



**grincon0**

18.11.09 // c-base berlin

# **Dandelion in Grin: Privacy-Preserving Transaction Aggregation & Propagation**

@quentinlesceller

# Outline

- Grin
  - Transactions
  - Blockchain
  - Open Problems

- Dandelion
  - Current problems in P2P network
  - What is Dandelion
  - Key terminology

- Grin & Dandelion
  - Dandelion Implementation in Grin
  - Solving the problem
  - Transaction Aggregation



# Grin



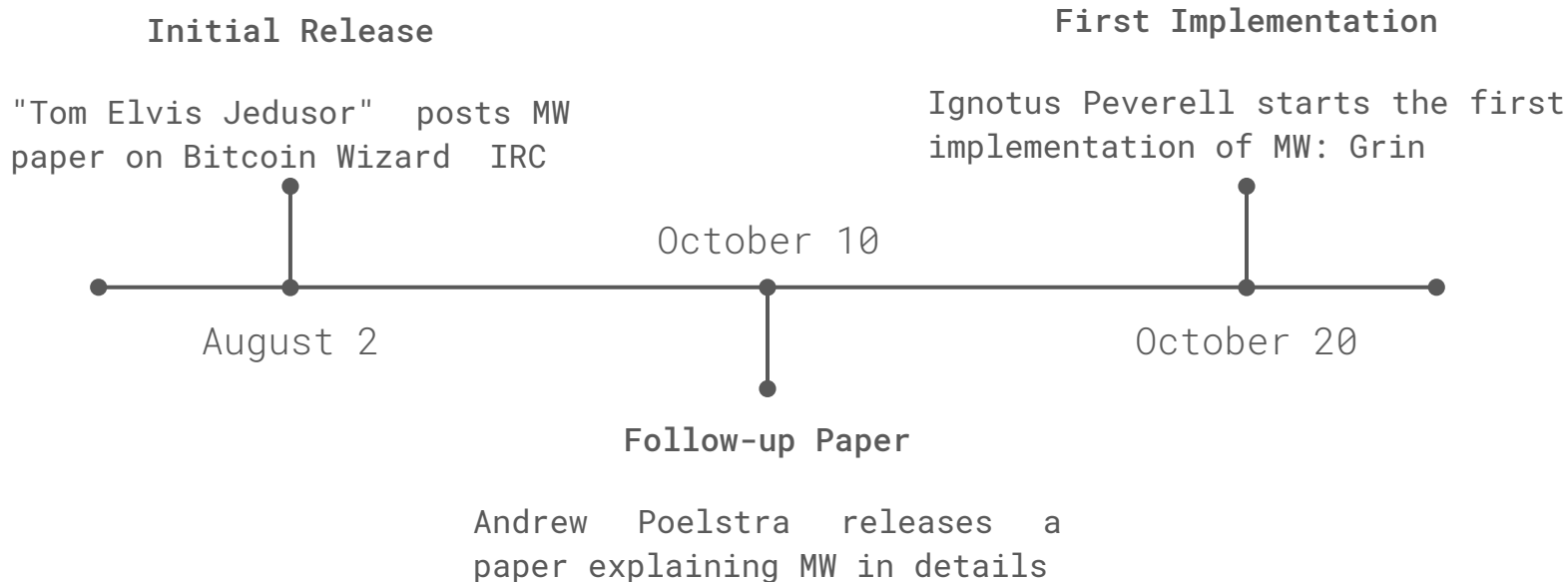
# What is MW/Grin?

- MimbleWimble (MW) is a completely new blockchain design that offers several benefits:
  - Privacy by default
  - Massively prunable
  - Relies on proven elliptic curve cryptography
- Output-based like Bitcoin but without script
- Grin is the first implementation of the protocol



# History

2016



# Grin Transactions

- In Bitcoin, every output has a script (script pubkey) attached to it. In order to spend one of them, conditions in the script must be met.
- In MW/Grin outputs only have public keys: no script.
- Hence MW/Grin transactions are scriptless.



# Grin Transactions

A Grin transaction contains the following parts:

- Inputs (reference to old outputs)
- Outputs: confidential transactions (amounts are blinded)  
+ range proofs
- Kernel: difference between outputs and inputs + fee + signature



# Grin Transactions

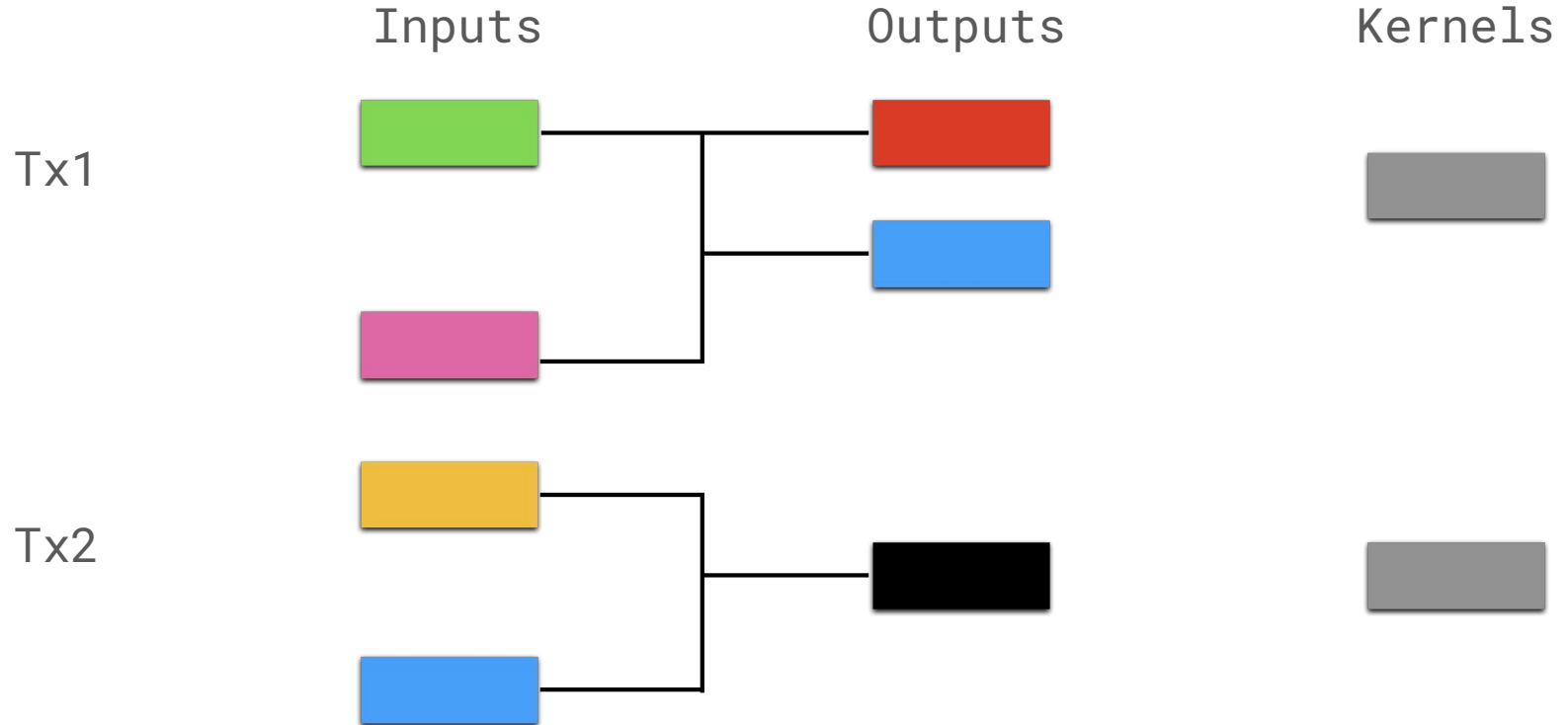
A Grin transaction validation is based on two properties:

- Verification of zero sums.
- Possession of private keys.

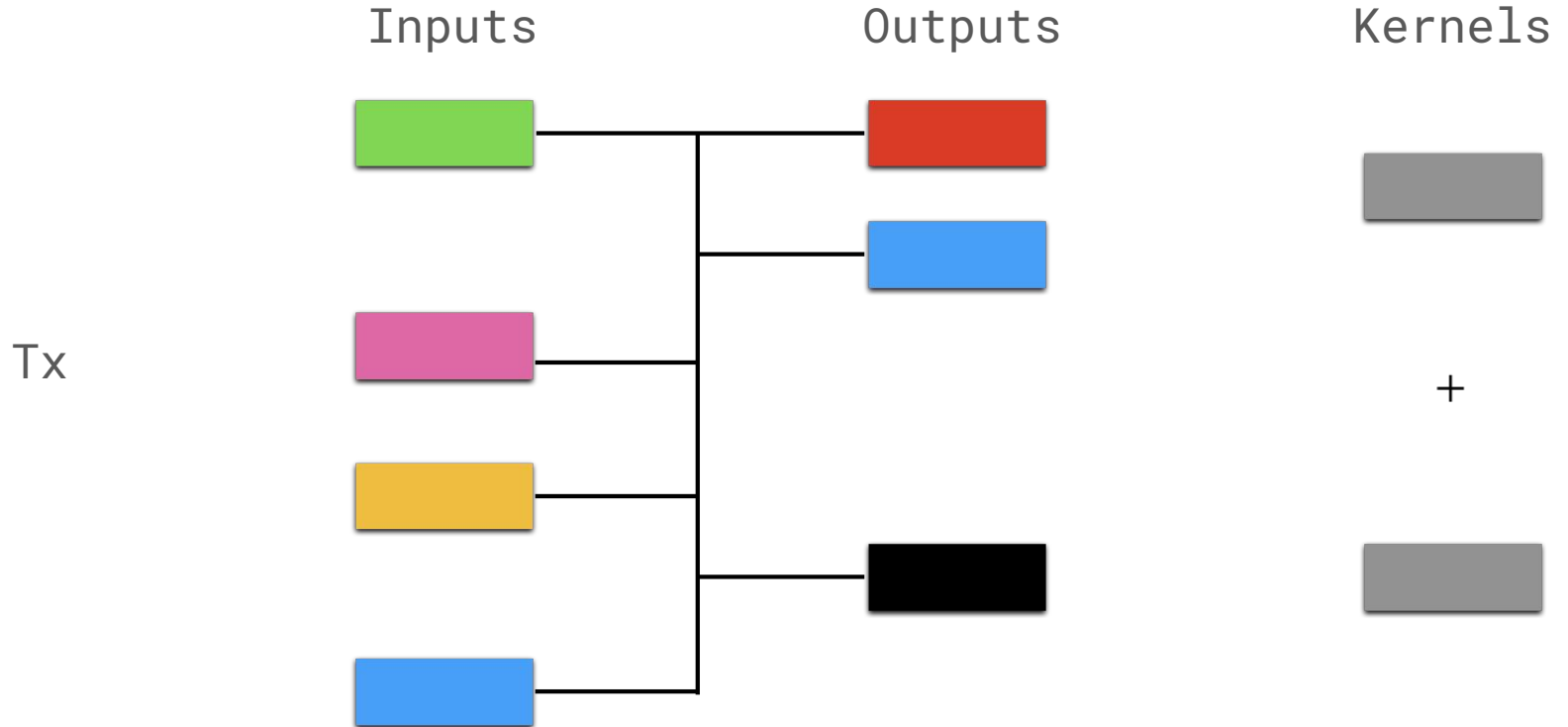




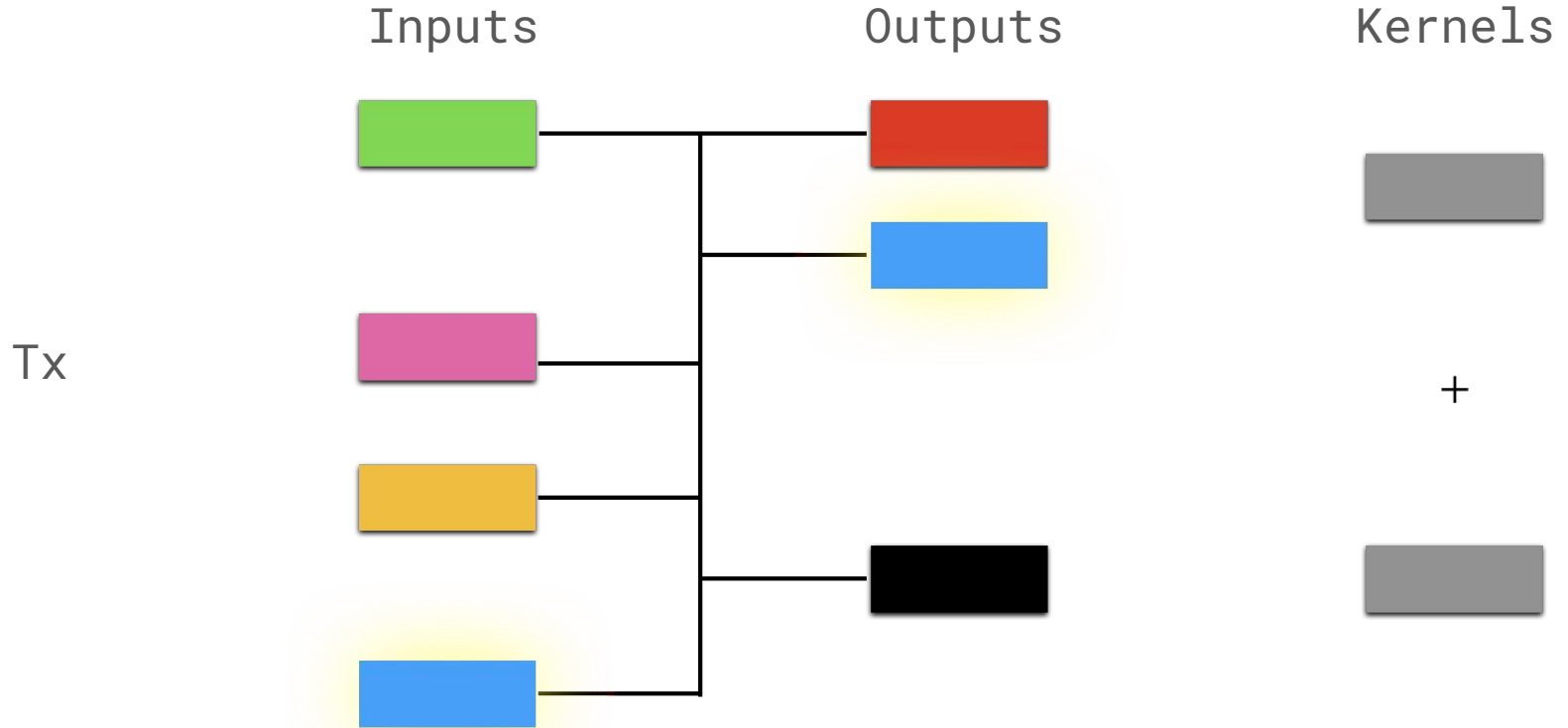
# Grin Transactions



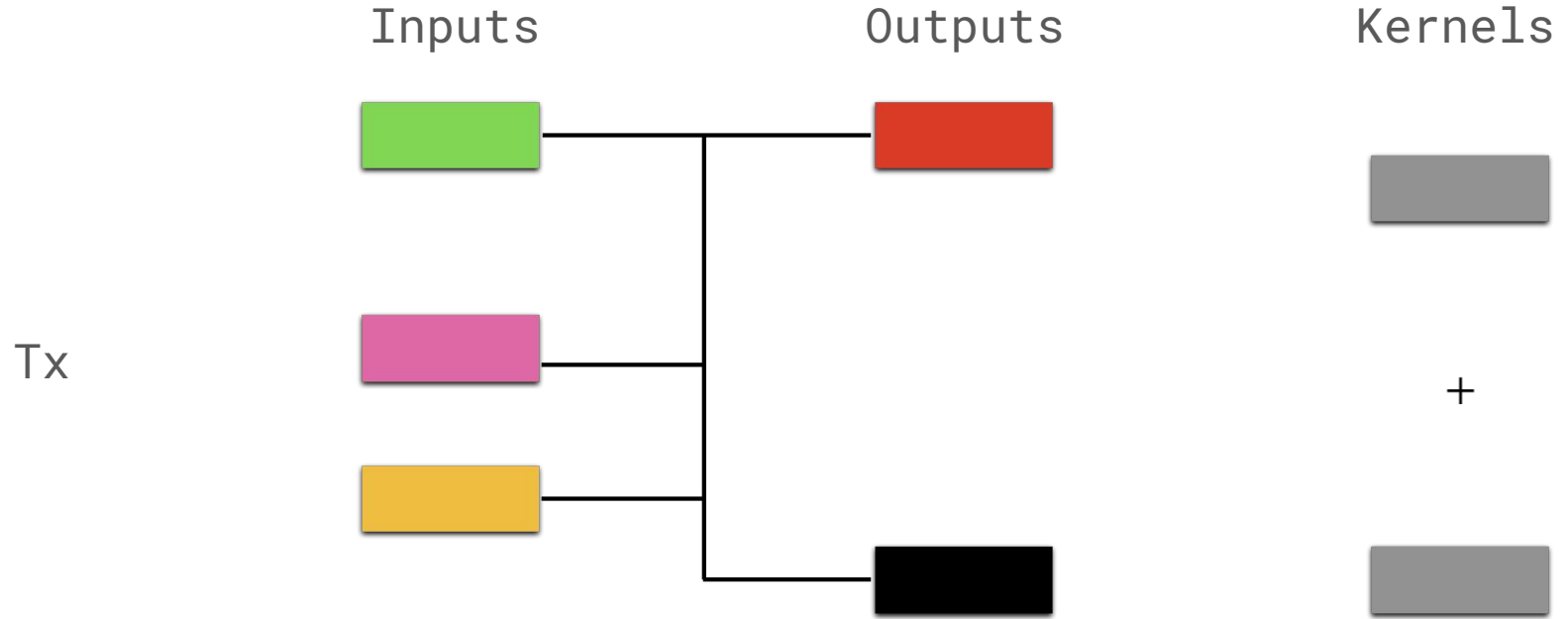
# Grin Transactions



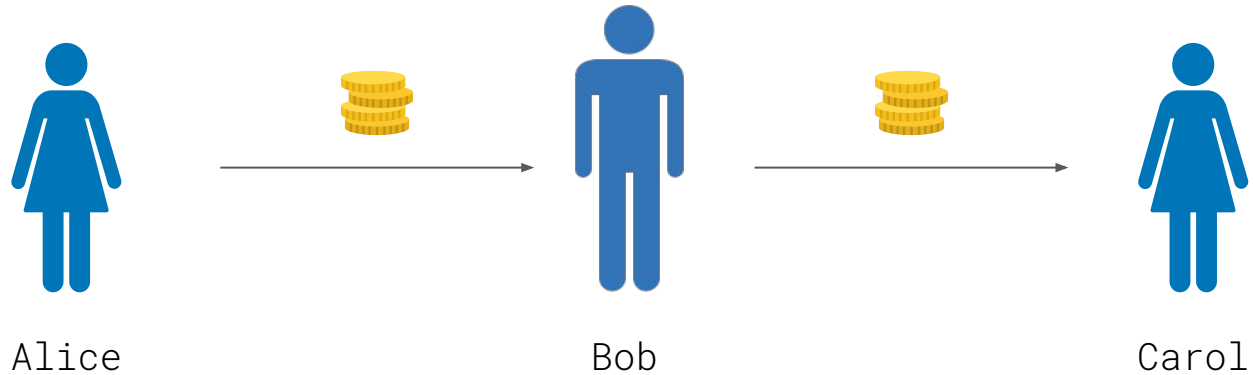
# Grin Transactions



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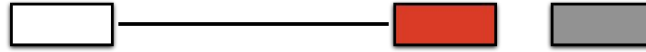


# Grin Transactions

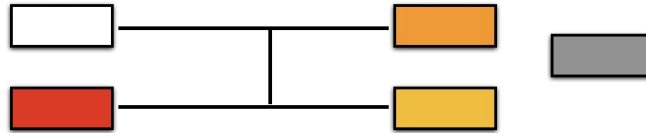


# Grin Blockchain

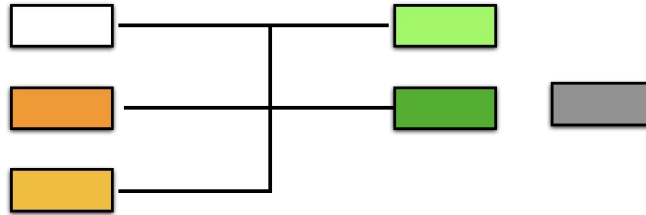
Block 1



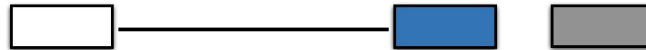
Block 2



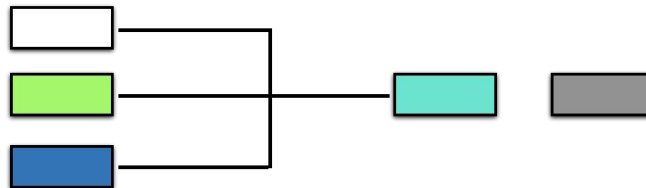
Block 3



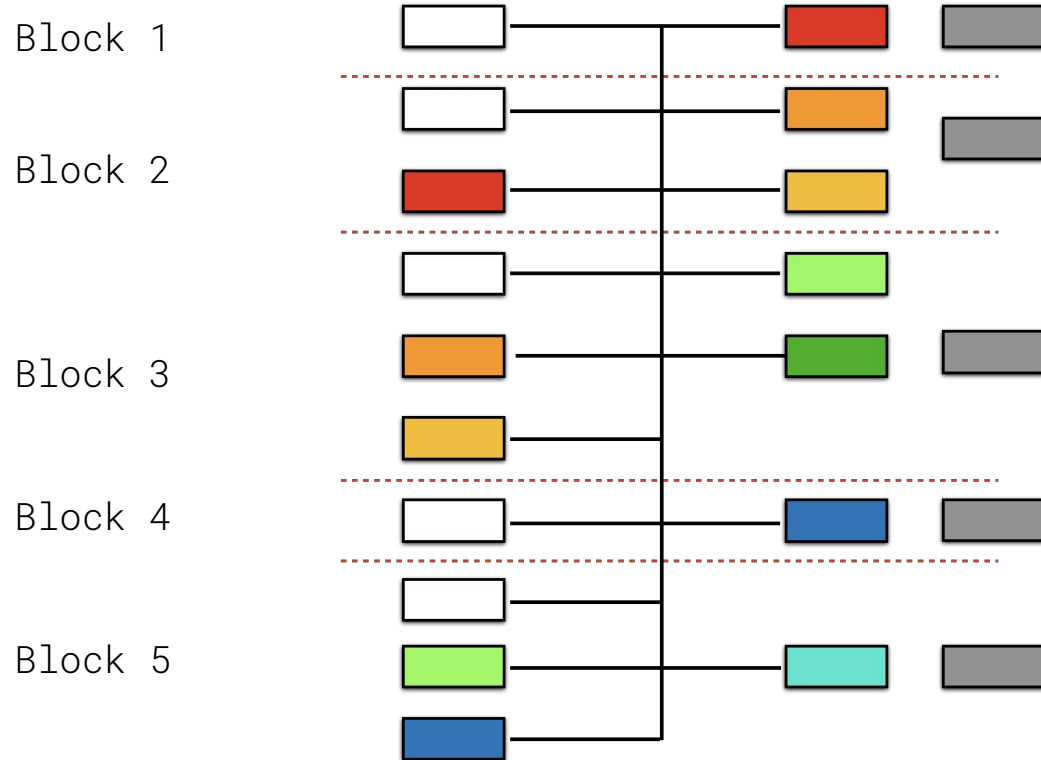
Block 4



Block 5



# Grin Blockchain





# Grin Blockchain

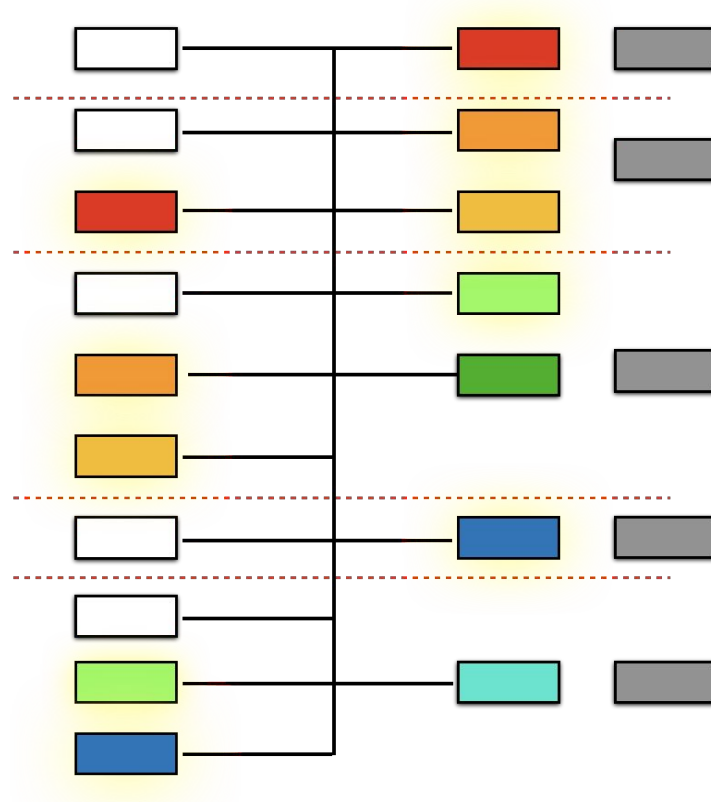
Block 1

Block 2

Block 3

Block 4

Block 5



# Grin Blockchain

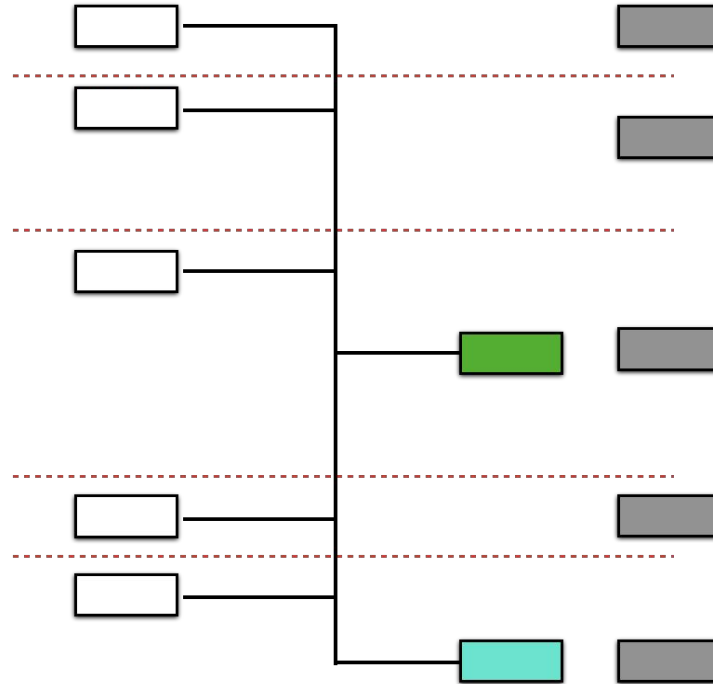
Block 1

Block 2

Block 3

Block 4

Block 5



# Open Problems

- Mentioned by Andrew Poelstra at Scaling Bitcoin 2016

## Open Problems

Bulletproofs: Short Proofs for Confidential Transactions and More. Bünz et al.

- Smaller rangeproofs? Aggregation of rangeproofs?
- Peer-to-peer protocol that can handle transaction merging
- Quantum resistance

Switch Commitments: A Safety Switch for Confidential Transactions. Ruffing et al.



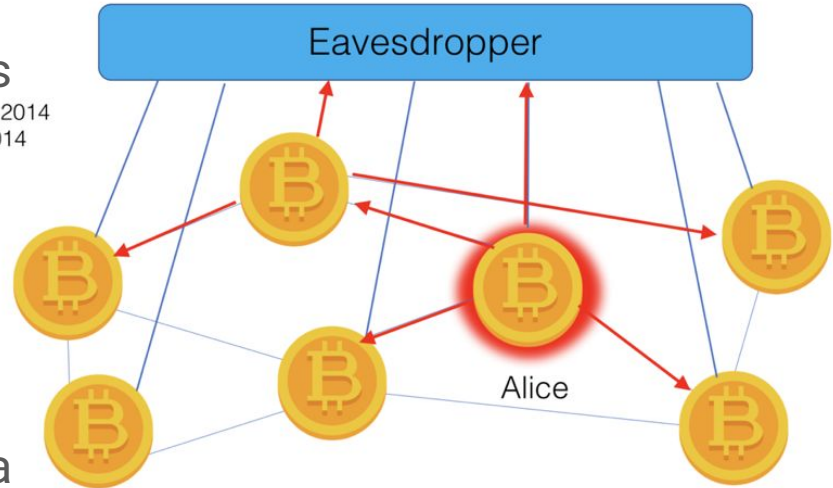


# Dandelion

# Problem in the current P2P network

- The P2P network currently forwards content in a structured way that allows observers to deanonymize users
- An eavesdropper is capable to assign an IP to a bitcoin address
- Identify the first sender of a Bitcoin transaction

Biryukov et al., 2014  
Koshy et al., 2014



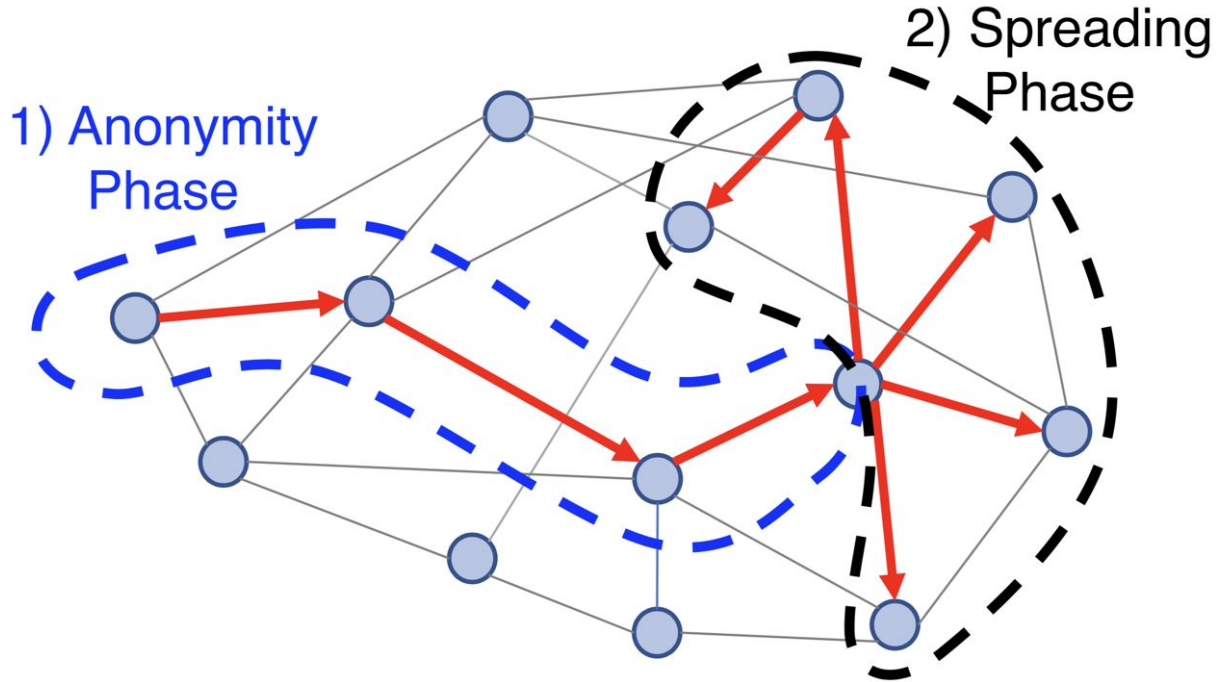
# What is Dandelion?

- Dandelion is a simple networking policy to improve the anonymity in a peer-to-peer network.
- Created by Shaileshh Bojja, Giulia Fanti and Pramod Viswanath (University of Illinois).
- A BIP was written by Giulia Fanti, Andrew Miller, Surya Bakshi, Shaileshh Bojja and Pramod Viswanat.

<https://github.com/dandelion-org/bips/blob/master/bip-dandelion.mediawiki>



# What is Dandelion?



# Key Terminology

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Stem transaction	A transaction during the anonymity phase.
Stem memory pool	Also called stempool. The pool where the stem transactions are stored.
Dandelion relay	The peer chosen to relay the stem transaction. Updated every X minutes.
To stem	To broadcast to the Dandelion relay only.
To fluff	To broadcast to all the peers normally

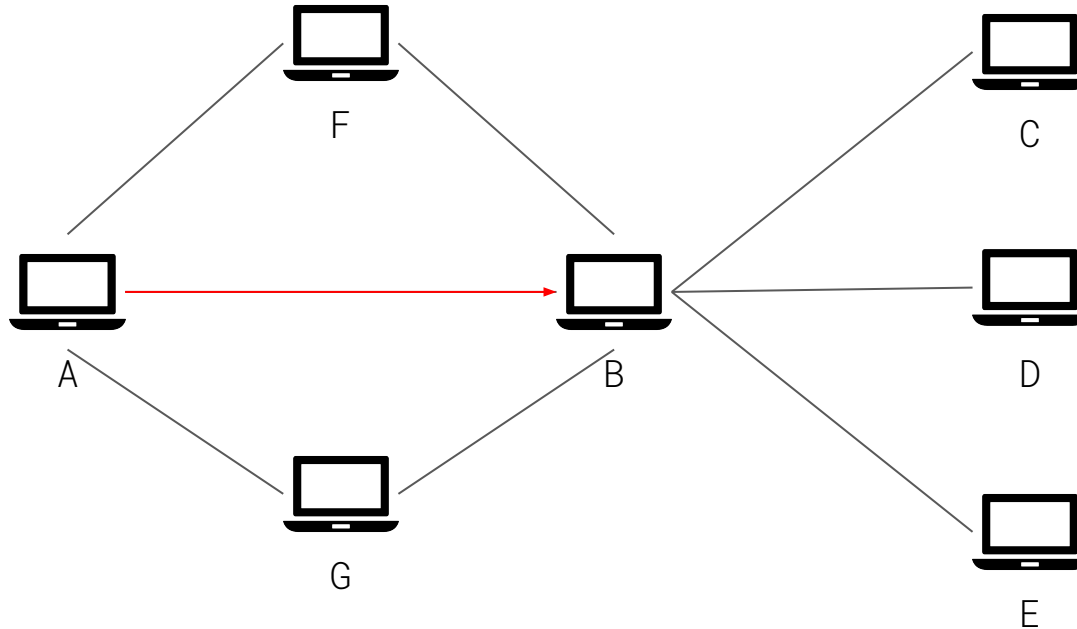
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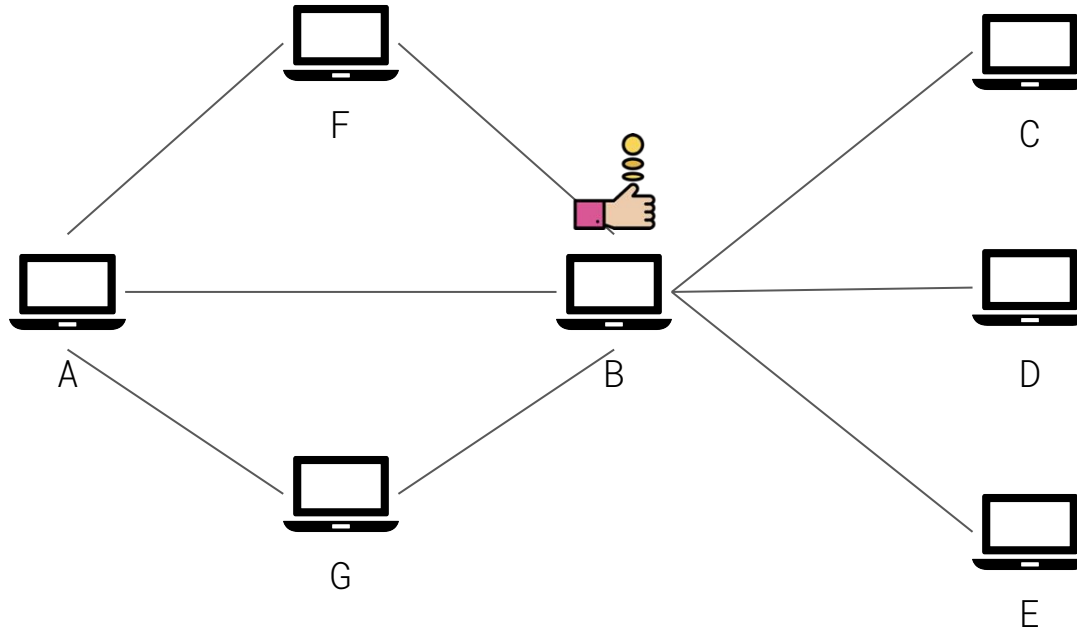
# Dandelion Step-by-Step

Step 1: A sends a Stem Transaction to B



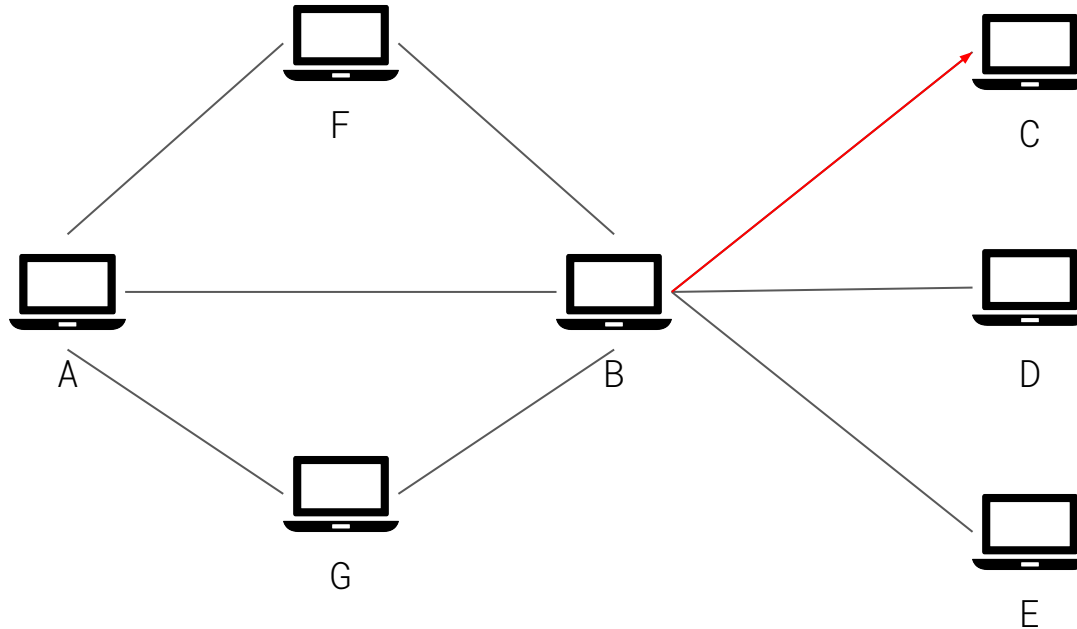
# Dandelion Step-by-Step

Step 2: B receives the Stem Tx and do a coin flip



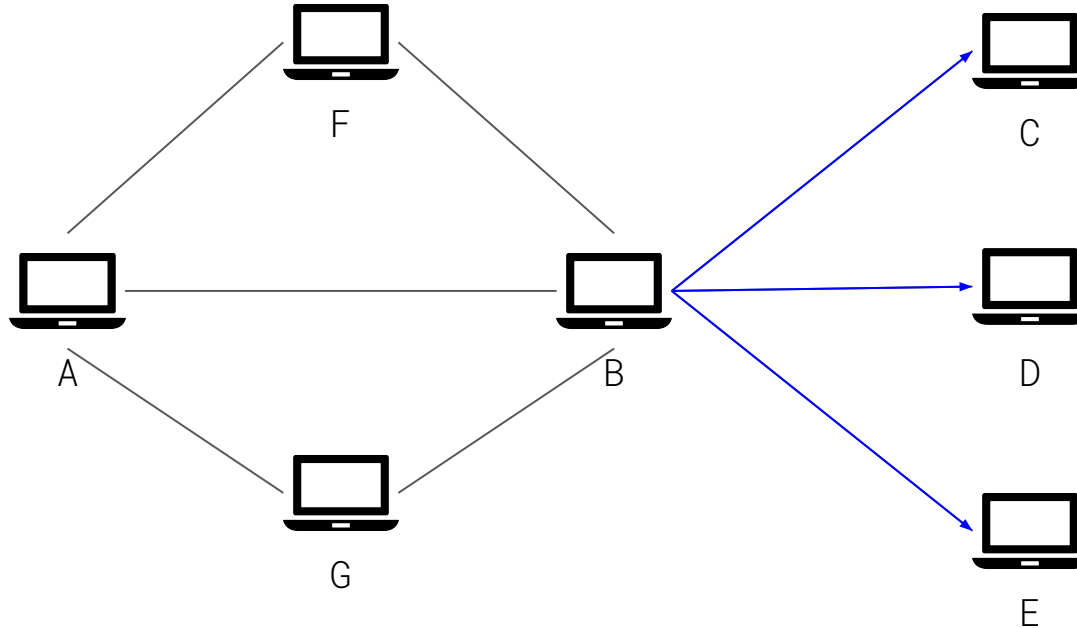
# Dandelion Step-by-Step

Step 3: B sends the stem transaction to its Dandelion Relay



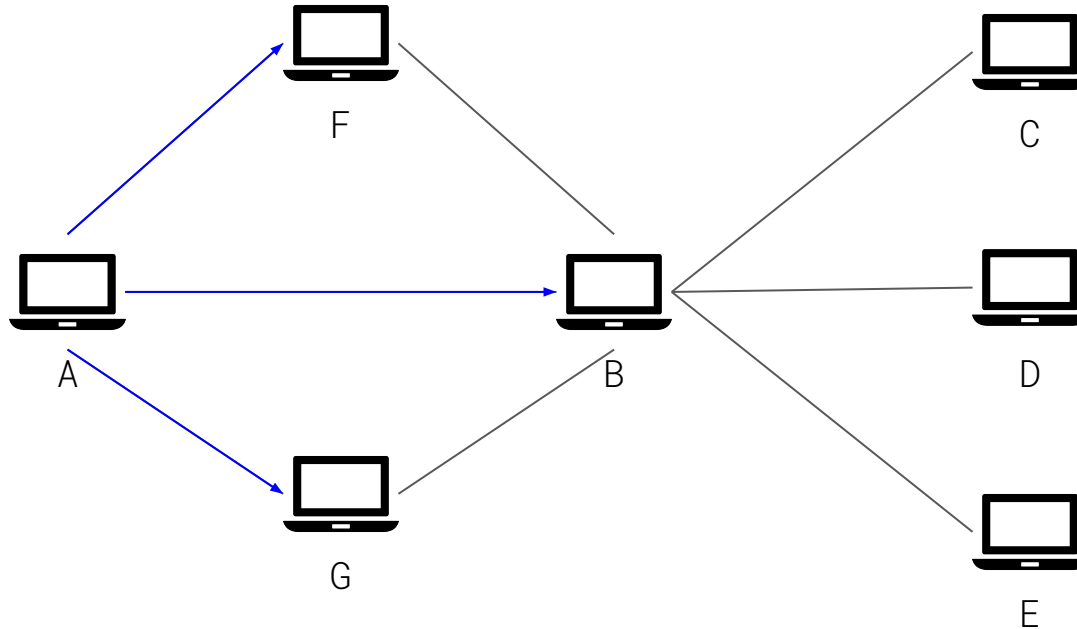
# Dandelion Step-by-Step

Step 3: B sends the transaction to all its peers



# Dandelion Step-by-Step

Step X: B does not play by the rules.



# What is Dandelion?

3 parameters:

- The Dandelion probability (by default 90%)
- The time between re-randomizations of the Dandelion relay (every 10 minutes)
- The embargo timer (3 minutes)



A black and white line drawing of a dandelion seed head on the left, with several seeds floating in the air above the text. The text "Dandelion in Grin" is written in a bold, black, sans-serif font.

# Dandelion in Grin



# Dandelion Implementation in Grin

## Basic implementation first

- Implemented in Grin in February.
- Work in collaboration with Giulia Fanti's team.
- In the testnet2 release.

### [WIP] Basic Dandelion #719

**Merged** ignopeverell merged 64 commits into `main` from `quentinlesceller:basic_dandelion` on 19 Mar

Conversation 23 · Commits 64 · Checks 0 · Files changed 24 +961 -82

quentinlesceller commented on 20 Feb • edited • Member

Work in progress.  
Adds a very simple Dandelion policy. Prerequisite to fix #706. Does not include transaction aggregation.

Including:

- add a stem transaction relay message type
- relay a valid stem transaction in stem phase 90% of the time, otherwise diffuse as we do now
- monitor our transactions so we can re-send if we never see them from the fluff phase.
- create a stem pool to aggregate transaction in the future.

TODO:

- ☒ Add a stem memory pool
- ☒ Simple stempool architecture
- ☒ Add a stem memory pool config
- ☒ Add embargo time for every transaction in stem pool.
- ☒ Add a transaction monitor to send transaction in case not fluffed
- ☒ Add the selection of Dandelion relay every time interval
- ☒ Externalize the Dandelion settings
- ☒ Deal properly with child transaction
- ☒ Update `search_best_output` for stempool
- ☒ Update and add transaction test

quentinlesceller added some commits on 20 Feb

Initial Dandelion Commit X 9649f48

3 participants

Reviews: kargakis, ignopeverell

Assignees: No one—assign yourself

Labels: None yet

Projects: None yet

Milestone: No milestone

Notifications: [Unsubscribe](#)  
You're receiving notifications because you authored the thread.





# Solving the problem

How can we aggregate transactions trustlessly in a peer-to-peer protocol?

- No consensus on the content of the memory pool.
- Nodes should not be able to find out the transaction graph.

Can we use the Dandelion protocol to aggregate tx in Grin?



# Solving the problem

- We can aggregate transactions during the stem phase.
- Stop aggregating when fluff.
- New concept of patience: How long the node will wait for other transactions to aggregate before broadcasting again.



# Implementing Transaction Aggregation in Grin

- Could cause a denial of service.  
(Aggregation with low fee transactions then rejected by miners)
- Need to deploy some countermeasure  
(antiaggregation mechanism) PR #985
  - Basically, when a node receive an aggregated transaction, try to deaggregate it using other tx in its mempool.

Anti-aggregation mechanism for multi-kernel t  
#984

Merged quentinlesceller merged 15 commits into mimblewimble:master from quentinlesceller

Conversation 16 Commits 15 Checks 0 Files changed 5



quentinlesceller commented on 19 Apr • edited

Fix #799.

This PR adds an anti-aggregation mechanism in Grin.  
The following function where implemented:

- `aggregate_with_cut_through` aggregate multiple tx in one big tx with cut-through
- `aggregate` which aggregates without cut-through (used internally for deaggregation)
- `PartialEq` for transaction for faster testing
- `deaggregate` based on a set of transaction, this function is capable to deaggregate transaction as much as possible.
- `deaggregate_and_add_to_mempool`.

Whenever we receive a multi kernel transaction, we first try to deaggregate it.

- If we are able to deaggregate it, we add the subset in our memory pool.
- If we are not able to deaggregate it, we add the transaction as is in our memory pool.

One step closer to stempool aggregation :).



# Implementing Transaction Aggregation in Grin

Implemented in Grin end of May.

PR #1067

Integrated since testnet2 release.

## Minimal Transaction Pool #1067

**Merged** antiochp merged 65 commits into [mablewible:master](#) from [antiochp:minimal\\_tx\\_pool](#) on 30 May

Conversation 49 Commits 65 Checks 0 Files changed 61



antiochp commented on 15 May • edited •

Member

+ (smiley) (edit) (flag)

This is still very early - but wanted to push this up to get feedback before going any further on this.

The existing tx pool impl is pretty large (~2000 lines of code) and relatively complex. This PR proposes an alternative solution - leveraging our `txhashset` to check if we can add a new tx to the pool (as an alternative to building and maintaining the "directed acyclic graph" of inputs/outputs in the existing impl).

Basically - if aggregate new tx and the existing tx pool together we can check via a readonly txhashset extension is we can successfully add this single aggregated tx to the current chain state via the extension.

This covers all the usual checks -

- attempting to spend non-existent outputs
- attempting to "double spend" outputs
- coinbase maturity checks

But - we can leverage all our existing txhashset code to do all these checks, in the *exact same way* we do when applying new blocks to the chain.

Possible downsides -

- Is this slower? How much slower?
- Reconciling new blocks against the pool - we lose some of the benefits of the DAG here, when calculating which txs are still compatible with the more recent chain state and which txs must be evicted from the pool.

Not yet implemented -



# Implementing Transaction Aggregation in Grin



Node sends a transaction on the network, it's directly broadcasted to the next Dandelion relay as stem transaction.



The Dandelion relay waits a period of time (the patience timer), in order to get more stem transactions to aggregate.



At the end of the timer, the relay does a coin flip for each new stem transaction and determines if it will stem it (send to the next Dandelion relay) or fluff it (broadcast normally).

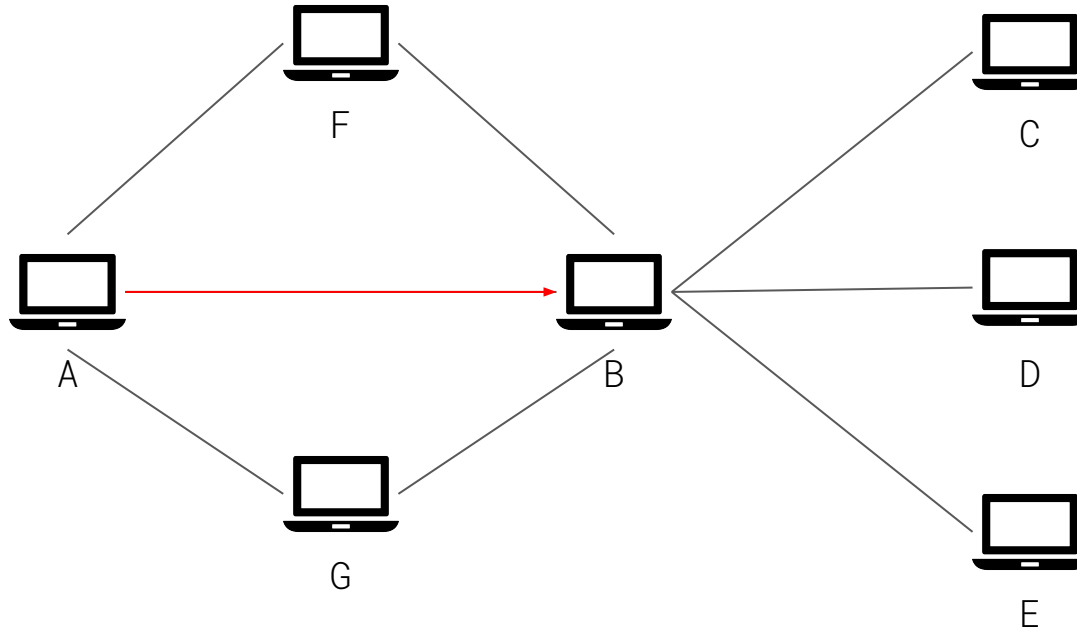


Then the relay will take all the transactions to stem, aggregate them, and broadcast them to the next Dandelion relay. Same for the transactions to fluff, except that it will broadcast the aggregated transactions “normally” (to a random subset of the peers).



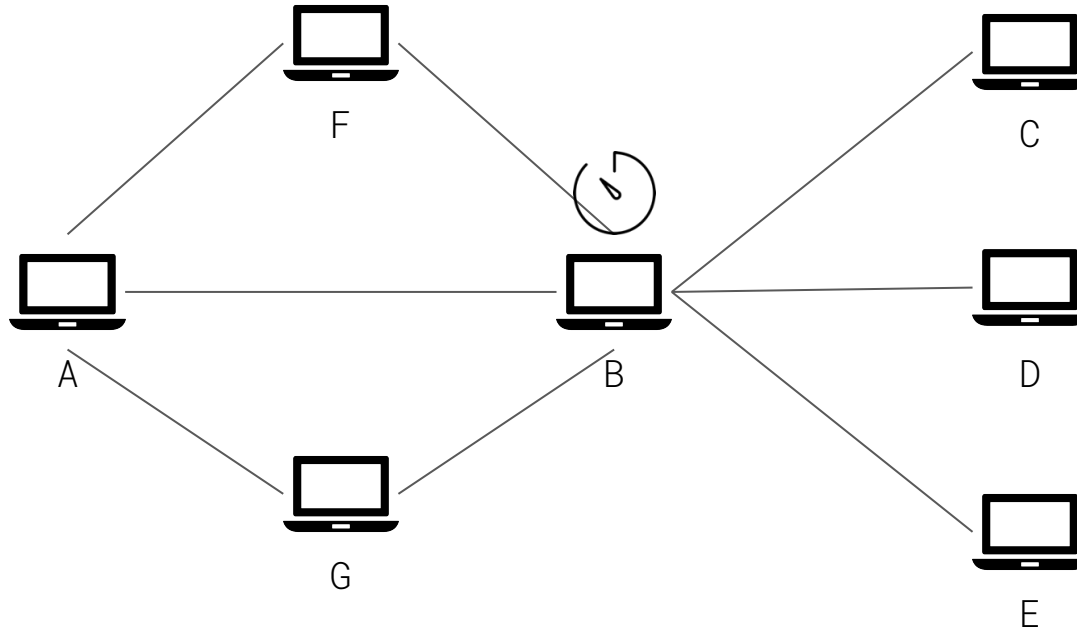
# Grin Dandelion: Step-by-Step

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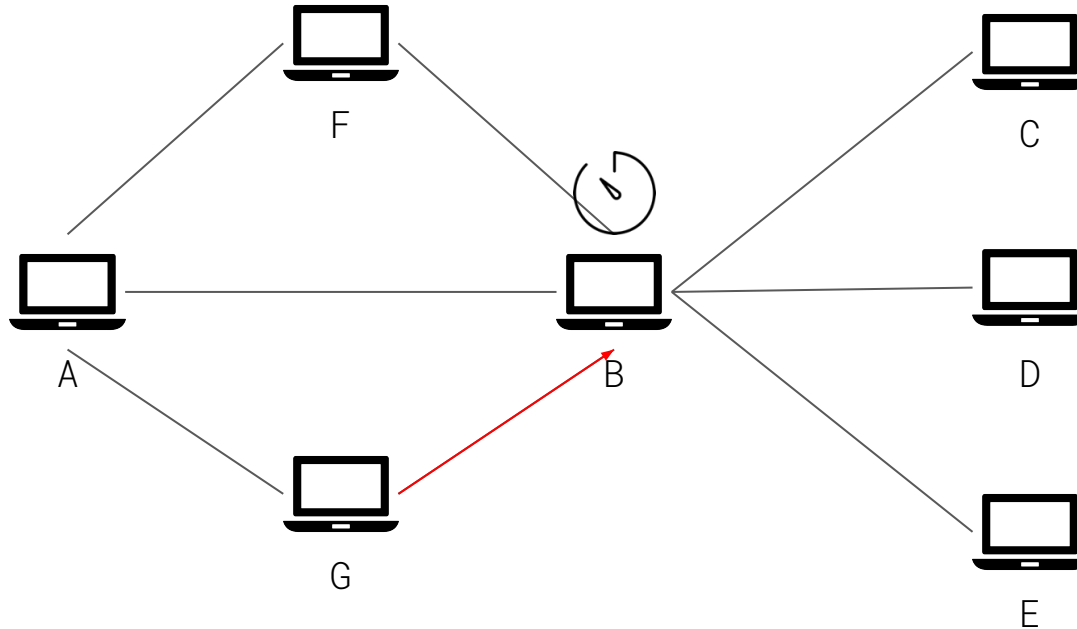
# Grin Dandelion: Step-by-Step

Step 2: B waits



# Grin Dandelion: Step-by-Step

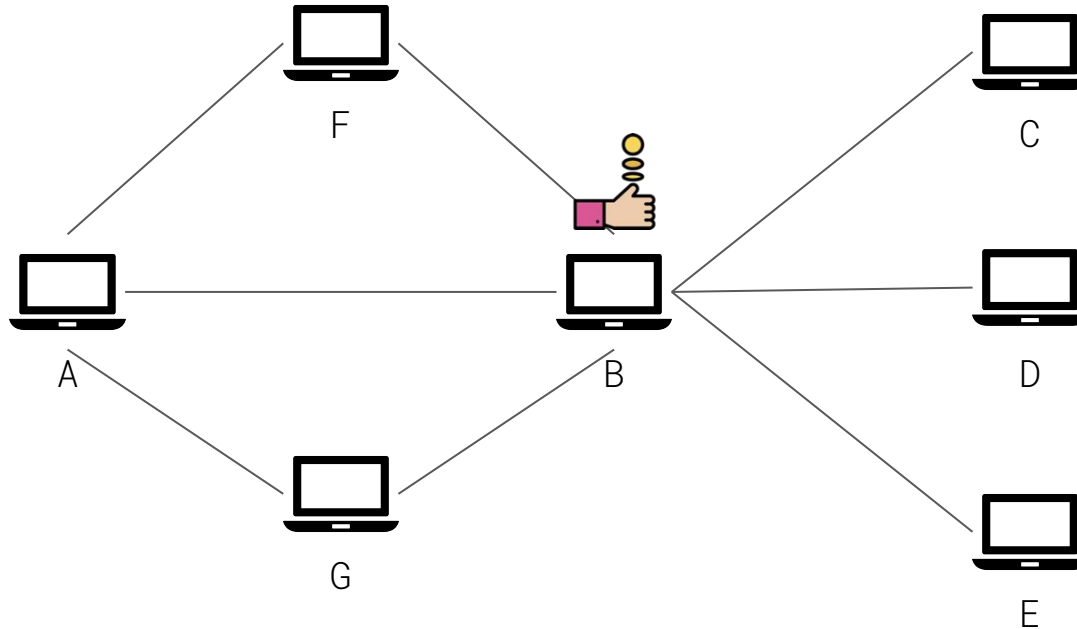
Step 2: B waits





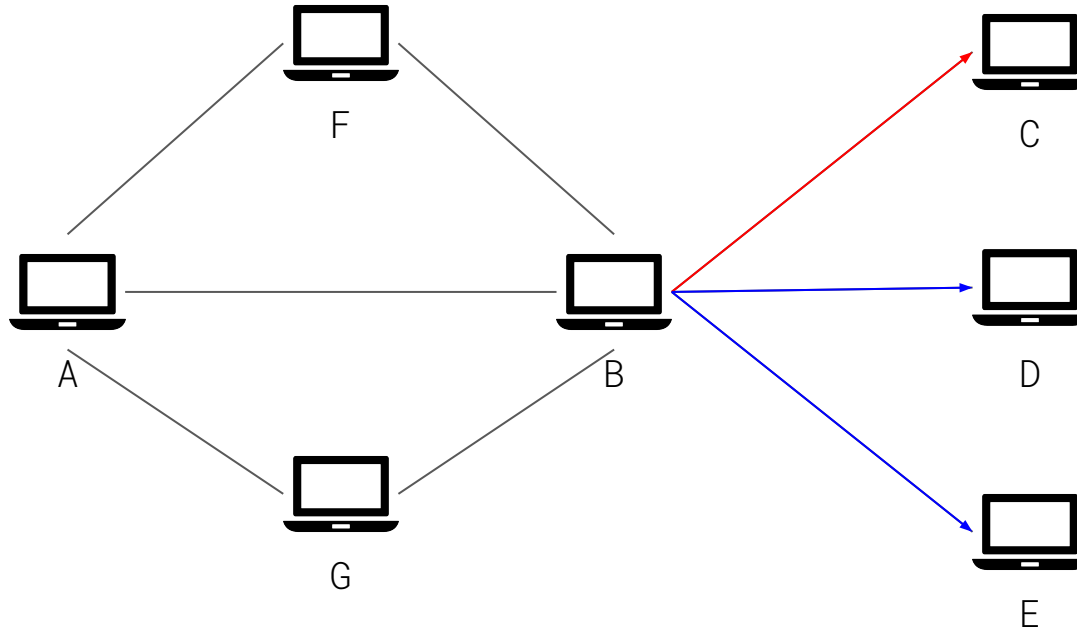
# Grin Dandelion: Step-by-Step

Step 3: B does a coin flip for each new stem transaction and marks them as "To Stem" or "To Fluff"



# Grin Dandelion: Step-by-Step

Step 4: B broadcast aggregated transactions



# Current challenges and future work

- Hard to simulate a whole network
- Quantify how many “natural” aggregations happens on the network
- Test our parameters



# References

- <https://github.com/mimblewimble/grin> - Code Repository
- <https://www.grin-forum.org> - Forum and Links to Resources
- [https://gitter.im/grin\\_community/](https://gitter.im/grin_community/) - Public and Dev Chat
- <https://github.com/gfanti/bips/blob/master/bip-dandelion.mediawiki> - Dandelion BIP
- <https://github.com/mimblewimble/grin/pull/719> - Initial Implementation of Dandelion protocol in Grin
- <https://github.com/mimblewimble/grin/pull/1023> - Work-in-progress implementation of the aggregation in Grin
- <https://github.com/mimblewimble/grin/pull/1067> - Minimal Transaction Pool
- A. Biryukov, D. Khovratovich, and I. Pustogarov. Deanonymisation of clients in bitcoin p2p network. In Proceedings of the 2014 ACM SIGSAC Conference on Computer and Communications Security, pages 15–29. ACM, 2014.
- G. C. Fanti, S. B. Venkatakrishnan, S. Bakshi, B. Denby, S. Bhargava, A. Miller, and P. Viswanath. Dandelion++: Lightweight Cryptocurrency Networking with Formal Anonymity Guarantees. Proceedings of the ACM on Measurement and Analysis of Computing Systems, 2(2):29:1–29:35, June 2018.
- Benedikt Bünz, Jonathan Bootle, Dan Boneh, Andrew Poelstra, Pieter Wuille, and Greg Maxwell. Bulletproofs: Efficient range proofs for confidential transactions. Cryptology ePrint Archive, Report 2017/1066, 2017. <https://eprint.iacr.org/2017/1066>.
- Ruffing, T., & Malavolta, G. (2017, April). Switch Commitments: A Safety Switch for Confidential Transactions. In International Conference on Financial Cryptography and Data Security (pp. 170–181). Springer, Cham.





<https://grin-tech.org>