

IBLT and weak block propagation performance



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Invertible Bloom Lookup Tables (IBLT)

- Credit Gavin Andresen

- Based on the work of Michael T. Goodrich and Michael Mitzenmacher

- <http://arxiv.org/abs/1101.2245>

- Allows efficient reconciliation of similar sets

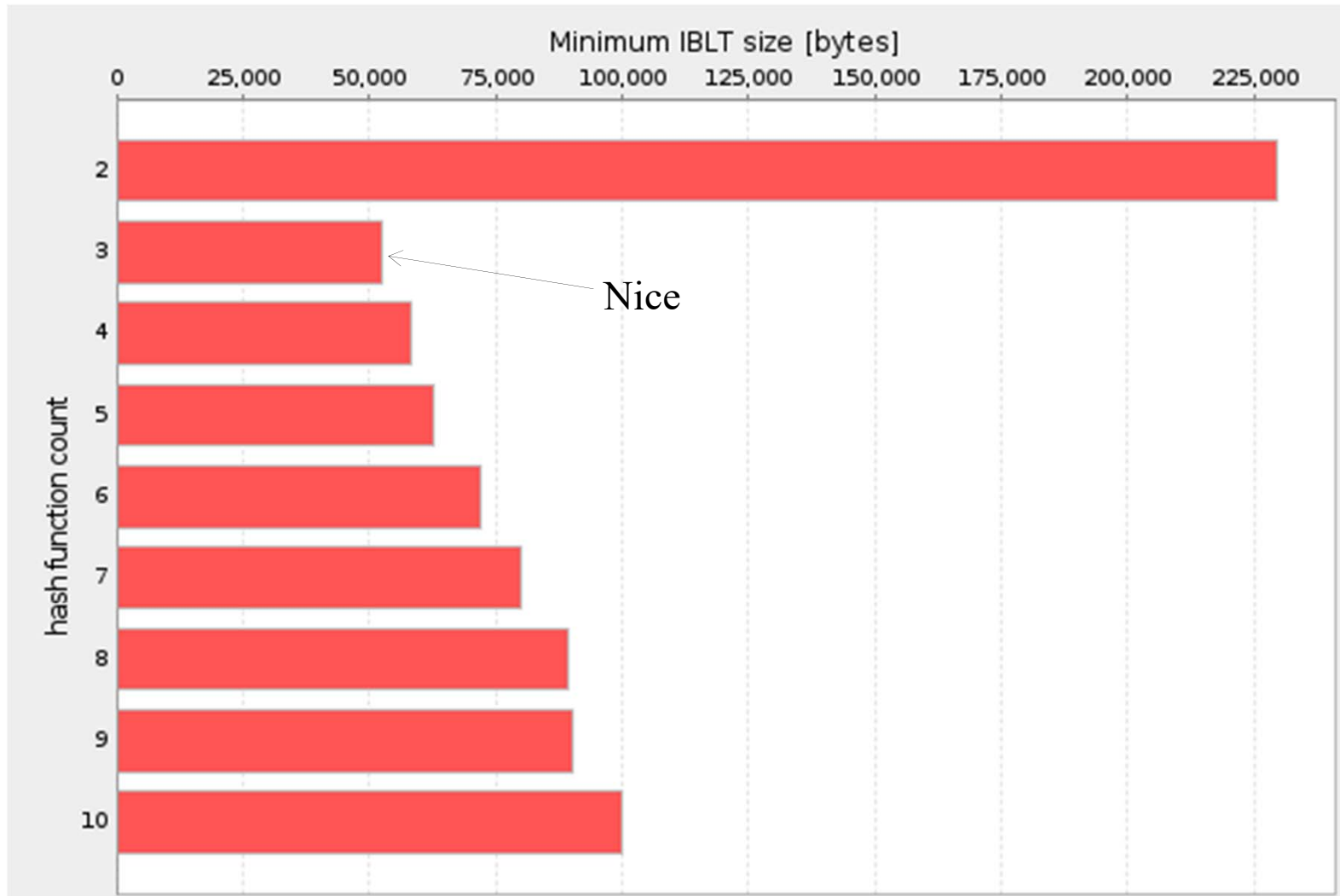
- Great if block is similar to mempool

IBLT

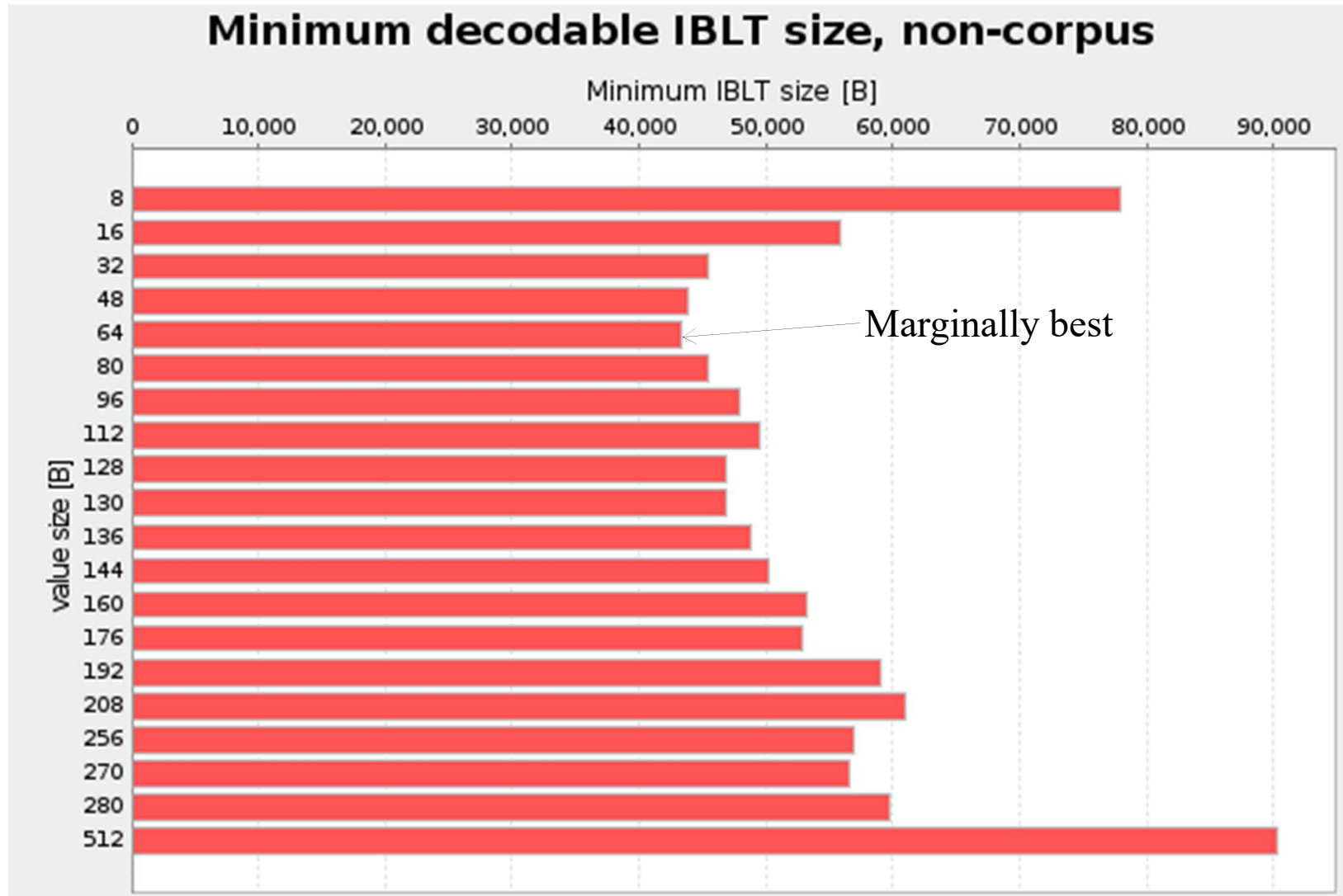
IBLT parameters

- Number of hash functions?
- Value size, 8B? 64B? 128B?
 - Bigger values → More waste
 - Smaller values → More cell overhead

IBLT hash functions



Value size, we like 64 bytes



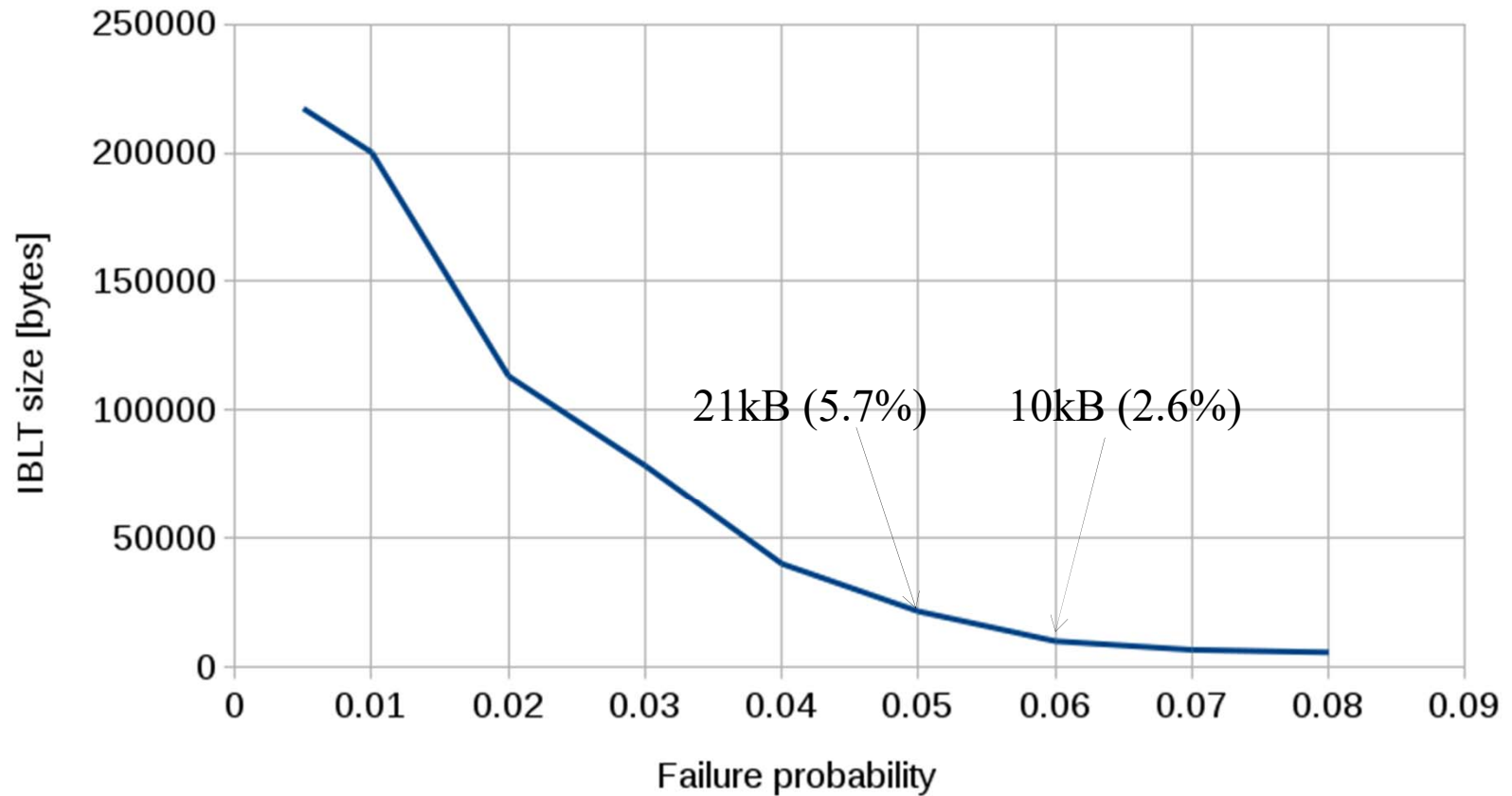
Real data?

- Bitcoin-corpus covers 721 blocks from 4 nodes
- Average block size 381891
- Focus (randomly) on Australian node
- How small can we make the IBLT?

Result for Australia

Failure probability vs IBLT size

Corpus data Australia

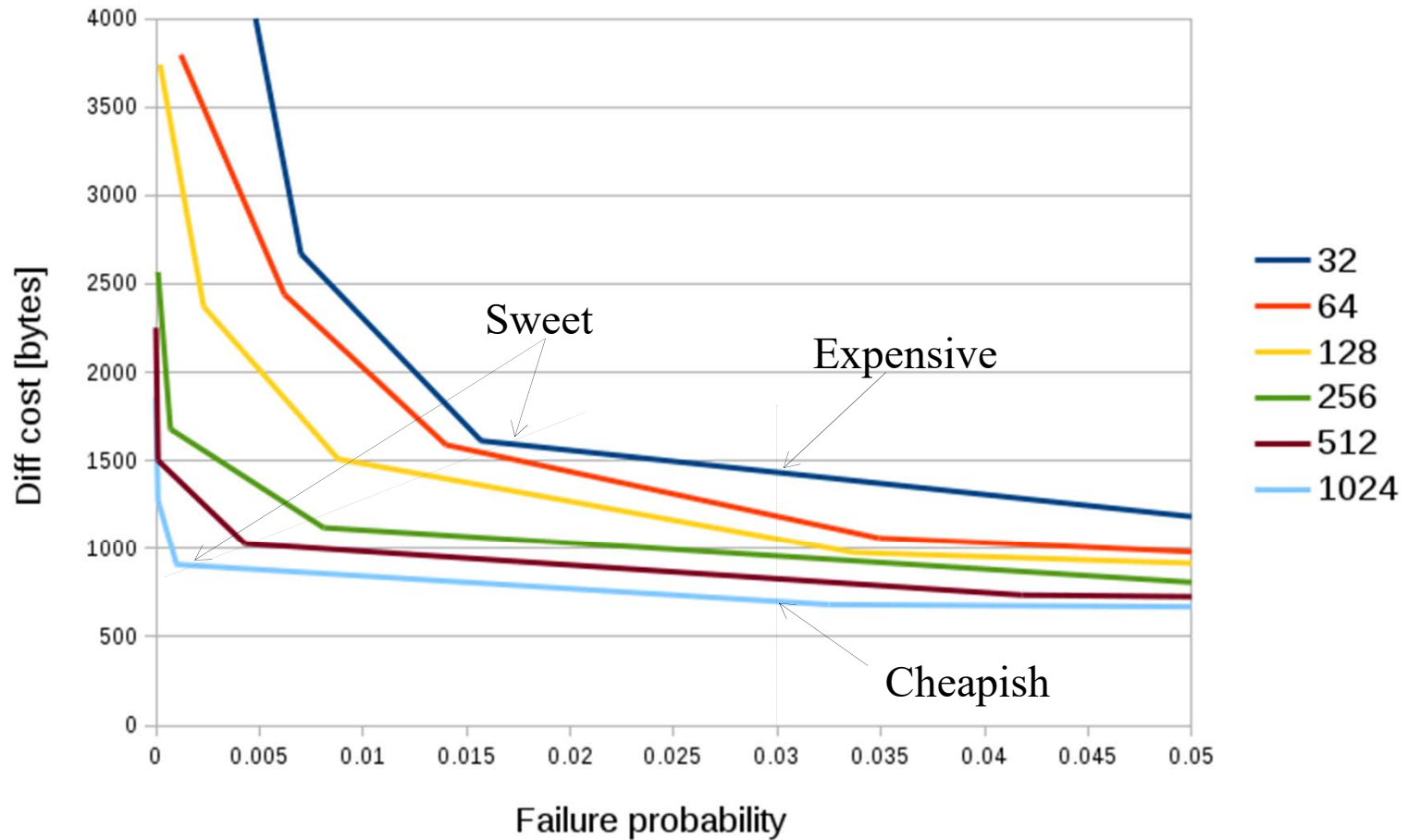


Scaling

- What happens when differences increase?
- Measure failure probability for increasing differences.
 - Select diffs randomly
 - Select IBLT size
 - Encode/decode many times to measure failure probability

Cost per diff

Failure probability vs Diff cost for 32-1024 diffs



Example

- Assumptions

- Diffs increase linearly with tx rate

- Open question: How do differences change with transaction rate?

- Block size increase linearly with tx rate

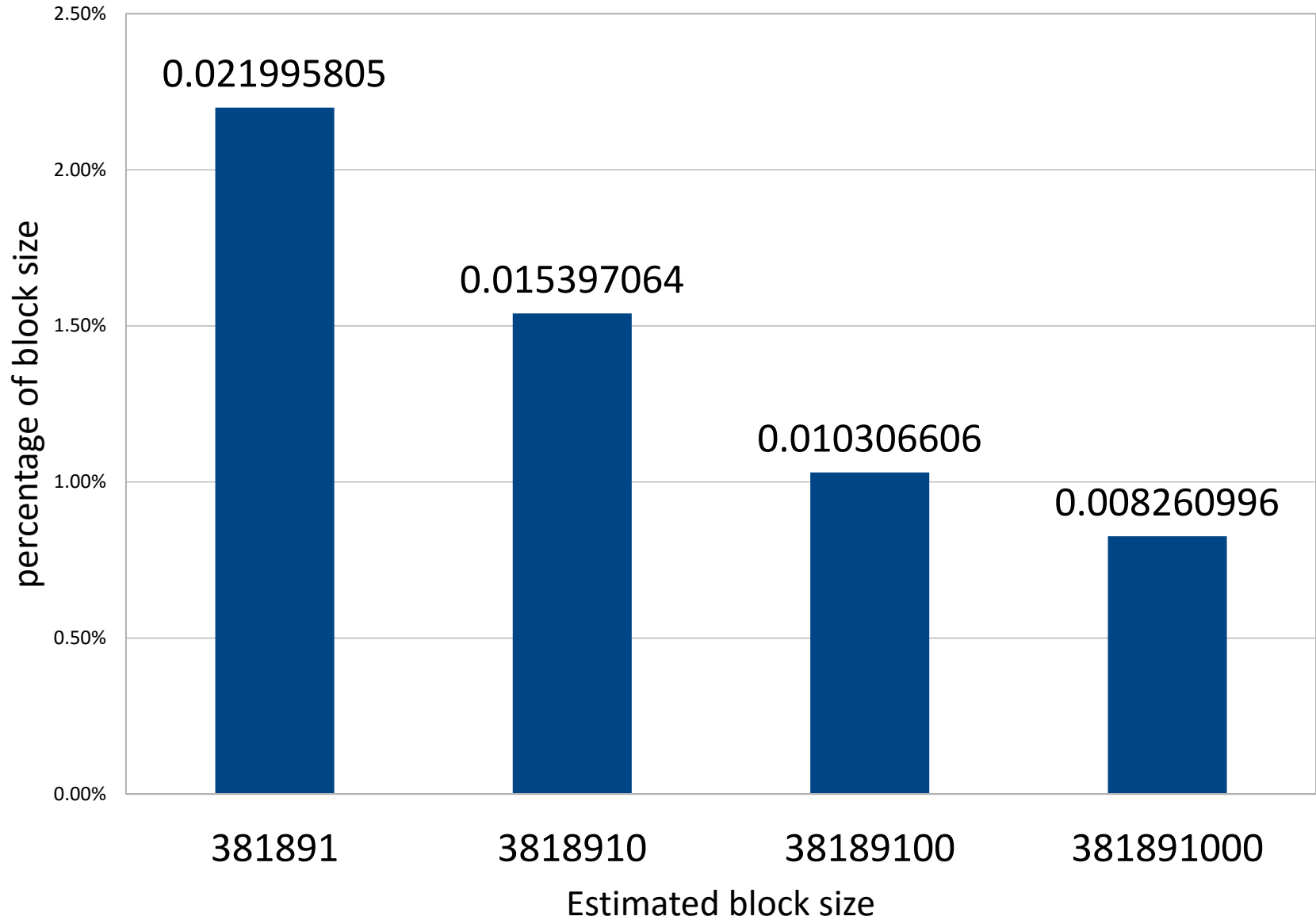
- Corpus average 6 diffs

- Increase tx rate by factor 10, 100 and 1000

- Target 5% failure probability

Example

5% failure probability target



So far we've...

- tested fixed sized IBLTs on bitcoin-corpus. **21KB (5.7%)**.
- examined the scaling properties of IBLTs. **The bigger, the better.**

Bitcoin IBLT Protocol

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 Transaction which occurs in block

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■ Transaction which occurs in block

Node 1 remembers how different the incoming block was from its mempool (assuming it will be similar for peers)

Bitcoin IBLT Protocol

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IBLT Protocol: Dynamic Sizing

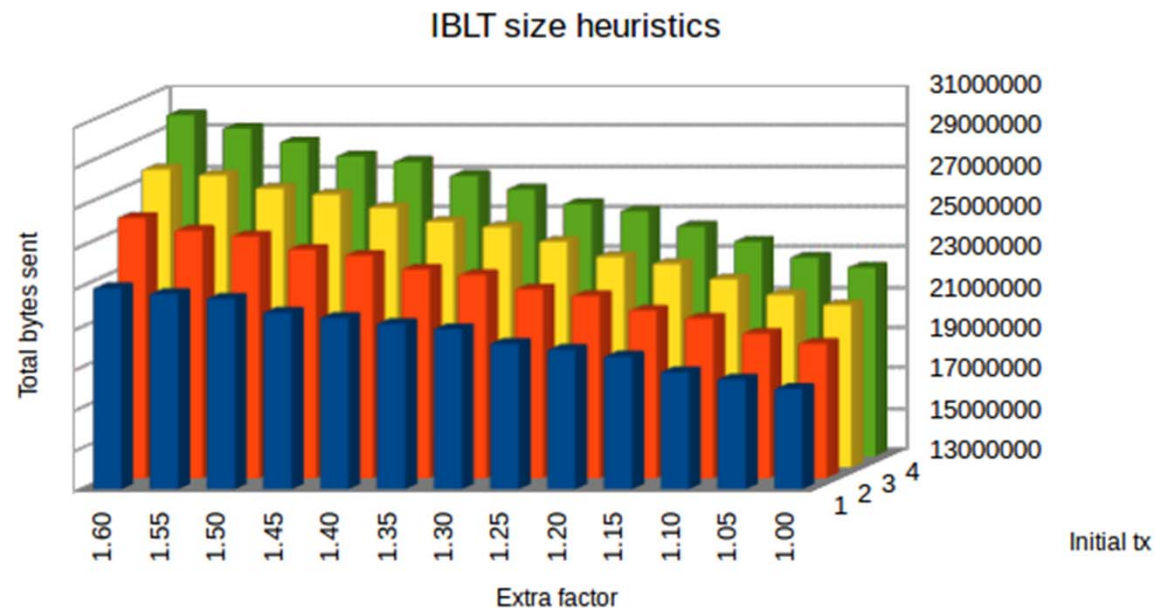
- How do we choose IBLT size?
 - Mempools tend to be very similar.
- Assume receiver's mempool about as different from block as ours was.
 - Add some extra to cover differences...

Dynamic Estimate Extra Factors

- Fixed factor (eg. assume an extra 2 txs to reconstruct)
- Variable factor (multiply total slices)

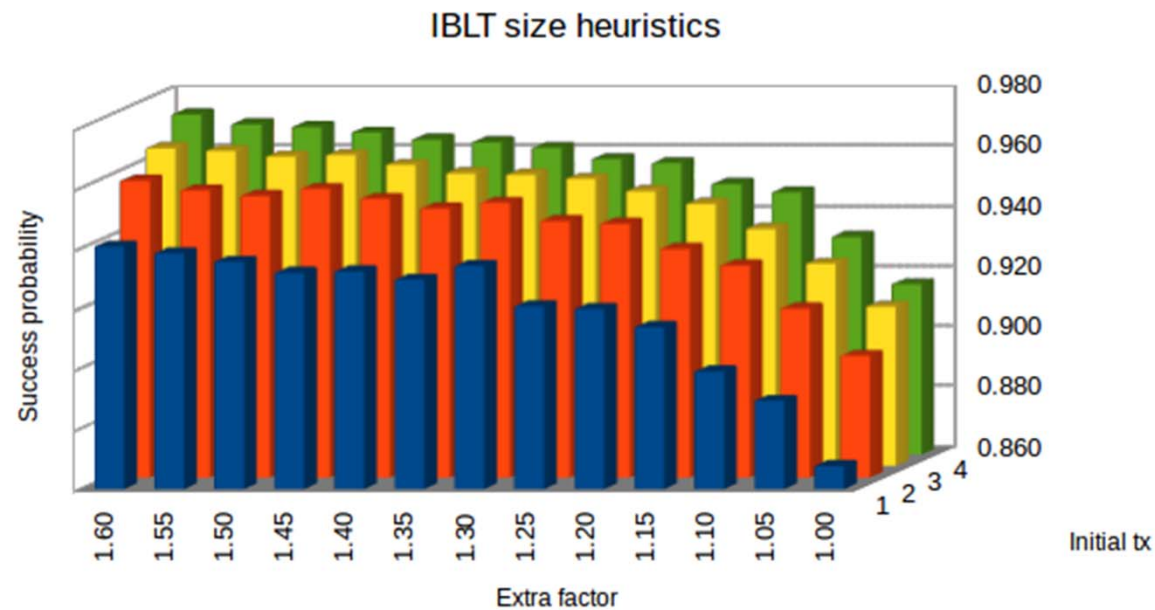
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Dynamic Estimate Extra Factors

- Fixed factor (eg. assume an extra 2 txs to reconstruct):
+10 slices
- Variable factor (multiply total slices): **x1.35**

IBLT Corpus Performance

- Across our 825 MB corpus:
 - 20 MB transmitted (95% reconstructed)
 - 4% of blocks sent “raw”

Weak Blocks

aka. Near Blocks

Weak Blocks

- Miners broadcast “not quite good enough” blocks.
 - eg. within 20x required difficulty.
- Naturally ratelimited
- Offers (provable!) insight into miner mempools
- All blocks can be simply encoded in terms of previous weak blocks.**

Weak Blocks

Weak Blocks

Simple 2-byte encoding:

18,1,3,8,12,-1,14,0,10,-1,20,11,13,4,19,9,-1,-1,
5,16,-1,2,7,-1,-1,-1,-1

<tx1><tx2><tx3><tx4><tx5>...<tx10>

Weak Blocks Simulation

- Take corpus, randomly generate weak block from (best paying) txs in mempool approximately every 30s.
- Assume these weak blocks instantly transmitted to other nodes.
- First node to see a block calculates encoding to other nodes vs. last known weak block (if any)

Weak Blocks Simulation

- Raw blocks: 825MB
- Strong blocks using 30-second weak blocks:
 - 35MB (+/- 3MB)
 - **Total size increases to 1.51GB though!**

Super Weak Blocks?

- If blocks are full, we want the first weak block as soon as possible.

Super Weak Blocks?

- If blocks are full, we want the first weak block as soon as possible.
- 16x super-weak first* blocks:
 - 27MB (+/- 1.7MB)
 - (Total size increases to 1.53GB)
 -

*Handwave: define first!

Weak Blocks Simulation

- Note that we've seen that real blocks diverge much more than bitcoin-corpus peers!
 - **Expect worse compression in practice.**

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IBLT + Weak Blocks?

- Raw blocks: 825 MB
- IBLT: 20 MB (95% recovery)
- Weak blocks: 27 MB / 1530 MB total
- Together: 15 MB (98%) / 233 MB (65%) total
 - Or 434MB and 86% (fixed 133 buckets)
 - Or 804MB and 96% (fixed 400 buckets)

Deployment

•New block transmission message:

– [prev-weak-block][references][rawtxs][ibltseed][fee-hint][added-set][removed-set][iblt-size][iblt-buckets][ordering-info]

Deployment: Weak Blocks

- Start with weak block threshold $1/10000$ difficulty
 - Ratchet up to $1/20$ as we see stronger weak blocks.

Future

- Canonical fee-per-byte ordering?
 - Much better for IBLT and weak block encoding.
- Coinbase encoding
 - Incentive to publish weak blocks (save 500 bytes)
- Block blast
 - Over half encodings give block < 3k.
- IBLT Mempool Sync
 - gmaxwell, may save ~70 bytes per tx per peer.

Questions?