ae83efa45b53adf8fbb2890d2f16e1a42362eb9c0bc8a698b5d05
Parent	078cbb262b42657f219418bf1ed2f097c60fe3b14c97b66deac52692fd6984b7
Child(ren)	0263351821e95c1ad9c93136c78c3e034f458d4e778d1908e00ed852489555fc
Version	1
Time	2018-11-03 18:40:52 UTC
Mined in	1m 1s
PoW algorithm	Secondary
Secondary scale	3,324
Edge bits	29
Nonce	13145007527189516869
Solution difficulty	217,724
Network difficulty	102,126
Total difficulty	1,246,983,019
Kernel offset	bf361013a24247fff5001ed401d197714c9bb212a9d3f87878d33567e6ae2b12
Total kernel offset	1b745cdd667c5184c32dfb7615293e9148745fa8009c60e3694b0f48606229e7
Reward	60 + 0.004 Grin

Kernels (2)

#	Type	Excess	Fee	Lock height
0	Coinbase	08464989659d1223834139eca9f8db8a3e1011f2e1841bb1e55364ee8fa2d4d90f		23,882
1		094f7e47add827f973273fa8cccd31751d41c0905812df09e5ff84d1411d9e92a5	0.004	23,862

Inputs (1)

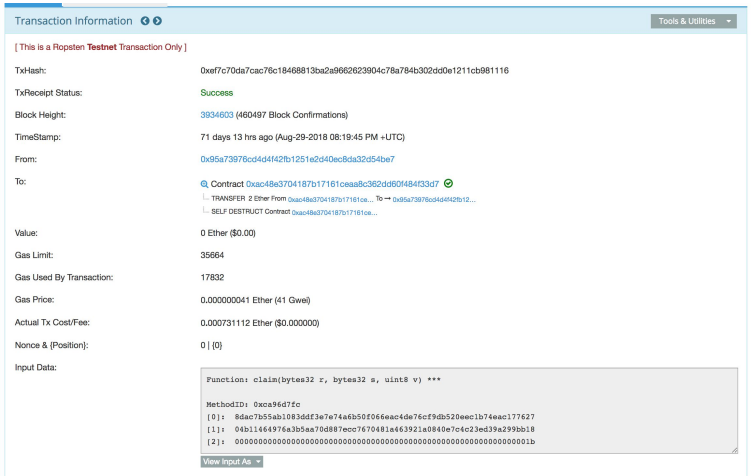
#	Commit
0	085a021dffae47e92105b2ce6d317fa5755cd77759106bb9cac86e99ada9269c2c

Outputs (2)

#	Type	Commit
0		083cab62ebc6f304324d61f59d35ffb956dd000d1e1f7132bc9217994b49179cc3
1	Coinbase	08d8d7b528df0541031963180cedd920dc984b8979cbfaf9dbf11ed1abfe9be2fb

Atomic swaps on testnet

T3: first Grin-tETH swap



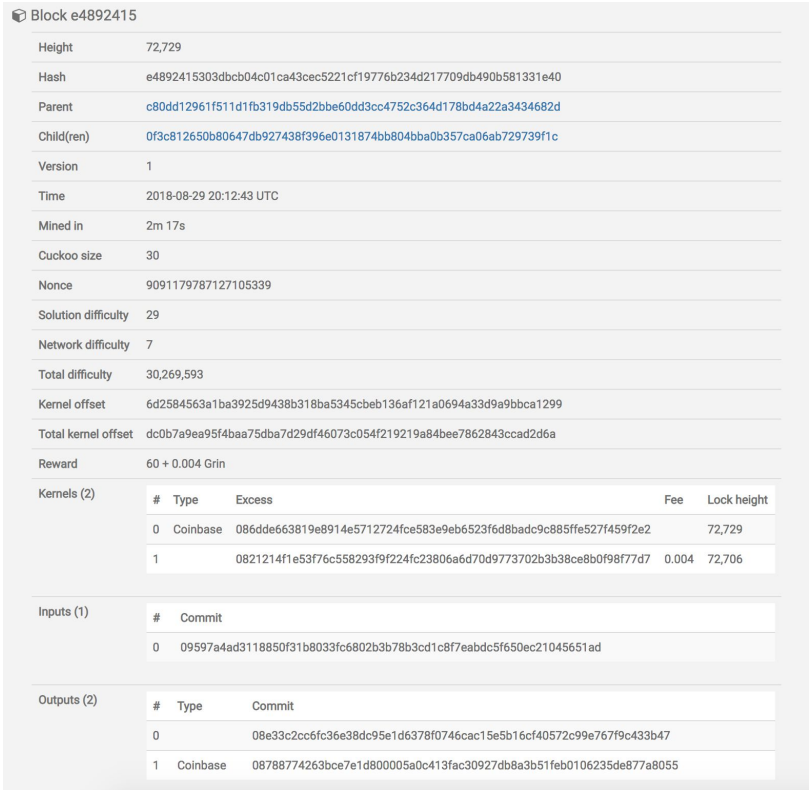
Transaction Information

Tools & Utilities

[This is a Ropsten **Testnet** Transaction Only]

TxHash:	0xef7c70da7cac76c18468813ba2a9662623904c78a784b302dd0e1211cb981116
TxReceipt Status:	Success
Block Height:	3934603 (460497 Block Confirmations)
TimeStamp:	71 days 13 hrs ago (Aug-29-2018 08:19:45 PM +UTC)
From:	0x95a73976cd4d4f42fb1251e2d40ec8da32d54be7
To:	Contract 0xac48e3704187b17161ceaa8c362dd60f484f33d7 TRANSFER 2 Ether From 0xac48e3704187b17161ce... To 0x95a73976cd4d4f42fb12... SELF DESTRUCT Contract 0xac48e3704187b17161ce...
Value:	0 Ether ($0.00)
Gas Limit:	35664
Gas Used By Transaction:	17832
Gas Price:	0.000000041 Ether (41 Gwei)
Actual Tx Cost/Fee:	0.000731112 Ether ($0.000000)
Nonce & {Position}:	0 | {0}
Input Data:	Function: claim(bytes32 r, bytes32 s, uint8 v) *** MethodID: 0xca96d7fc [0]: 8dac7b55ab1083ddf3e7e74a6b50f066eac4de76cf9db520eec1b74eac177627 [1]: 04b1464976a3b5aa70d887ecc7670481a463921a0840e7c4c23ed39e299bb18 [2]: 000000000000000000000000000000000000000000000000000000000000001b

View Input As



Block e4892415

Height	72,729
Hash	e4892415303dbcb04c01ca43cec5221cf19776b234d217709db490b581331e40
Parent	c80dd12961f511d1fb319db55d2bbe60dd3cc4752c364d178bd4a22a3434682d
Child(ren)	0f3c812650b80647db927438f396e0131874bb804bba0b357ca06ab729739f1c
Version	1
Time	2018-08-29 20:12:43 UTC
Mined in	2m 17s
Cuckoo size	30
Nonce	9091179787127105339
Solution difficulty	29
Network difficulty	7
Total difficulty	30,269,593
Kernel offset	6d2584563a1ba3925d9438b318ba5345cbeb136af121a0694a33d9a9bbca1299
Total kernel offset	dc0b7a9ea95f4baa75dba7d29df46073c054f219219a84bee7862843ccad2d6a
Reward	60 + 0.004 Grin

Kernels (2)

#	Type	Excess	Fee	Lock height
0	Coinbase	086dde663819e8914e5712724fce583e9eb6523f6d8badc9c885ffe527f459f2e2		72,729
1		0821214f1e53f76c558293f9f224fc23806a6d70d9773702b3b38ce8b0f98f77d7	0.004	72,706

Inputs (1)

#	Commit
0	09597a4ad3118850f31b8033fc6802b3b78b3cd1c8f7eabdc5f650ec21045651ad

Outputs (2)

#	Type	Commit
0		08e33c2cc6fc36e38dc95e1d6378f0746cac15e5b16cf40572c99e767f9c433b47
1	Coinbase	08788774263bce7e1d800005a0c413fac30927db8a3b51feb0106235de877a8055

Code

Proof-of-concept code is available on Github

Can be used to perform Grin-BTC/ETH swaps on T4

4 round trips of communication

```
(ENV) grinswap:~/MW/grinswap$ ./swap sell
################################
# Grin -> BTC/ETH atomic swap
#
# This script is used for selling grin coins for Bitcoin or Ether through an atomic swap
#
# What is the name of the wallet you want to use? wallet
# How much grin do you want to sell? 100
# Which currency would you like to receive? [BTC/ETH]: BTC
# How much BTC do you want to receive? 0.1
# At which Bitcoin address would you like to receive this? mmzi4QaUwXfA3vncequpQbDiasGUn2GA57
# What is the height of the last Grin T4 block? 30509
#
# Created file 'ac28de17_seller_1.json', please send it to the buyer
################################
```

That’s all!

Reading material

Adaptor signatures / scriptless scripts:

https://www.youtube.com/watch?v=ovCBT1gyk9c
https://joinmarket.me/blog/blog/flipping-the-scriptless-script-on-schnorr
https://lists.launchpad.net/mimblewimble/msg00086.html

Grin-ETH atomic swap on T3:

https://medium.com/grinswap/first-grin-atomic-swap-a16b4cc19196

Proof-of-concept code:

https://github.com/GrinSwap/proof-of-concept

Q&A

https://grin-tech.org