mas.s62
lecture 12
txid malleability and segregated witness

2018-03-19

Tadge Dryja

schedule stuff

hope people were able to attend the expo, it was fun

office hours tomorrow

pset03 due wed 21st

today

tx malleability

segregated witness

I'm endoring an ICO -

Anne's intermittent cookie offering

malleability

ability to deform under pressure

bitcoin is modeled after gold, which is the most malleable metal; thus bitcoin is a highly malleable system

malleability

actually, it's when adversaries can modify ciphertexts, messages, signatures, etc and things still 'work'

In the case of bitcoin, transactions can be changed and still be valid!

tx asymmetry

recall the tx format; inputs and outputs don't look the same

txid:index (36B) signature (100B)	script (25B) amount (8B)
txid:index signature	script (pubkey) amount

what gets signed

sign the whole transaction, inputs and outputs

But inputs contain signatures

and you can't sign the signature

what gets signed

remove the signature fields, sign, then put signatures in

change any bit of the signed message, and the signature is invalid

what gets signed

remove the signature fields, sign, then put signatures in

change any bit of the signed message, and the signature is invalid

but txid is the hash of the message, including signatures

signature malleability

3rd party malleability

leading zeros

"low s" can flip the sign of the signature and it's still valid

signature malleability

1st party

recall signing uses a nonce k

use a different k, different signature on the same message

RFC6979 defines deterministic k algo, but not detectable by observers

so you've been malleated

txid changes

outputs are still the same

which inputs also still the same

so no big deal?

so you've been malleated

in most cases, some wallets have trouble

broadcast tx 2d5cac, which never got confirmed

Instead malleated to 9cba3e

Wallet shows unconfirmed forever

dependent txs

spending unconfirmed change output from tx1 7feec1. Sign and broadcast tx2

tx1 changes to b2068c!

tx2 invalid, refers to txid which can never be confirmed

dependent txs

txid change is annoying but can refer to malleated txids and re-sign

what if you can't re-sign?

dependent txs

txid change is annoying but can refer to malleated txids and re-sign

what if you can't re-sign?

multisig, pre-signed txs

very important in payment channels / lightning network

different ideas

use non-malleable signatures?

lamport signatures were non-malleable

but many useful signature schemes are malleable

different ideas

don't sign your inputs at all!

I really like this idea, allows many fun features

but dangerous: allows signature replays. Sign once, use many

how to fix malleability?

find out!

after intermission

segregated witness

strange name for straightforward idea

Don't include signatures in txids; txs are now defined by input pointers and outputs only

signature changes but txid doesn't

But backwards compatibility...?

soft fork

would have been easier to start out this way

But doable as a soft fork

but how...?

make outputs which don't require signatures

segwit version numbers

output script:

0 <pubkey hash>

sig script:

(nothing)

segwit version numbers

output script:

0 <pubkey hash>

sig script:

(nothing)

<pubkey hash> on top of stack; non-zero, coins move!

pubkey hash template

output script:

0 <pubkey hash>

now means pay to pubkey hash

but put the signature somewhere else

the "witness" field, old software never sees

new tx type
old tx format

txid:index (36B) signature (100B)	script (25B) amount (8B)
txid:index signature	script (pubkey) amount

new tx type

new tx format

txid:index (36B) signature (0B) [witness]	script (25B) amount (8B)
txid:index signature [witness]	script (pubkey) amount

omit to old nodes

when people ask for witness txs, include the witness

when they just ask for txs, give it to them without the witness field

omit to old nodes

old nodes: signature can't change; there isn't one!

new nodes: signature can change, but doesn't affect txid

(dis)agreement

new & old nodes agree on outputs, and which inputs get spent

just don't agree on how they got spent

also don't agree on..?

(dis)agreement

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also don't agree on..?

hint: biggest argument, from 2010...

(dis)agreement

new & old nodes agree on outputs, and which inputs get spent

just don't agree on how they got spent

also don't agree on..?

transaction size! (in bytes)

size (dis)agreement

old nodes don't see witness field; the 100+ bytes of pubkey / signature aren't there

those bytes don't count towards the 1M block size limit

-> block size increase soft fork

witness discount

to prevent spamming new nodes, witness bytes still count: ¼ a regular byte

(in new software, multiply non-witness bytes by 4 and count max block size as 4M)

end result: ~80% more txs / block

commit signatures

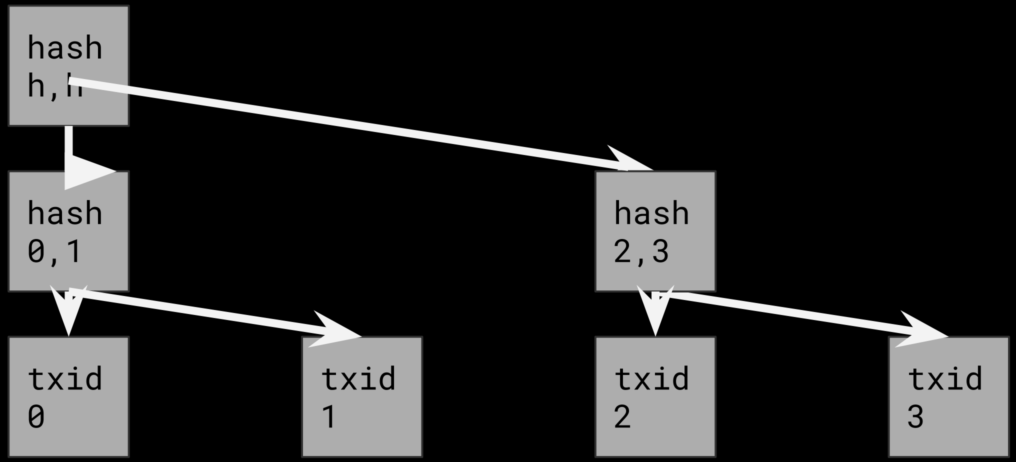
if signatures aren't in txid, they aren't in the merkle root

agree on utxo set, disagree on signature data

weird! disagreement on who signed multisig; bad for accountability

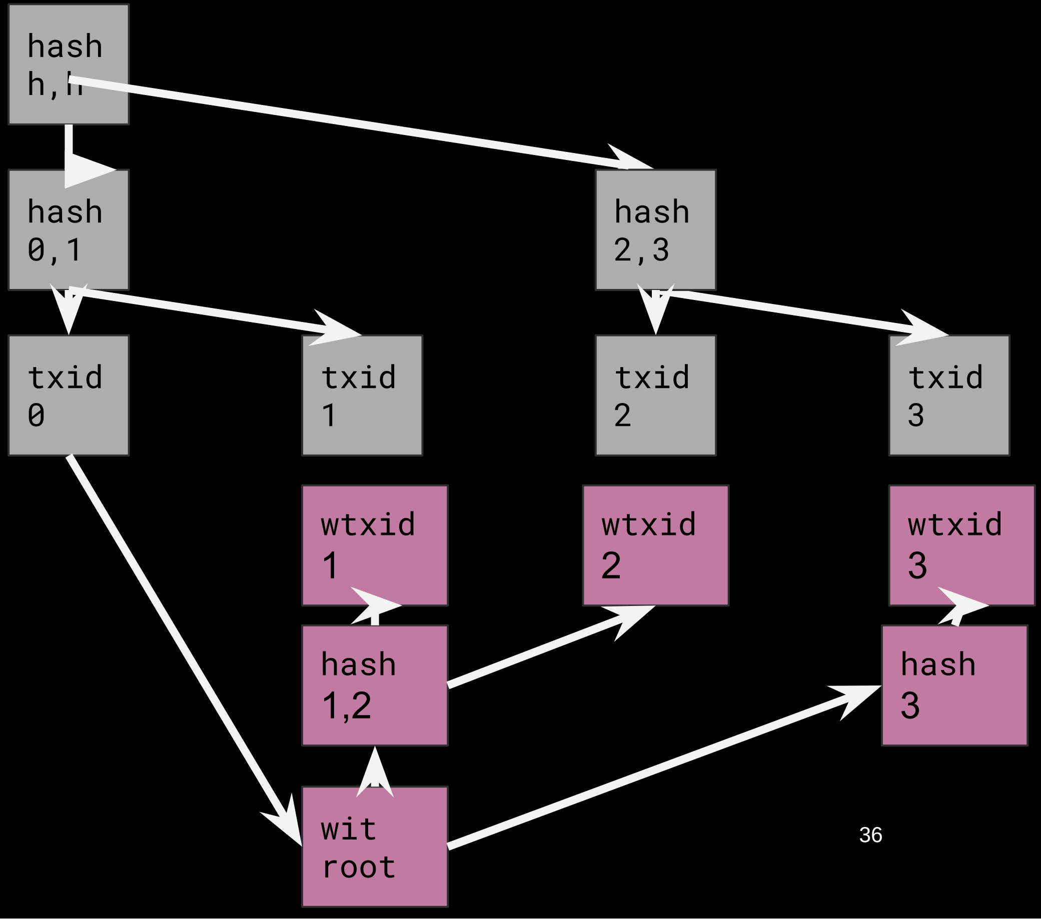
commit signatures

commit to all txids



commit signatures

make witness hash merkle tree; commit to witness root in coinbase tx



upgrade path

output script:

0 <pubkey hash>

now means pay to pubkey hash

1...16 <data>

means... no witness needed (yet!)

upgrade path

16 more versions to upgrade to

currently don't need anything, but new nodes can require new scripts, smart contracts, etc

nicer upgrade with less ugly code

don't send to 2 <pubkey> today!

segwit

fixes malleability, increases block size, does other stuff

some people don't like it

unclear why