mas.s62
lecture 11
fees

2018-03-14

Tadge Dryja

schedule stuff

happy π day

pset03 is out, delayed due to snow

office hours today instead

pset03 due wed 21st

today

pset3 description

fees

CPFP / RBF

long term incentives

pset03

grab utxos

install bitcoind, sync to testnet3

build transactions in code, submit to network

Block explorers aren't cheating. But they're also not as fun.

pset03

try to get familiar with bitcoin-cli

use any scripting you like (bash, python, go, node -- or anything that can talk to bitcoind's rpc)

I will add more utxos to grab in the next few days

transaction fees

difference between sum of input amounts and sum of output amounts

implicit; not encoded in the transaction

paid to whoever mines the block containing that tx

transaction fees

fee rate expressed in "satoshis per byte", one satoshi being 0.00000001

prioritize based on tx size as space is limited

unrelated to amount transferred; fee is "flat"

fee market

fee rate set by transaction signer

txs chosen by miners

auction process

bid for space in future blocks

miner side

sort mempool txs by fee rate

choose the top ~1MB

compute merkle root, mine

miner side

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choose the top ~1MB

compute merkle root, mine

but not that simple... why?

miner side - CPFP

tx dependencies make this into a much harder optimization problem

txs can depend on others

a "cheap" tx which allows a "expensive" tx to also be confirmed is called "child pays for parent"

transactor side

want to minimize fees

set to 1 sat / byte, sign and send

... easy right?

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set to 1 sat / byte, sign and send

... easy right?

it doesn't confirm!

transactor side

poor user experience

wallets with fixed fee per tx

fixed fee rates

user chooses fee rates (I dunno!)

low fee, outbid by other users

transactor side

many wallets are "stuck" once tx is sent, can't increase fee

child pays for parent - send a tx to yourself with high fee

CPFP downsides

inefficient - extra tx

exacerbates problem it's trying to solve! wastes space dealing with lack of space

dependency graphs are complex

replace by fee

double spend the tx with higher fee (lower change output)

simple, right?

replace by fee

double spend the tx with higher fee (lower change output)

simple, right?

default relay behavior is ignore double spends

(defined as any conflicting tx)

replace by fee

relay conflicting txs

require increase in fee; do not relay txs with same or lower fee

(why?)

replace by fee

relay conflicting txs

require increase in fee; do not relay txs with same or lower fee

DoS attack: make lots of conflicting txs with same fee, flood network

RBF controversy

hurts security of unconfirmed txs

could contact miners directly, but some effort to double spend if all nodes go with first-seen tx

RBF make double spends much easier (that's the point)

RBF controversy

0-conf txs have no security anyway; that's the point of the blockchain

UI issue: show unconfirmed tx?

show unconfirmed tx in SPV?

connect to multiple nodes?

RBF compromise

"opt in" RBF. Flag in the tx (input sequence number) to indicate RBF

IMHO: ugly code. Can't even tell what RBF policy nodes have

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inter mission

0x7f sec

fees in practice

highly variable!

very hard to predict!

further research needed

my favorite: locktime & RBF ramp

fees in practice

exchanges overpay

bitcoind wallet overpays

nobody cared for 7 years

gas price goes up, hummer -> prius

long term incentive

mining reward drops in half every 210000 blocks

eventually all coins mined (100 y)

rewards become negligible sooner than you might think!

long term incentive

no new coins to mine...

why mine?

long term incentive

no new coins to mine...

why mine?

tx fees

long term incentive

problem with tx fee only incentive:

tx fees are variable

without a backlog, fees are near 0

0 fees = no incentive to mine

miners stop

miner "attacks"

you're a miner

no fees in mempool, no reward

turn off your chips, turn back on once the mempool fills up

miner "attacks"

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no fees in mempool, no reward

turn off your chips, turn back on once the mempool fills up

or...?

miner "attacks"

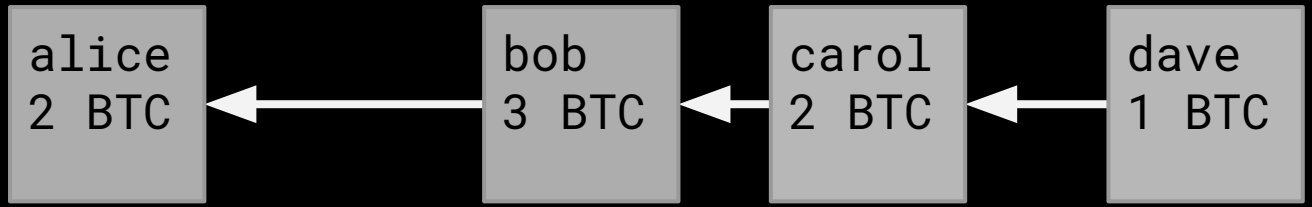
that last block had a couple coins in fees

re-mine it yourself!

if you find another (maybe empty) block on top, you take the fees!

miner "attacks"

instead of sequentially building the chain, miners keep fighting over the same block height



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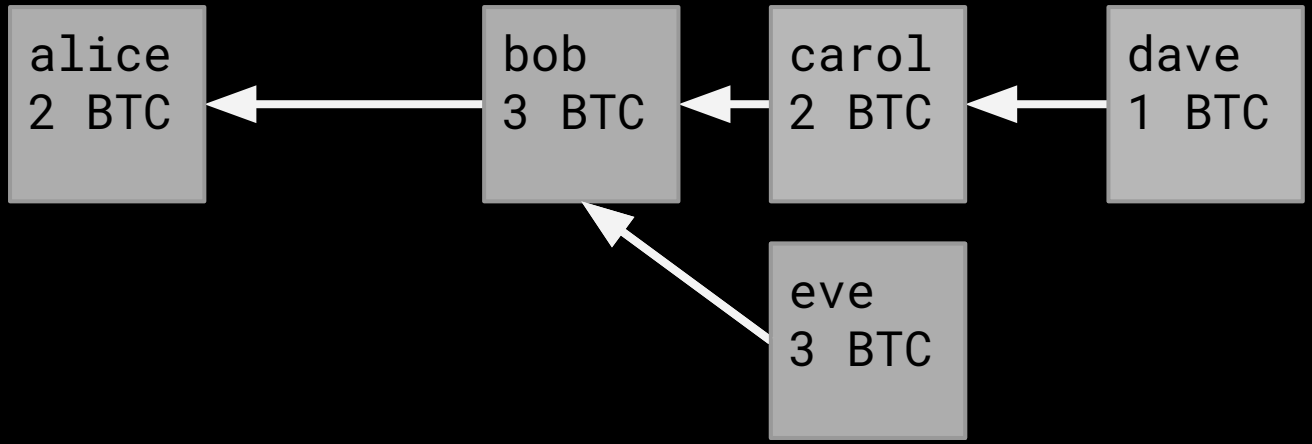

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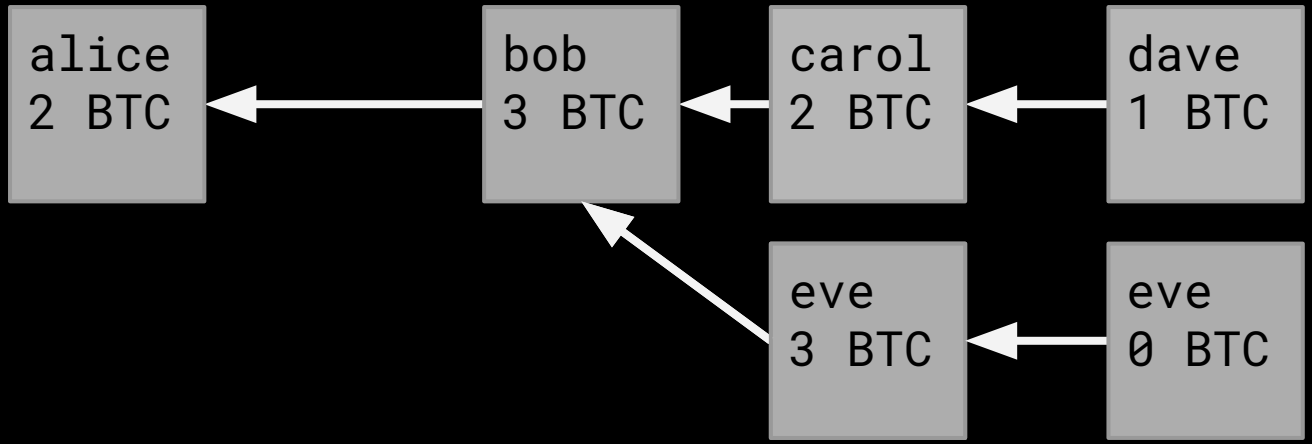

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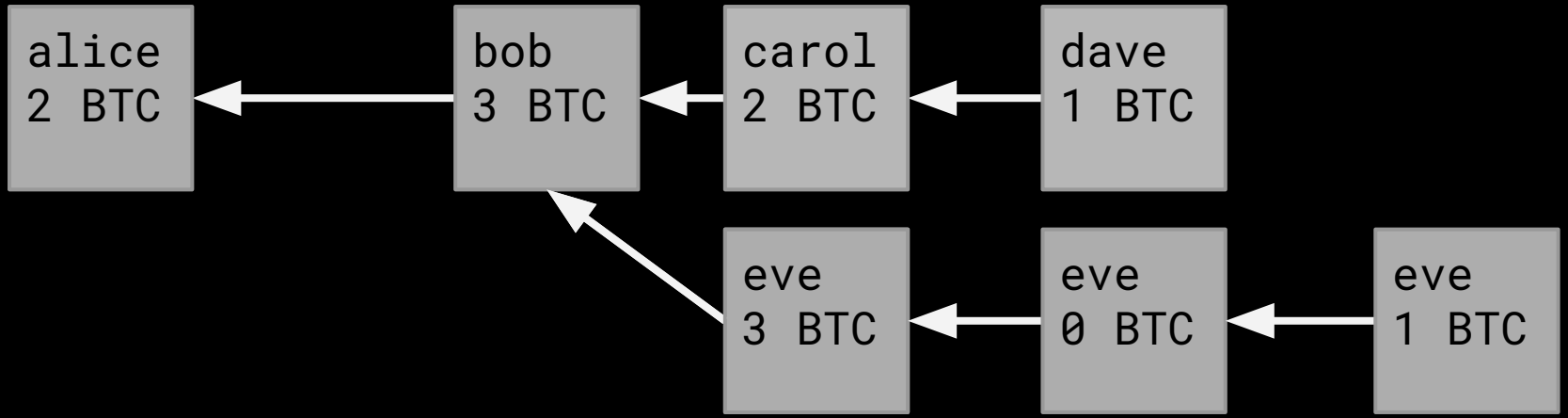

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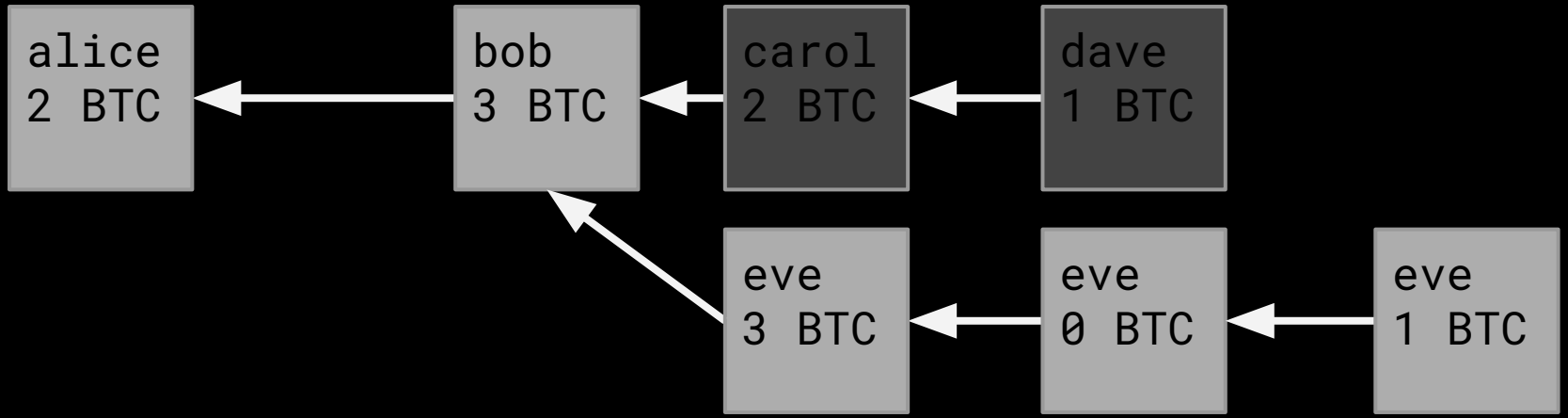

miner "attacks"

is this even an attack?

they're just trying to get paid

not a problem if low reward variance

which means... backlog

scalability balance

tx rate in Bitcoin, other systems

tradeoff:

too small -> few can have utxos, own their private keys

too large -> few can validate utxo set, verify rules

scalability balance

fee sniping / reorg is not harware related. Happens with arbitrarily powerful computers / networks

too large -> constant reorg races

largest miner wins (no longer memoryless)

dawn of the fee

we're just starting to understand fee markets

seems highly inelastic

people wasting millions of dollars

fun research area!

hope this works!