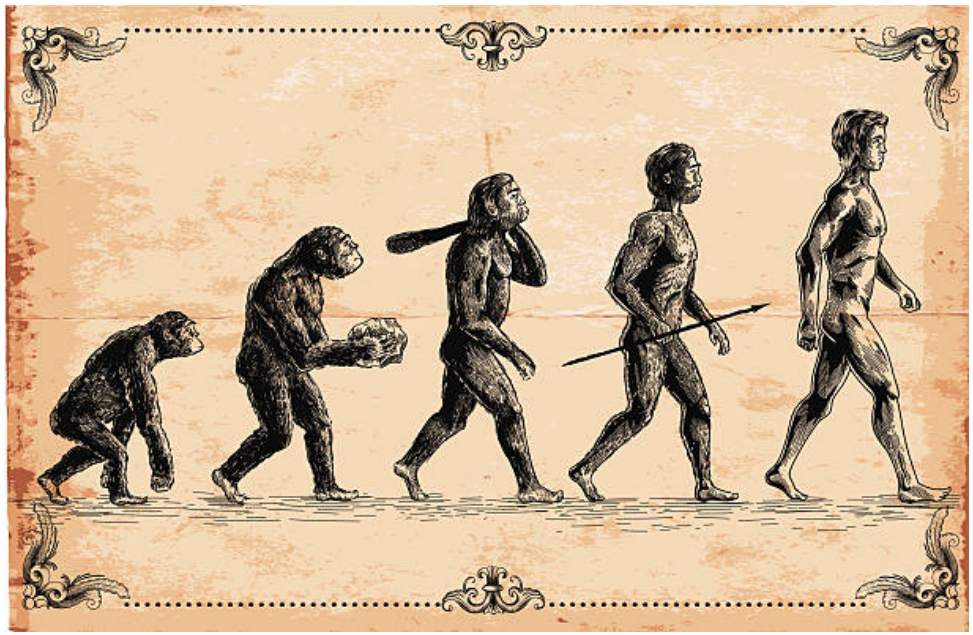
ePBS design evolution

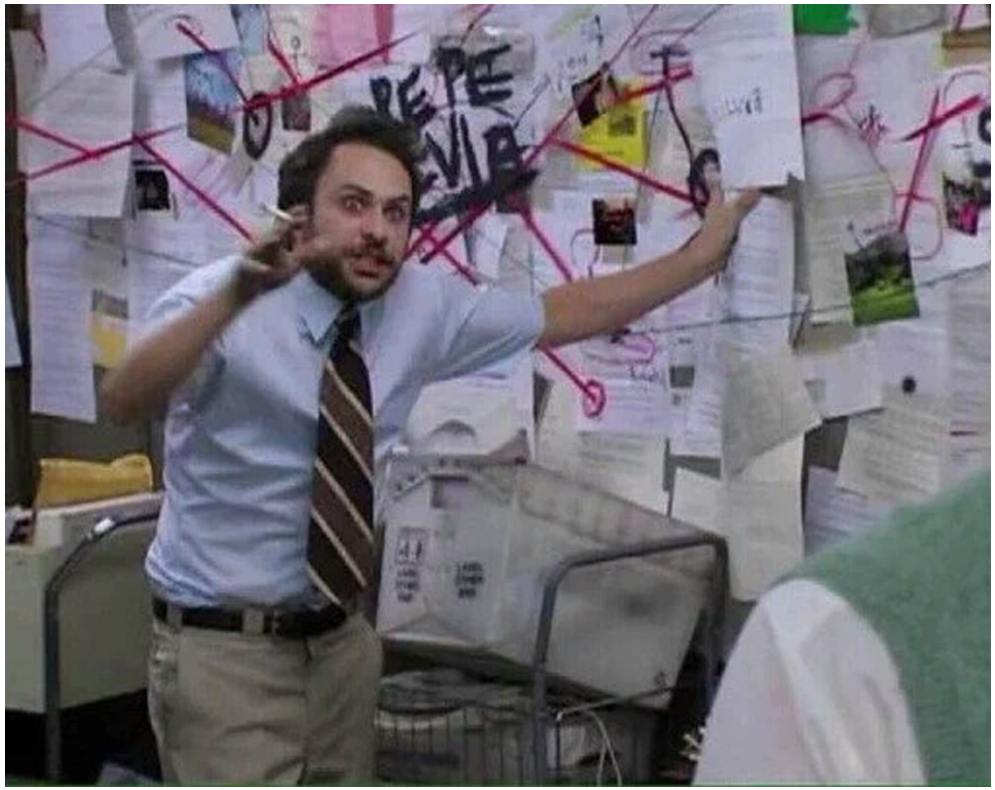


mike neuder – ethereum foundation

pbs.salon – july 17, 2023

Outline

- Desiderata
- Two-slot PBS
  - Sketch
  - Reorgs
- Desiderata pt. II
- Payload Timeliness-Committee
  - Sketch
  - Splitting
- Juxtaposition
  - Sub-slot mechanics
  - Builder fork-choice



Desiderata

https://ethresear.ch/t/why-enshrine-proposer-builder-separation-a-viable-path-to-epbs/15710

Desiderata

- *honest builder publication safety*

https://ethresear.ch/t/why-enshrine-proposer-builder-separation-a-viable-path-to-epbs/15710

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https://ethresear.ch/t/why-enshrine-proposer-builder-separation-a-viable-path-to-epbs/15710

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Desiderata

- *honest builder publication safety*
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- *permissionlessness*

https://ethresear.ch/t/why-enshrine-proposer-builder-separation-a-viable-path-to-epbs/15710

Desiderata

- *honest builder publication safety*
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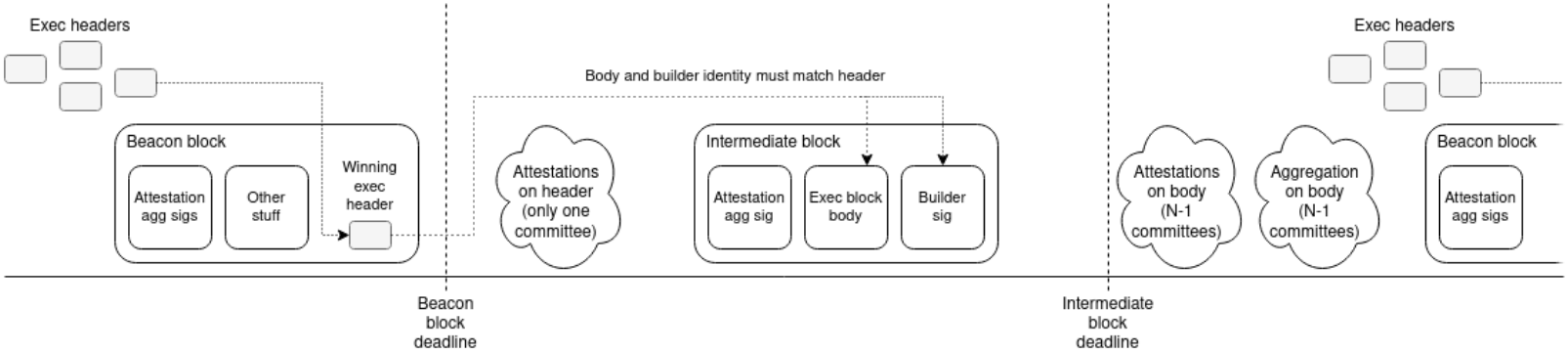
Desiderata

- *honest builder publication safety*
- *honest builder payment safety*
- *honest proposer safety*
- *permissionlessness*
- *censorship resistance*
- *roadmap compatibility*

https://ethresear.ch/t/why-enshrine-proposer-builder-separation-a-viable-path-to-epbs/15710

Two-slot PBS

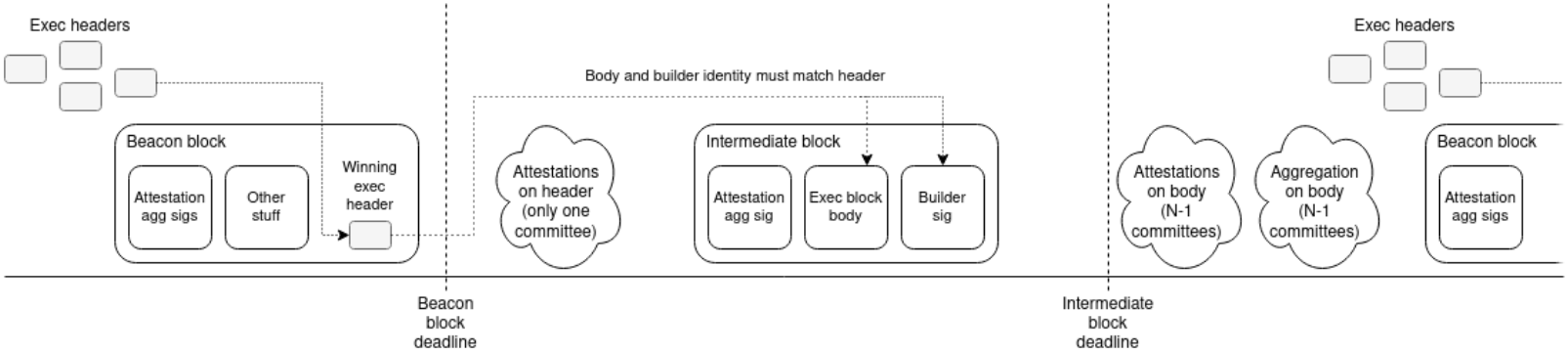
Sketch



https://ethresear.ch/t/two-slot-proposer-builder-separation/10980

Two-slot PBS

Sketch

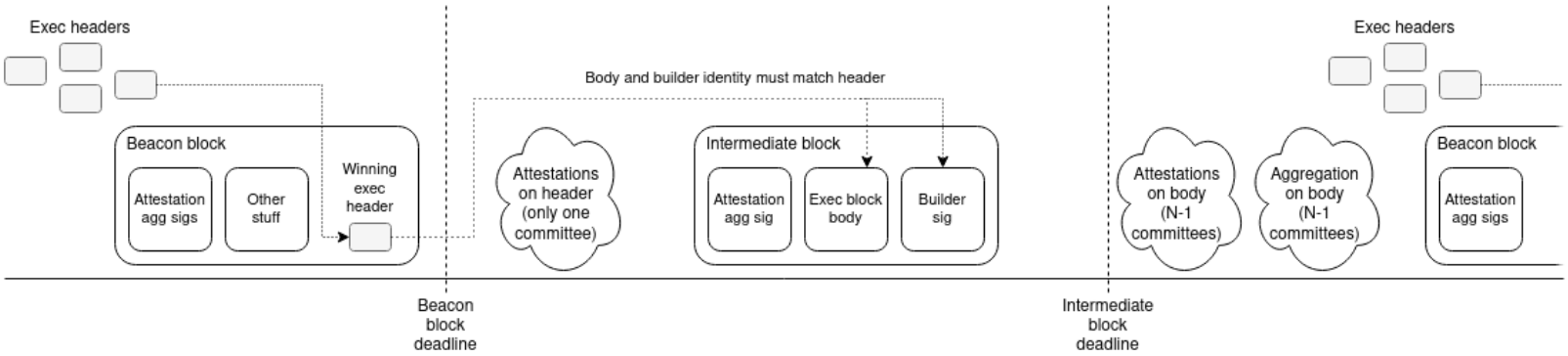


- Original desgin from Vitalik in October 2021

https://ethresear.ch/t/two-slot-proposer-builder-separation/10980

Two-slot PBS

Sketch



- Original desgin from Vitalik in October 2021
- Partition attesting committee over beacon block and intermediate block

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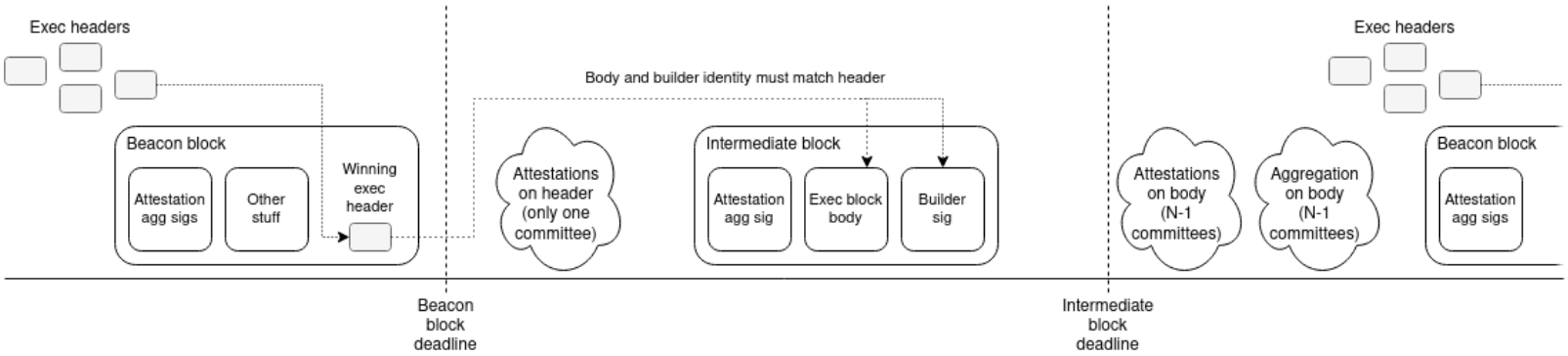
Two-slot PBS

Sketch

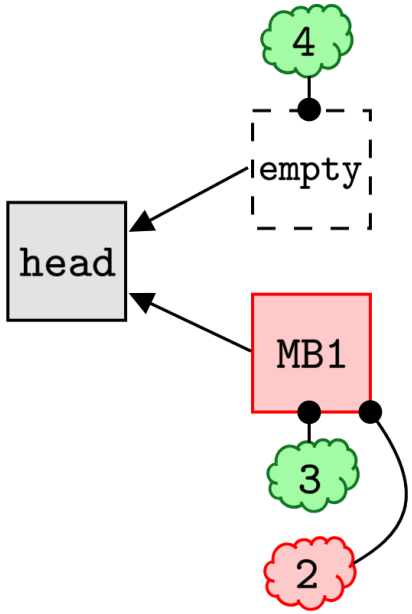


- Original desgin from Vitalik in October 2021
- Partition attesting committee over beacon block and intermediate block
- Became the canonical design. What people referred to when they discussed ePBS

https://ethresear.ch/t/two-slot-proposer-builder-separation/10980

Two-slot PBS

Ex-ante reorg

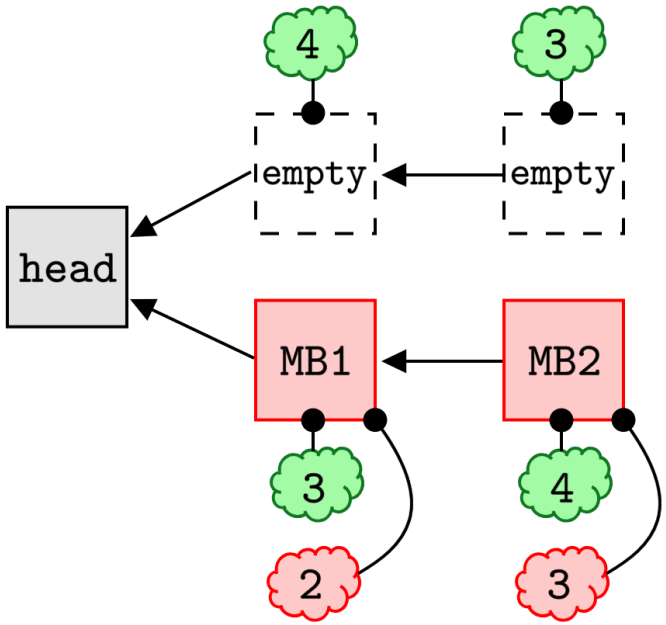


- Malicious proposer splits the honest attesting committee

https://notes.ethereum.org/@mikeneuder/epbs-reorgs

Two-slot PBS

Ex-ante reorg



- Malicious proposer splits the honest attesting committee
- Malicious proposer continues the split over a second slot

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Two-slot PBS

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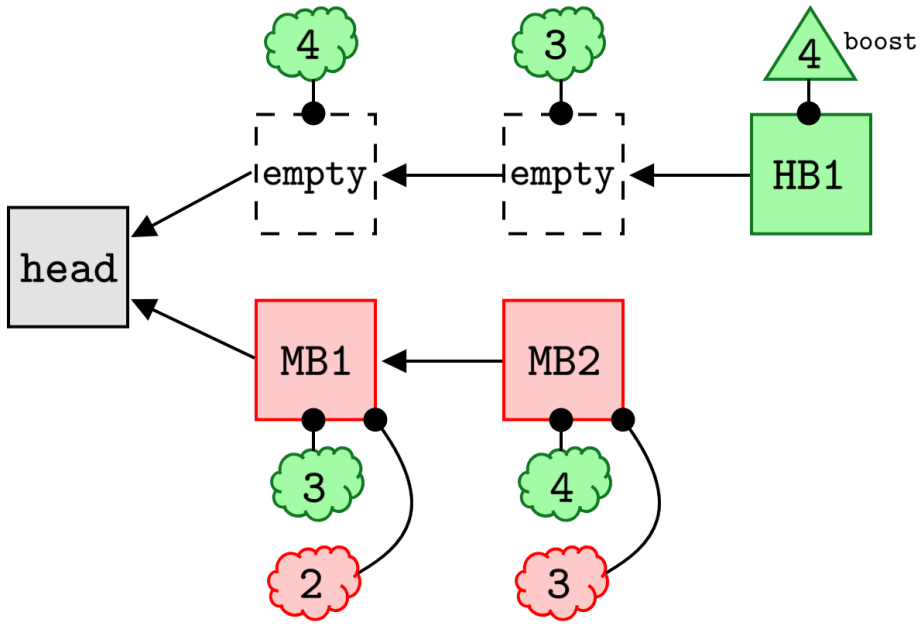

- Malicious proposer splits the honest attesting committee
- Malicious proposer continues the split over a second slot
- Honest proposer builds on the empty chain

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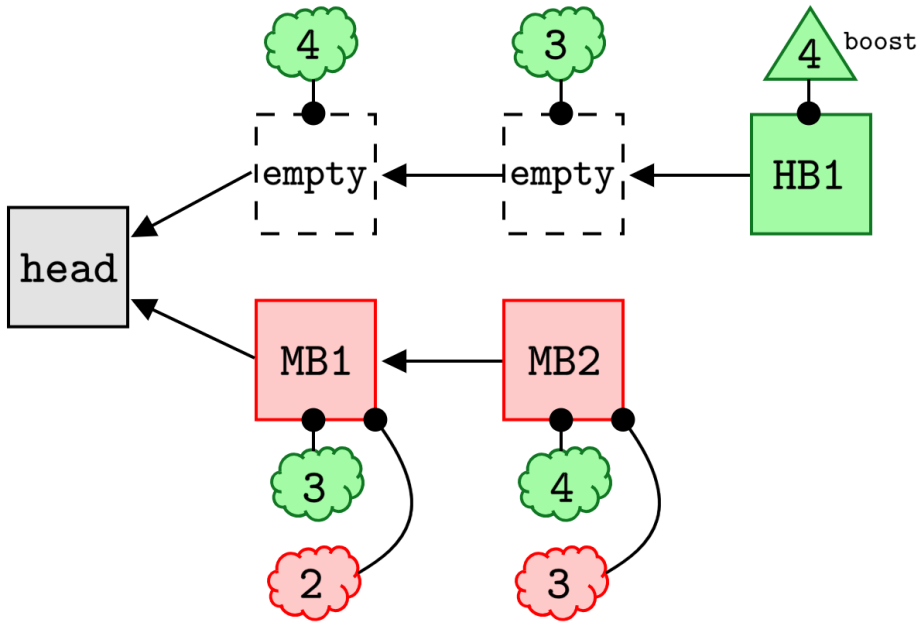
Two-slot PBS

Ex-ante reorg

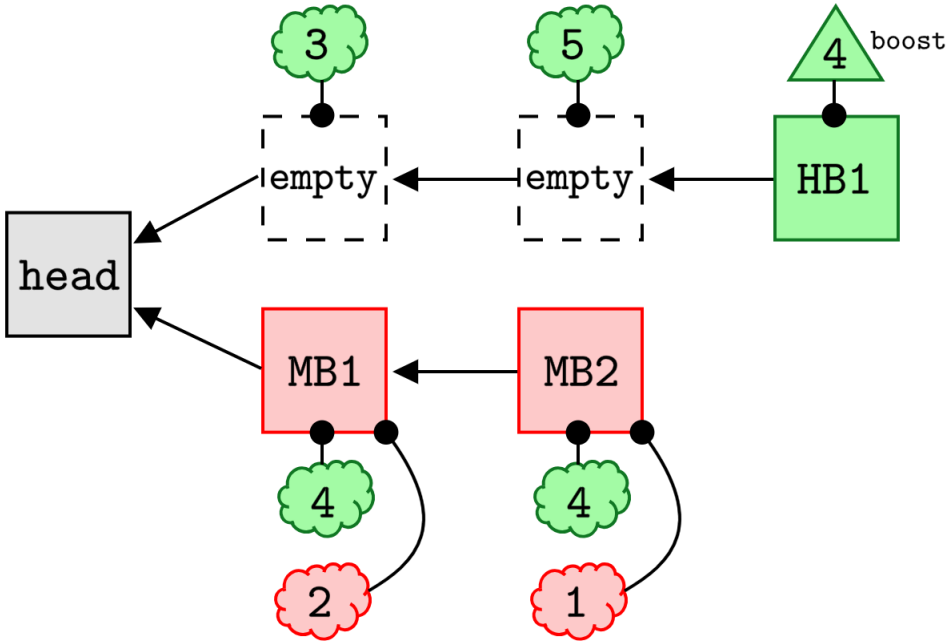


- Malicious proposer splits the honest attesting committee
- Malicious proposer continues the split over a second slot
- Honest proposer builds on the empty chain
- Malicious proposer releases private attestations, orphaning HB1

https://notes.ethereum.org/@mikeneuder/epbs-reorgs

Two-slot PBS

Reorgs



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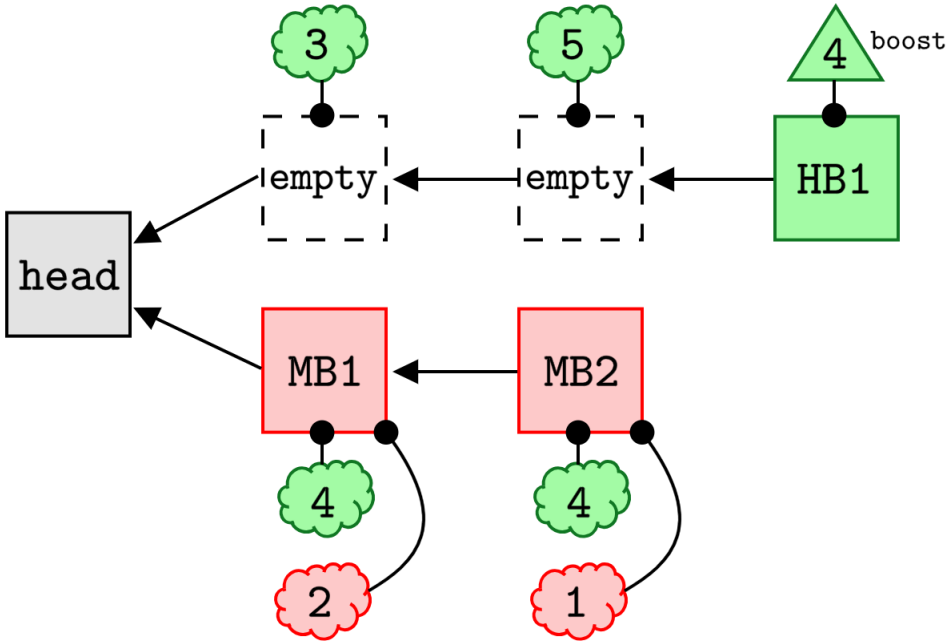
Two-slot PBS

Reorgs



- Malicious proposer still controls two slots, but not enough attestations to beat proposer boost

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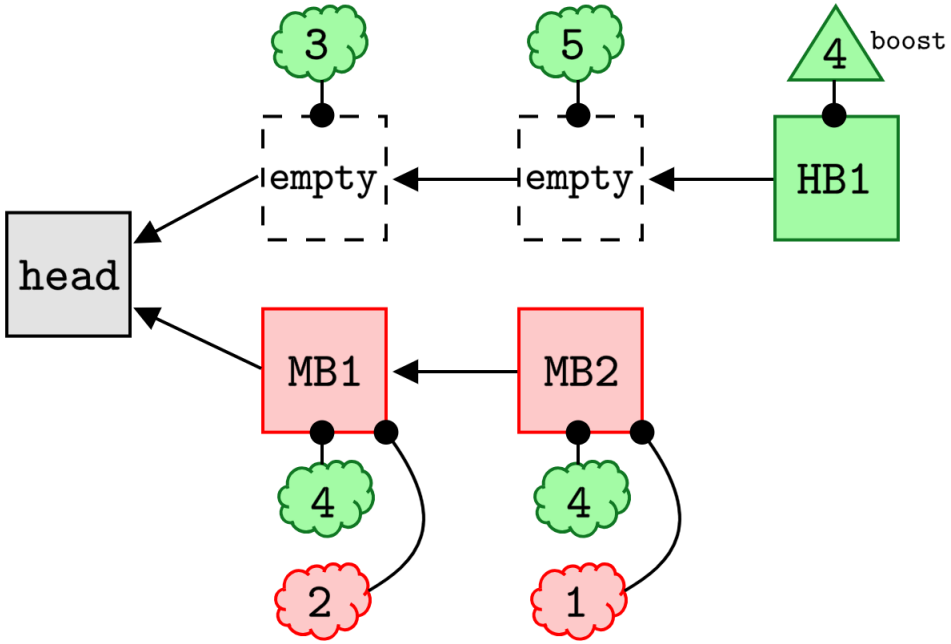
Two-slot PBS

Reorgs

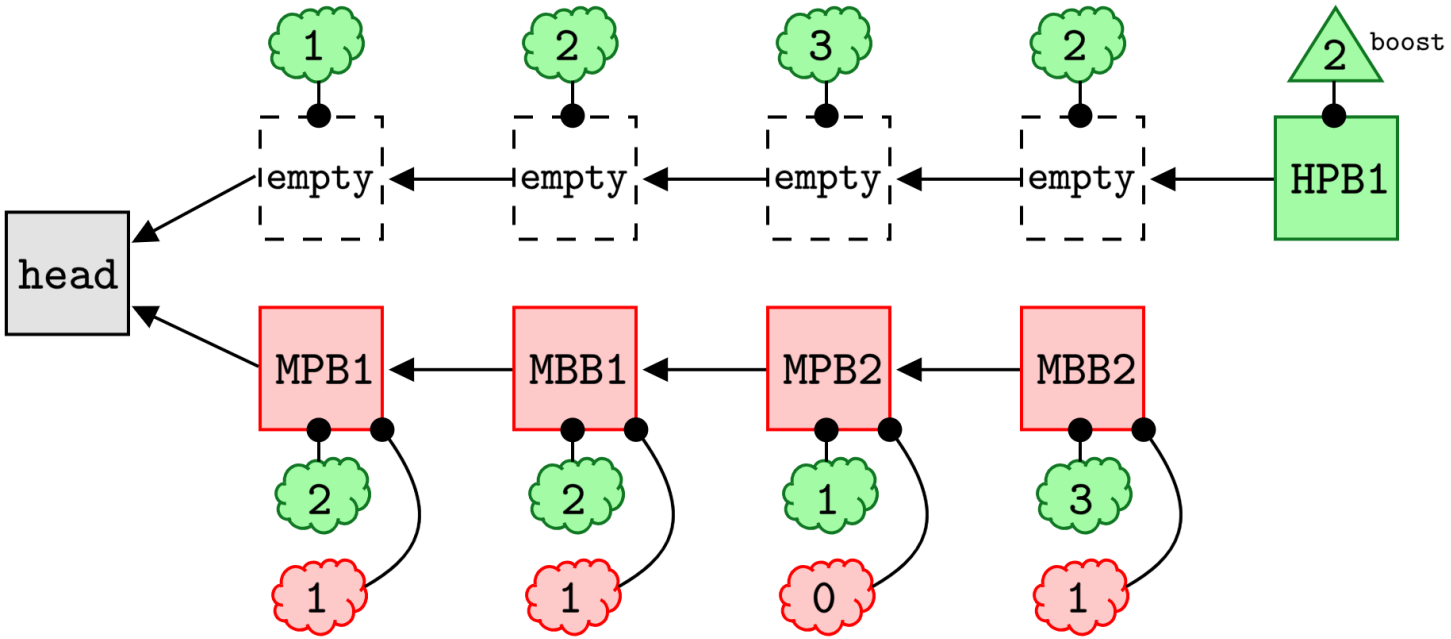


- Malicious proposer still controls two slots, but not enough attestations to beat proposer boost
- No ex-ante reorg possible in this case

https://notes.ethereum.org/@mikeneuder/epbs-reorgs

Two-slot PBS

Reorgs



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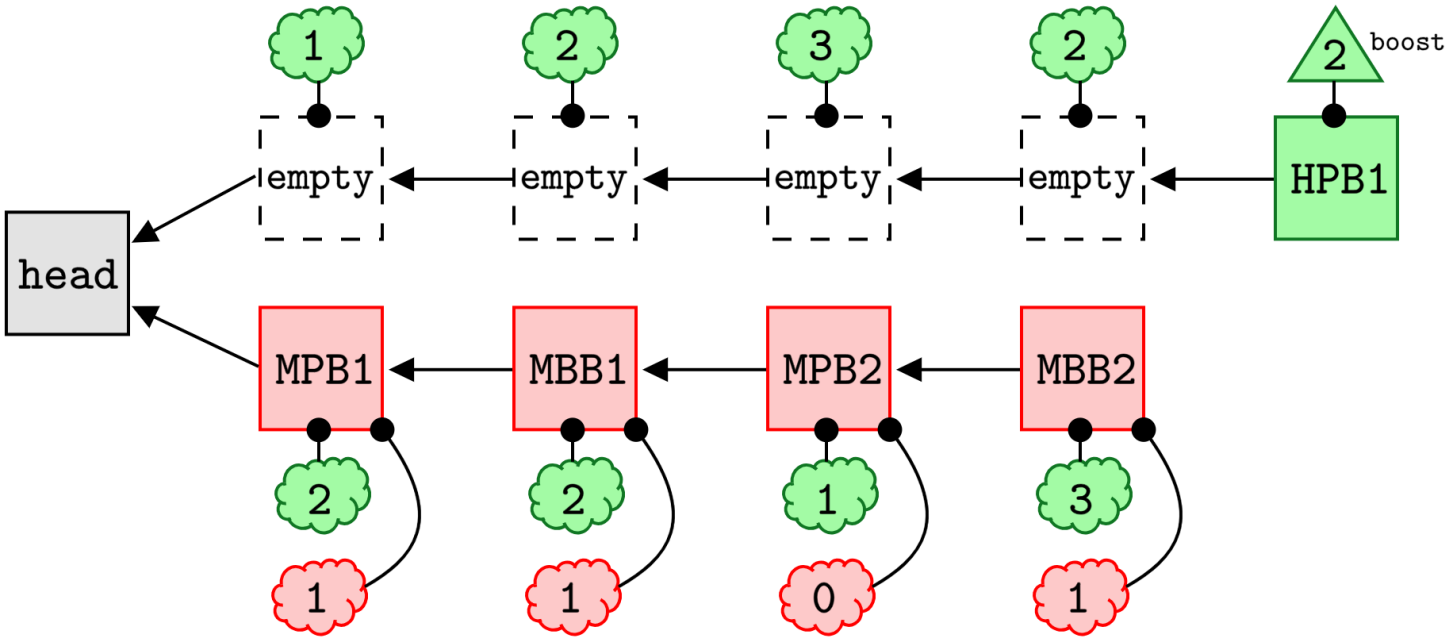
Two-slot PBS

Reorgs

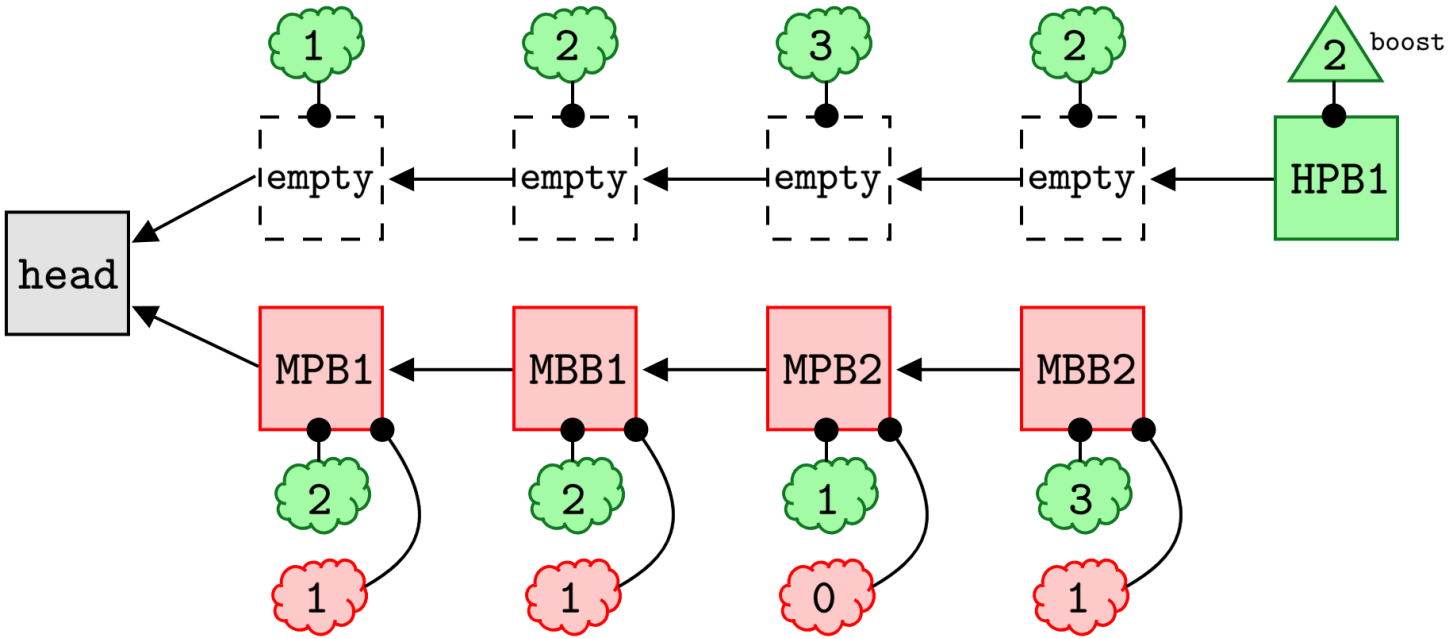


- Same allocation as before

https://notes.ethereum.org/@mikeneuder/epbs-reorgs

Two-slot PBS

Reorgs

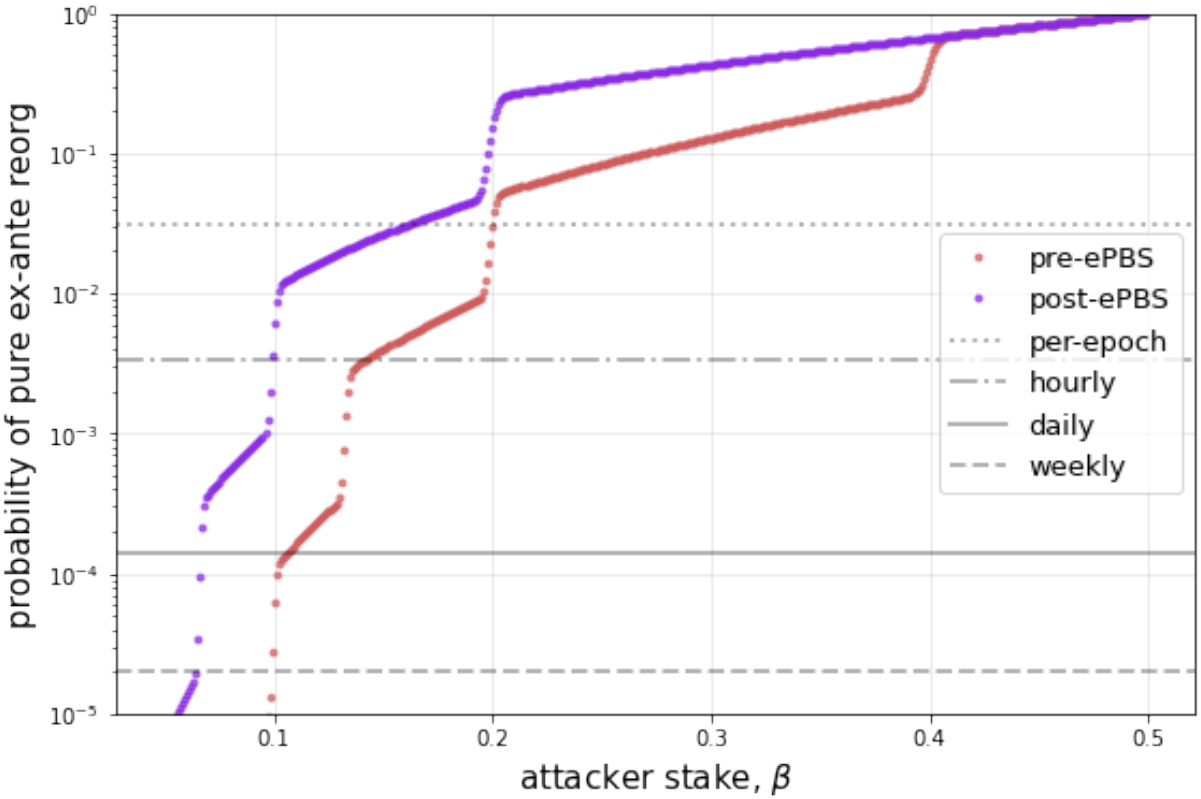


- Same allocation as before
- The ex-ante reorg *is possible* because the proposer boost is weaker

https://notes.ethereum.org/@mikeneuder/epbs-reorgs

Two-slot PBS

Reorg probabilities



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Two-slot PBS

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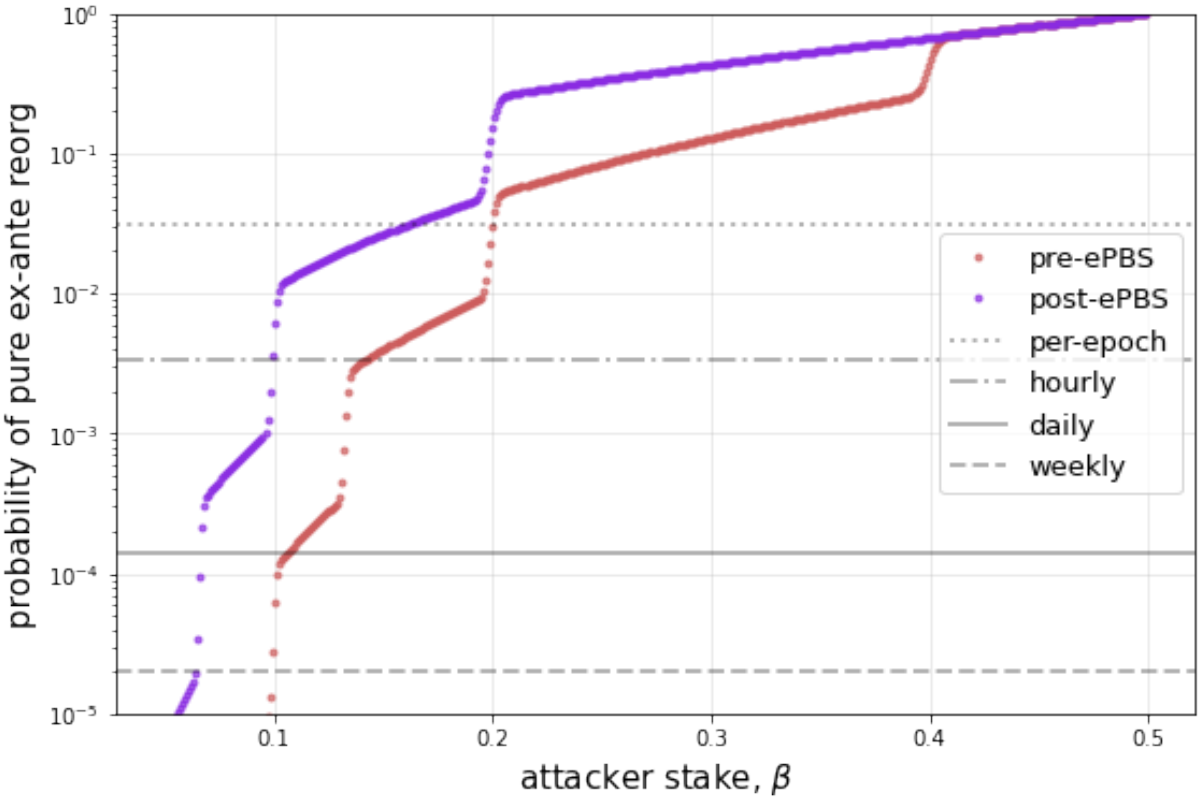

- Just ex-ante reorg probabilities, lower bound on all reorgs

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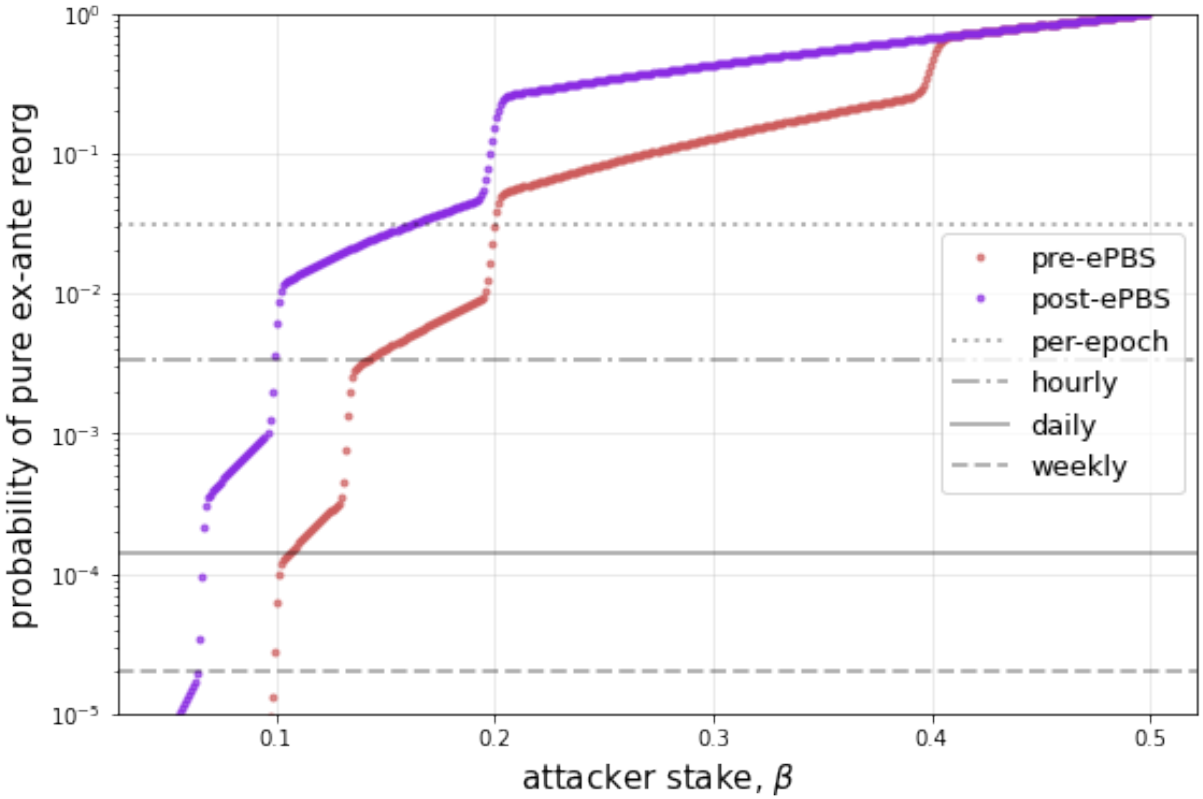
Two-slot PBS

Reorg probabilities



- Just ex-ante reorg probabilities, lower bound on all reorgs
- *Conclusion* – significantly weakens the protocol against reorgs

---

https://notes.ethereum.org/@mikeneuder/epbs-reorgs

Desiderata

Part II

A total of 211,902 forked blocks found

Height	Age	Txn	Uncles
17710885	20 mins ago	105	0
17710773	43 mins ago	164	0
17710754	47 mins ago	157	0
17710630	1 hr 12 mins ago	113	0

https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

Desiderata

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- Replace *honest builder publication safety*

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- With *honest builder same-slot publication safety*

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- Replace *honest builder publication safety*
- With *honest builder same-slot publication safety*
- This is pretty much the model today with `mev-boost`
- Low-Carb Crusader was so effective because it was a *same-slot* unbundling

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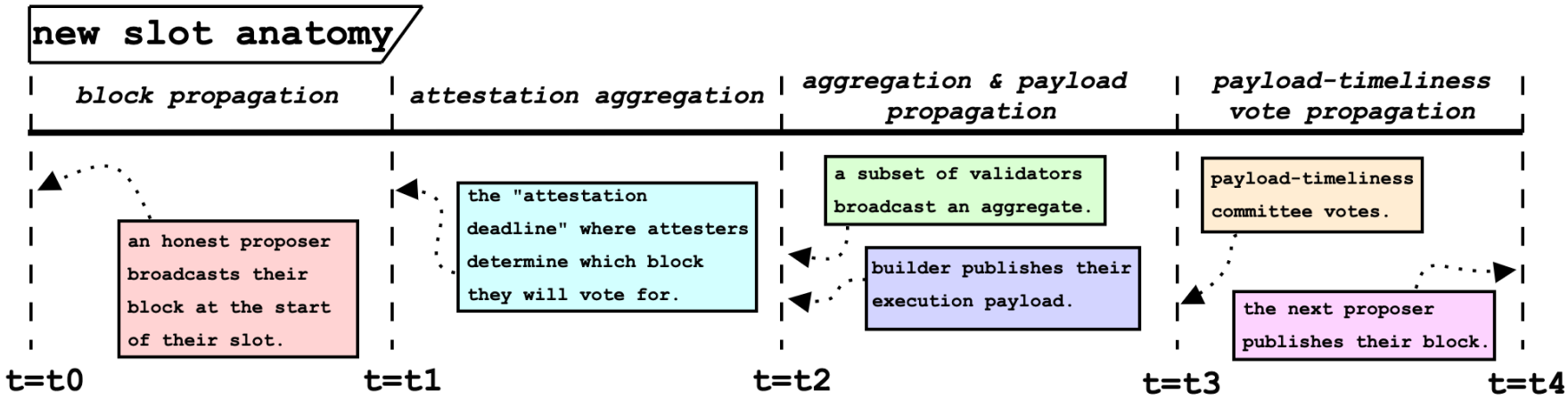
https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

Payload-Timeliness Committee

Sketch



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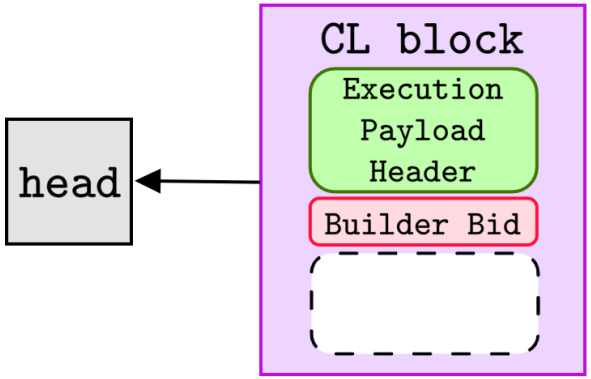

- Consensus-layer block is produced *without* any transactions

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Payload-Timeliness Committee

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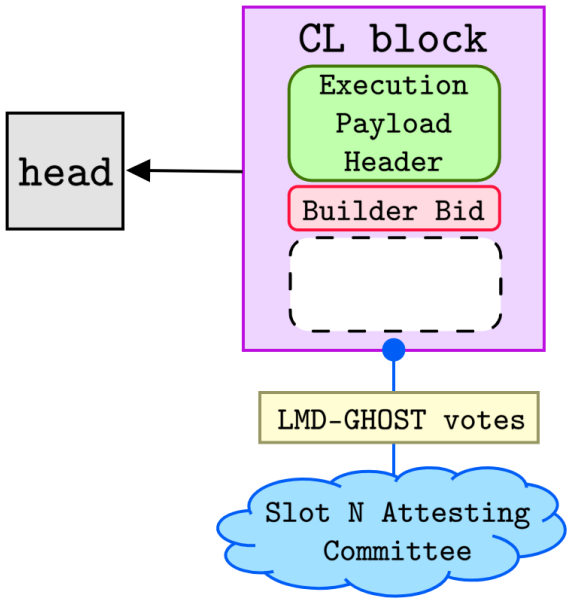

- Consensus-layer block is produced *without* any transactions
- Consensus-layer attestations remain the same

https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

Payload-Timeliness Committee

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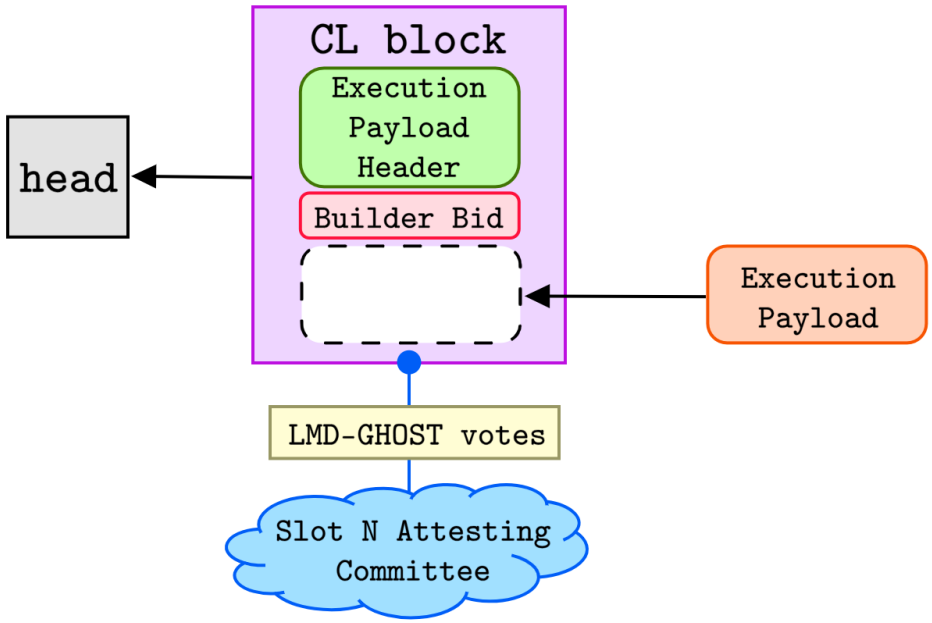

- Consensus-layer block is produced *without* any transactions
- Consensus-layer attestations remain the same
- Builder reveals the payload (list of transactions)

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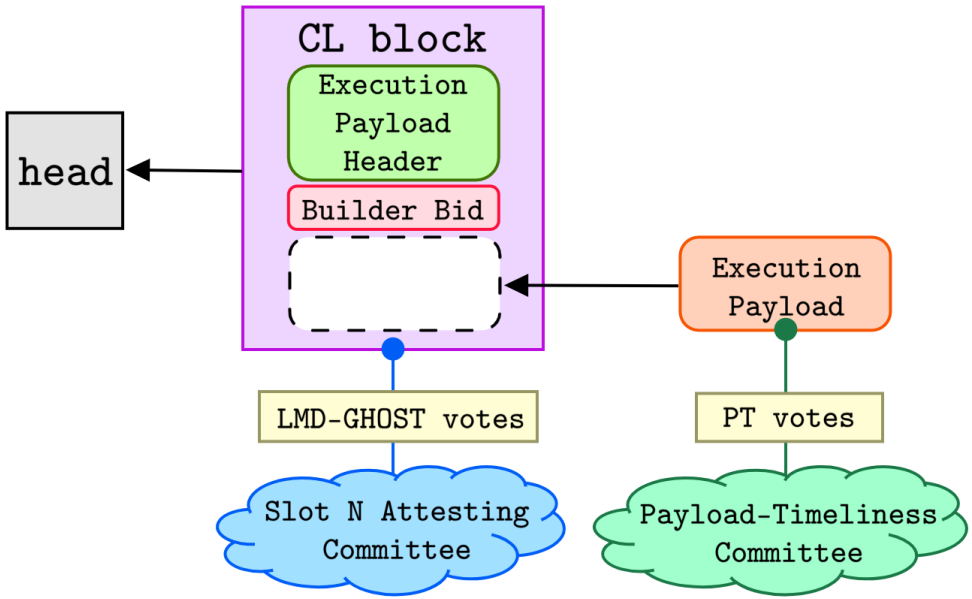
Payload-Timeliness Committee

Sketch

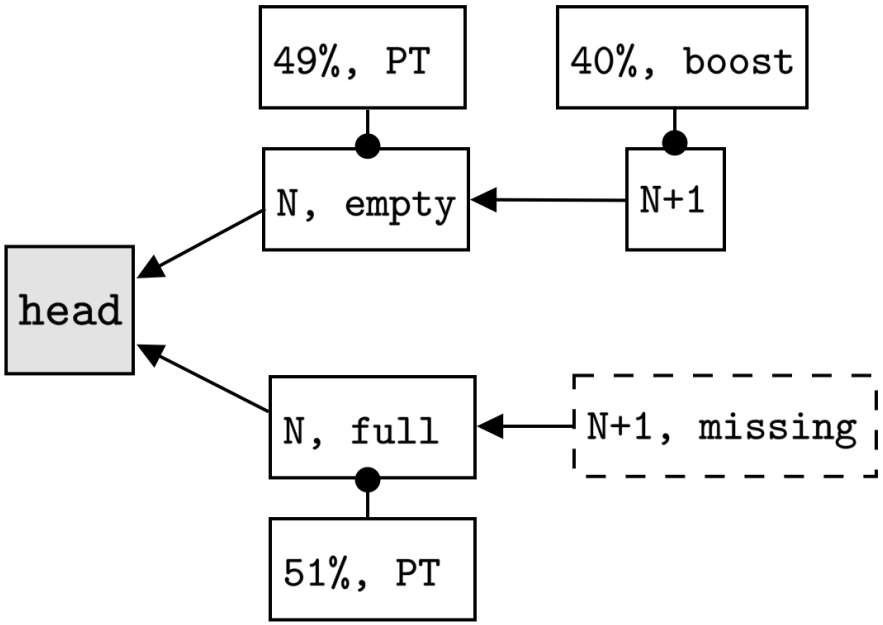


- Consensus-layer block is produced *without* any transactions
- Consensus-layer attestations remain the same
- Builder reveals the payload (list of transactions)
- Payload-Timeliness Committee votes on if the payload was published

https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

Payload-Timeliness Committee

Case 1



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Payload-Timeliness Committee

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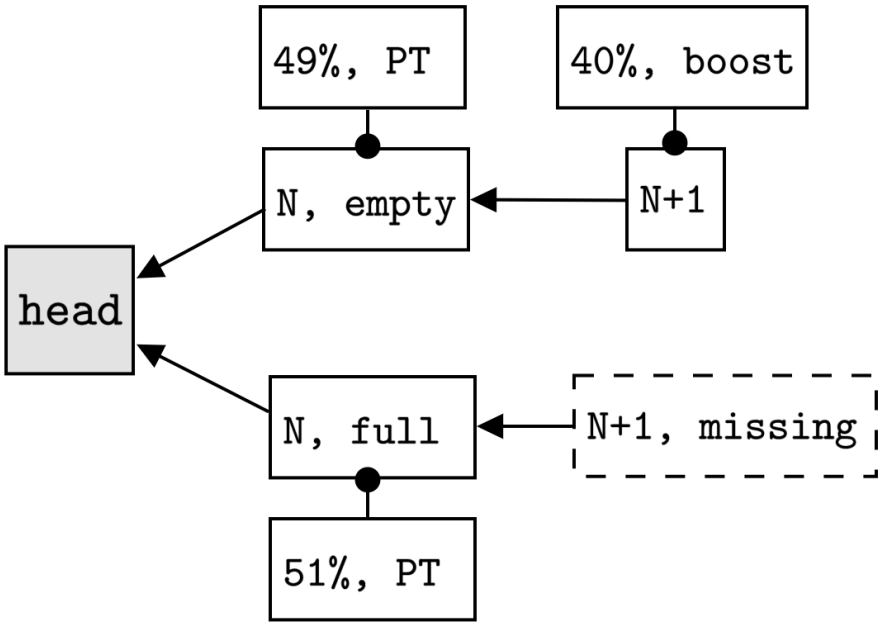

- PTC is split

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Payload-Timeliness Committee

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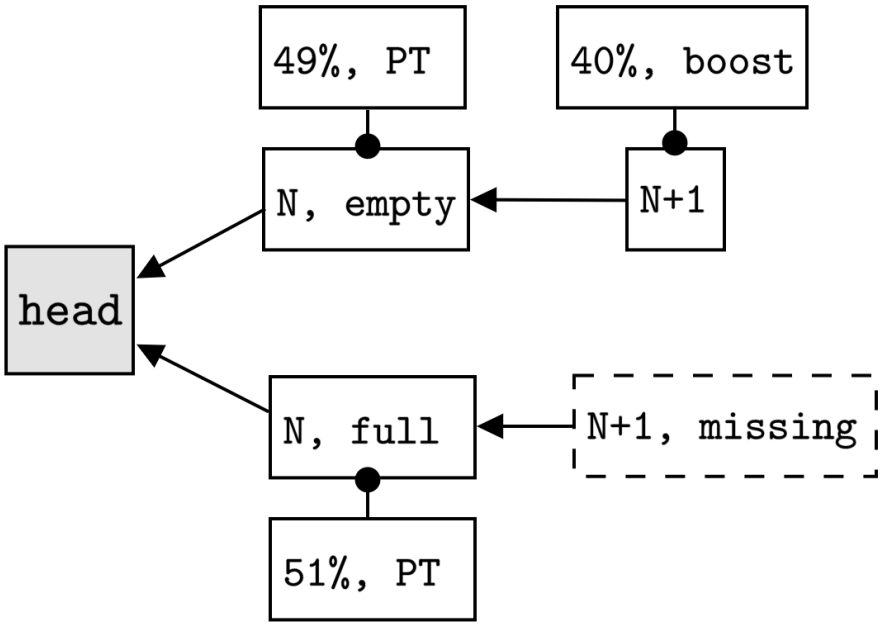
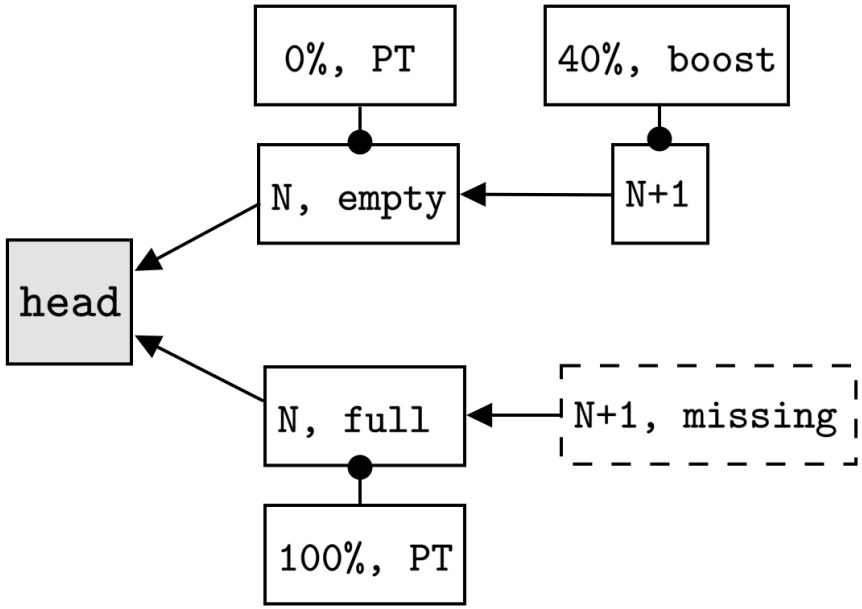


- PTC is split
- Boost gives N+1 sufficient weight to win the fork

https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

Payload-Timeliness Committee

Case 2



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Payload-Timeliness Committee

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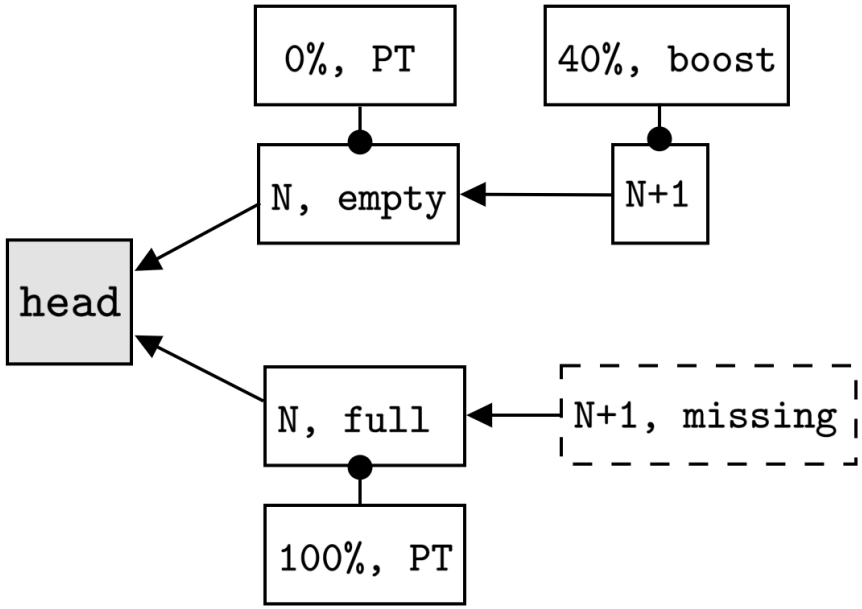

- PTC is in agreement

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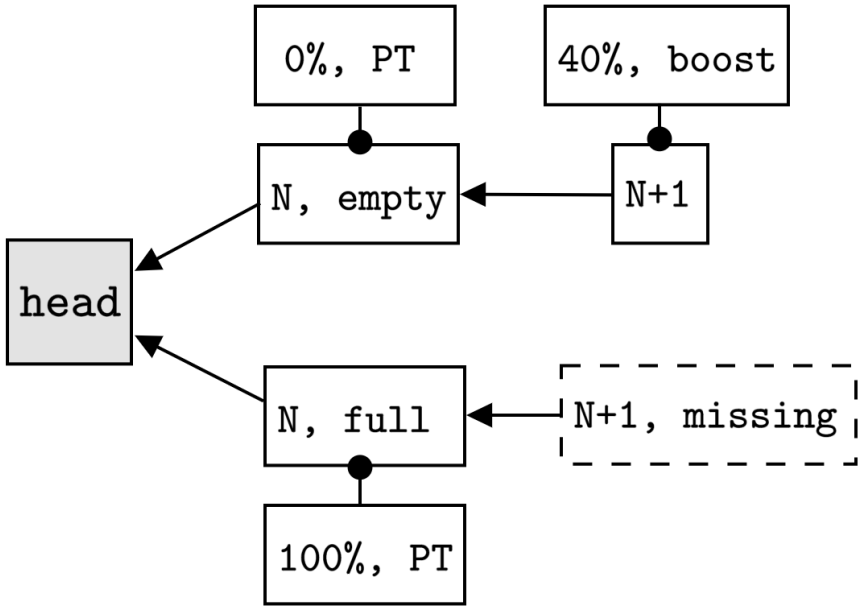
Payload-Timeliness Committee

Case 2

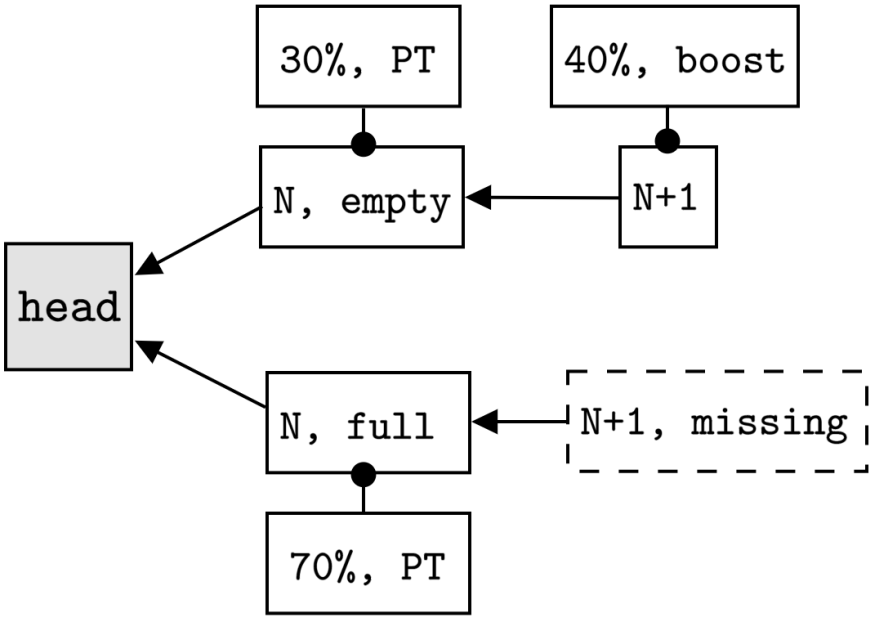


- PTC is in agreement
- N+1 proposer differs, and gets orphaned as a result

https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

Payload-Timeliness Committee

Case 3



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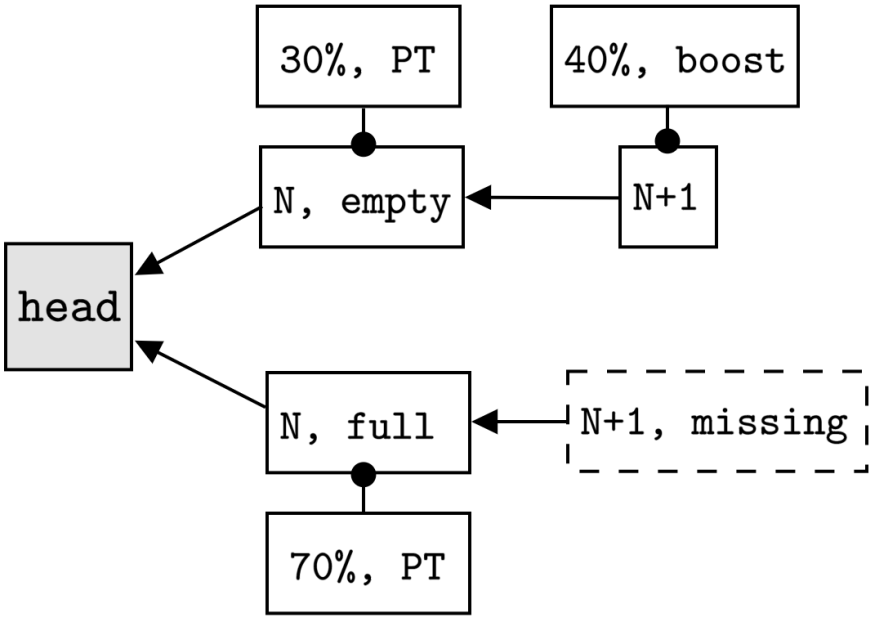
Payload-Timeliness Committee

Case 3



- PTC is split

https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

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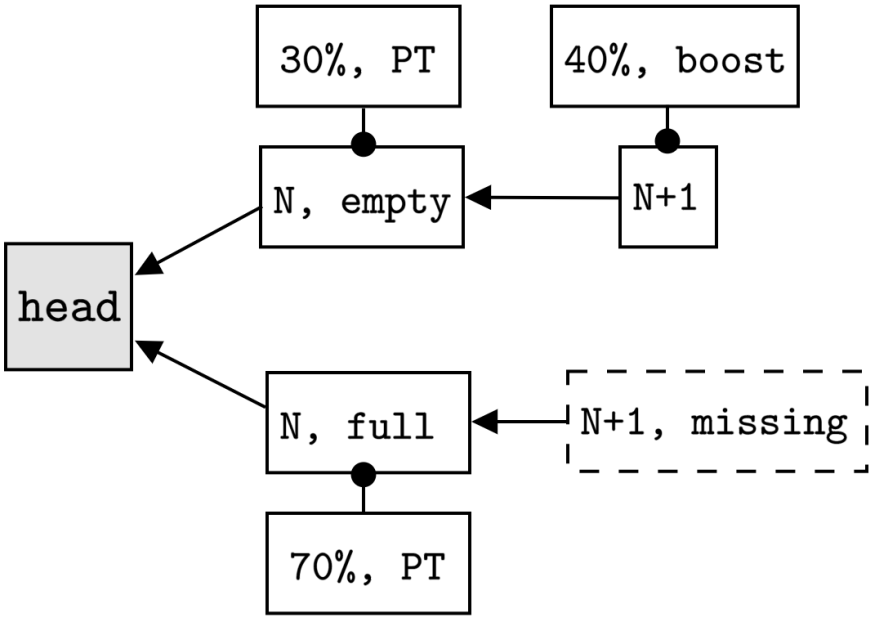

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- Results in a tie (worst case)

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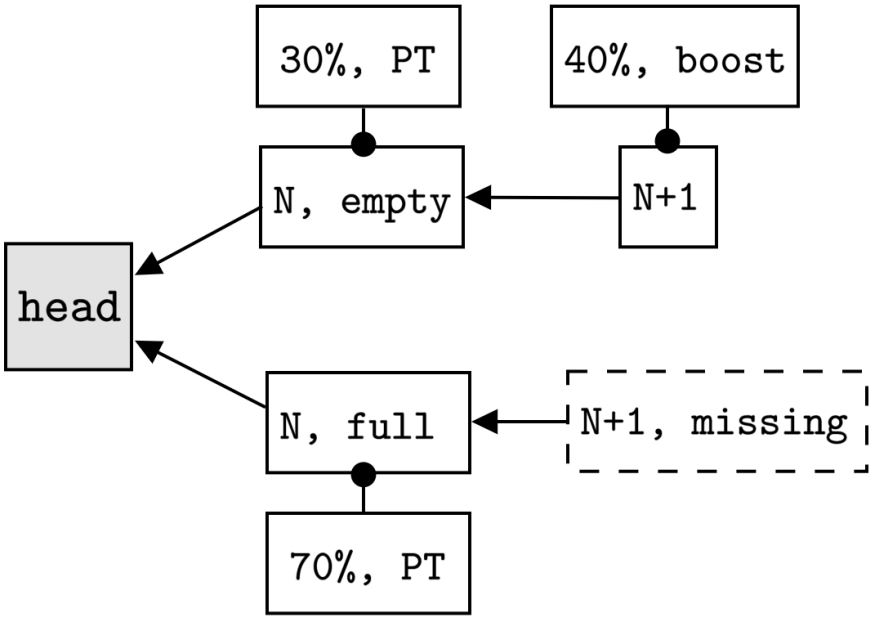

- PTC is split
- Results in a tie (worst case)
- Hard to get the proposer to disagree with that much of the PTC

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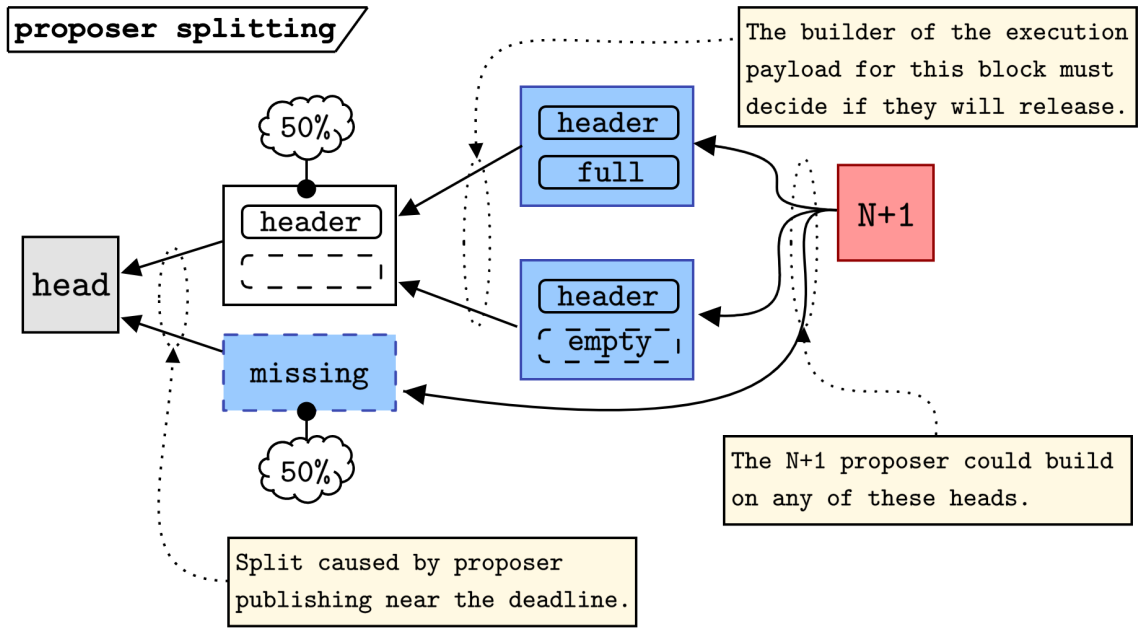
Proposer initiated splitting



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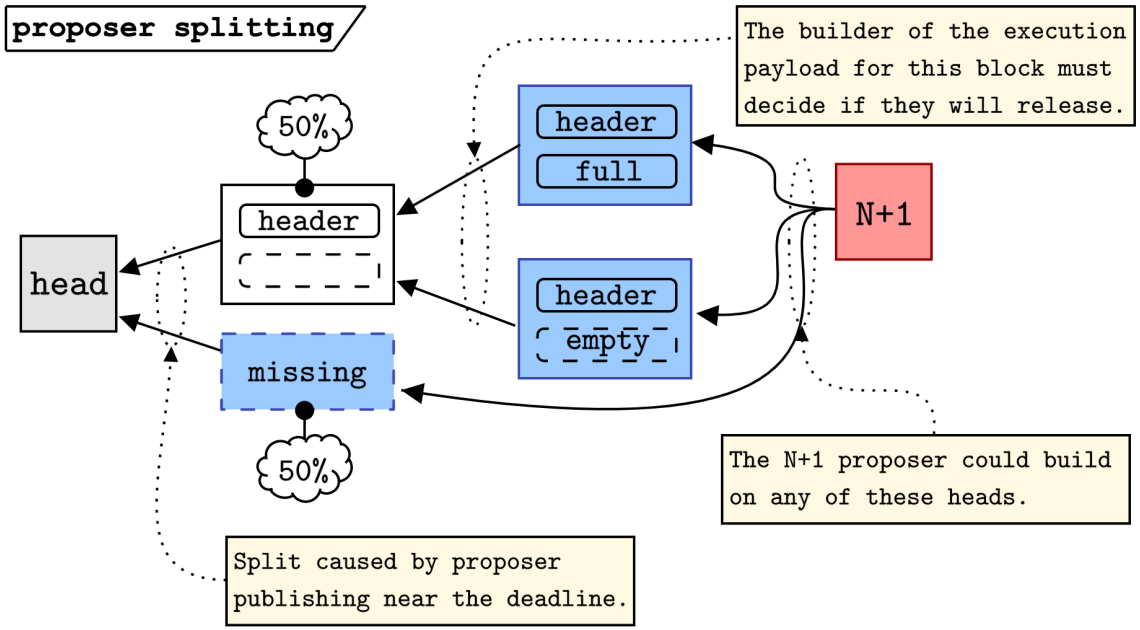

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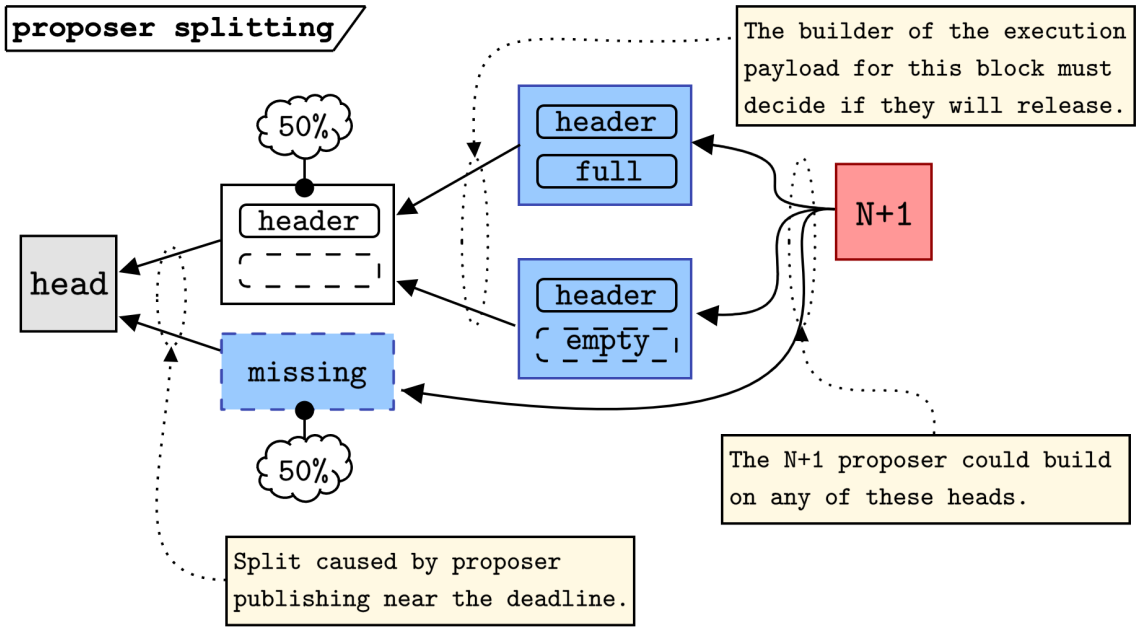

- Proposer can grief the builder into a bad decision
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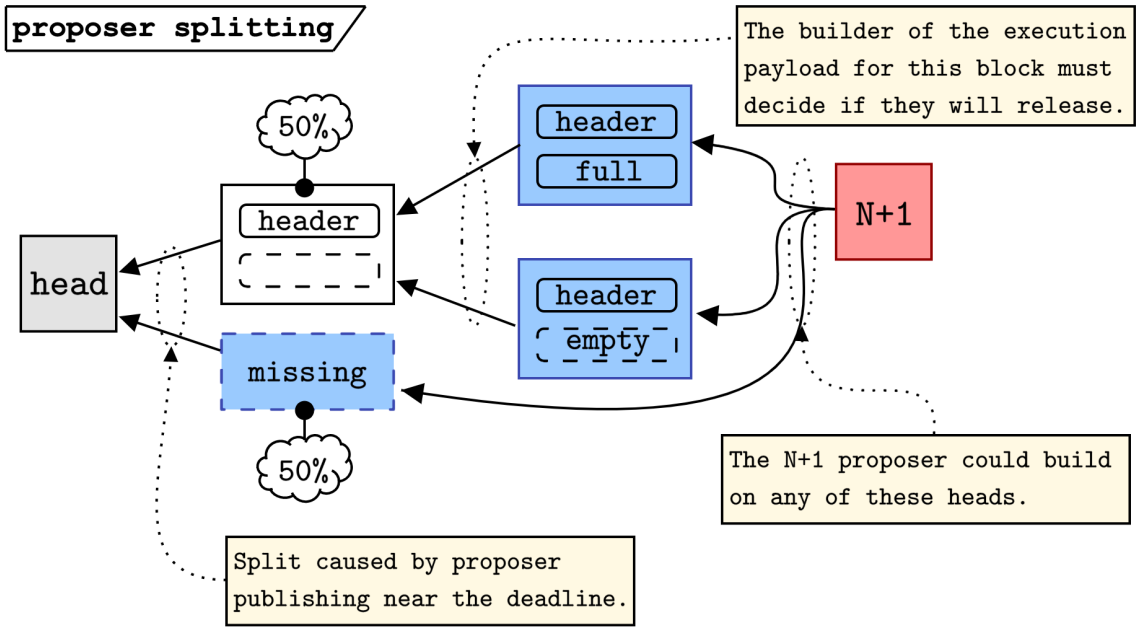

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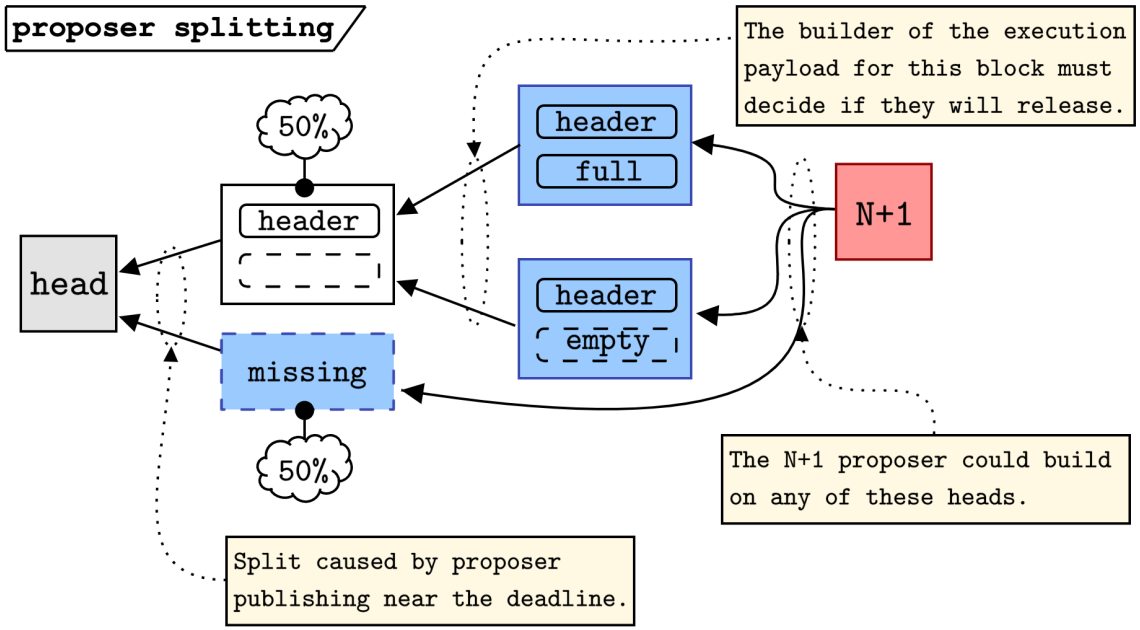

- Proposer can grief the builder into a bad decision
  - Publish and run the risk of your block not becoming canonical
  - Do not publish and run the risk of paying for nothing
- ... but this is worse today in `mev-boost`

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Juxtaposition

How do these all relate?

- Sub-slot mechanics

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- PEPC
  - Gives block-validity enforcement guarantees for the builder
  - Builder still needs some protection from equivocation

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