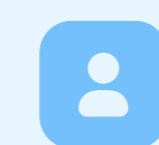
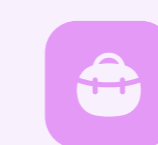


Decentralized Collaborative Version Control

DICG'21



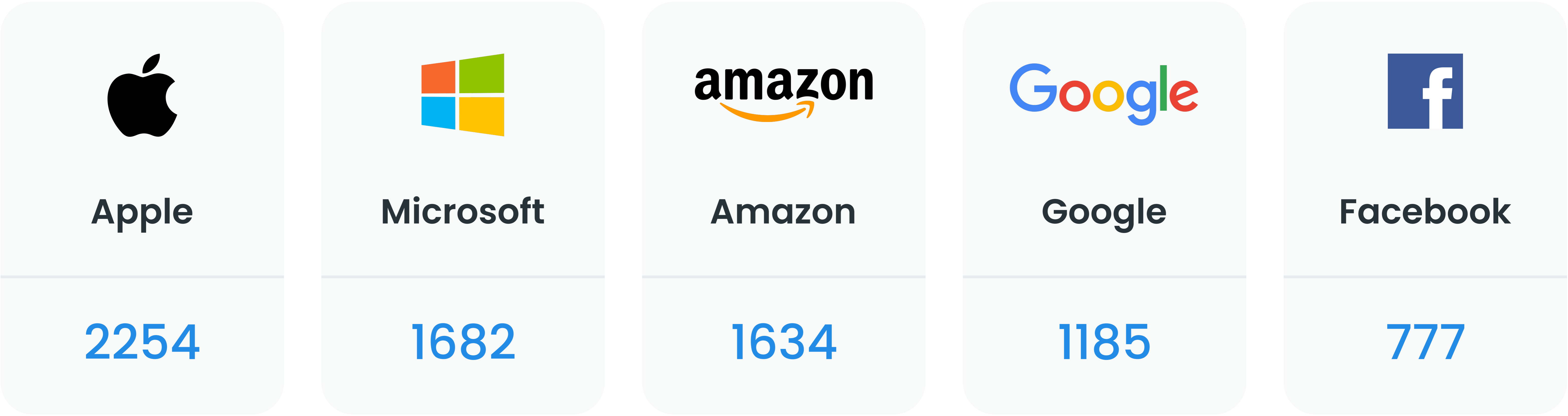
Bulat Nasrulin, Johan Pouwelse



TU Delft

Centralised Services Dominate the Market

5 Largest Corporations by Market Capitalisation



*Asset evaluation in billions of dollars

Decentralized Services as an Alternative

Decentralized Services as an Alternative



All Crypto

2450



Number of
Projects

11260

* As for December 5, 2021

Decentralized Services as an Alternative



All Crypto

2450



Number of
Projects

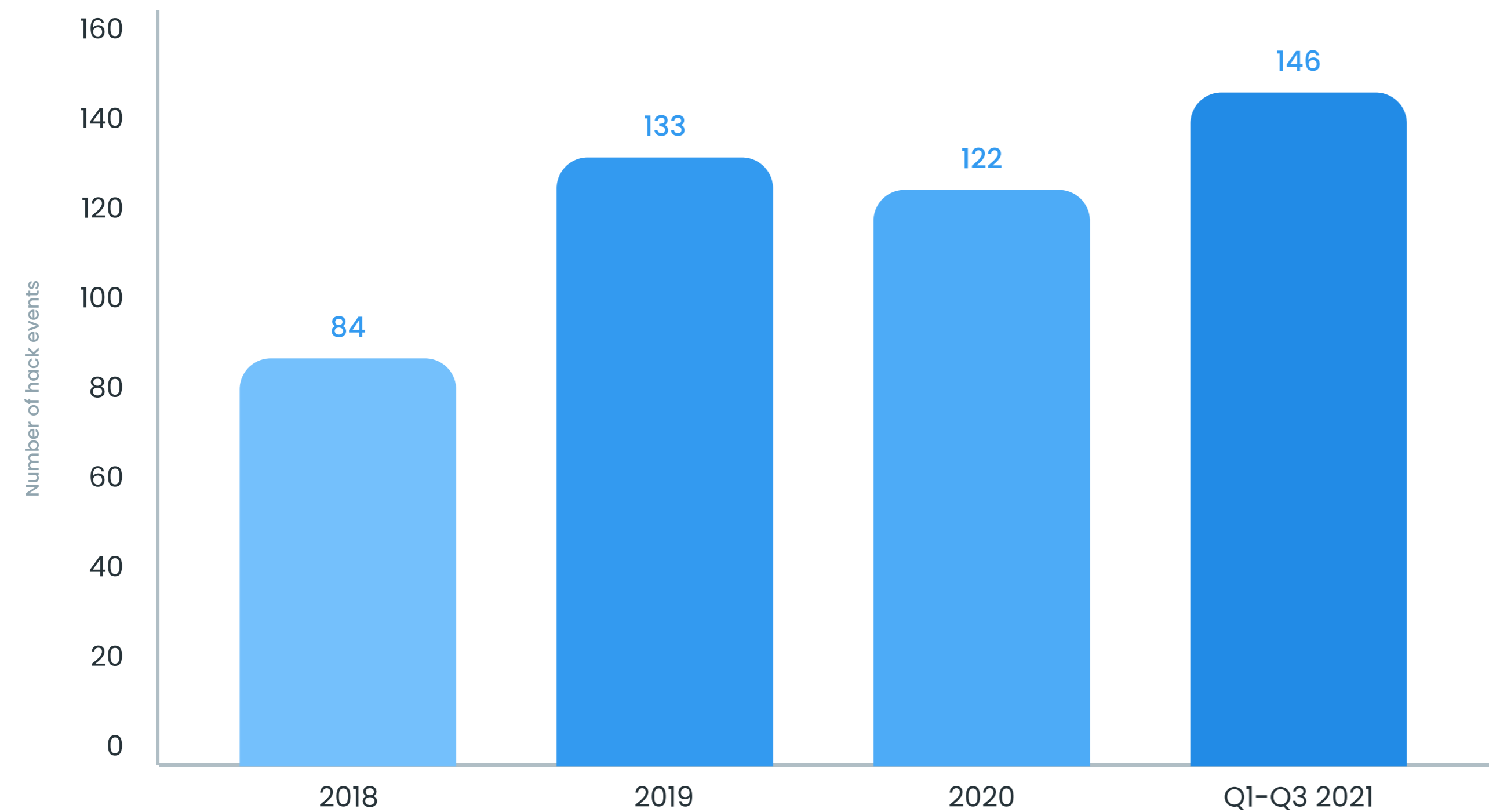
11260



* As for December 5, 2021

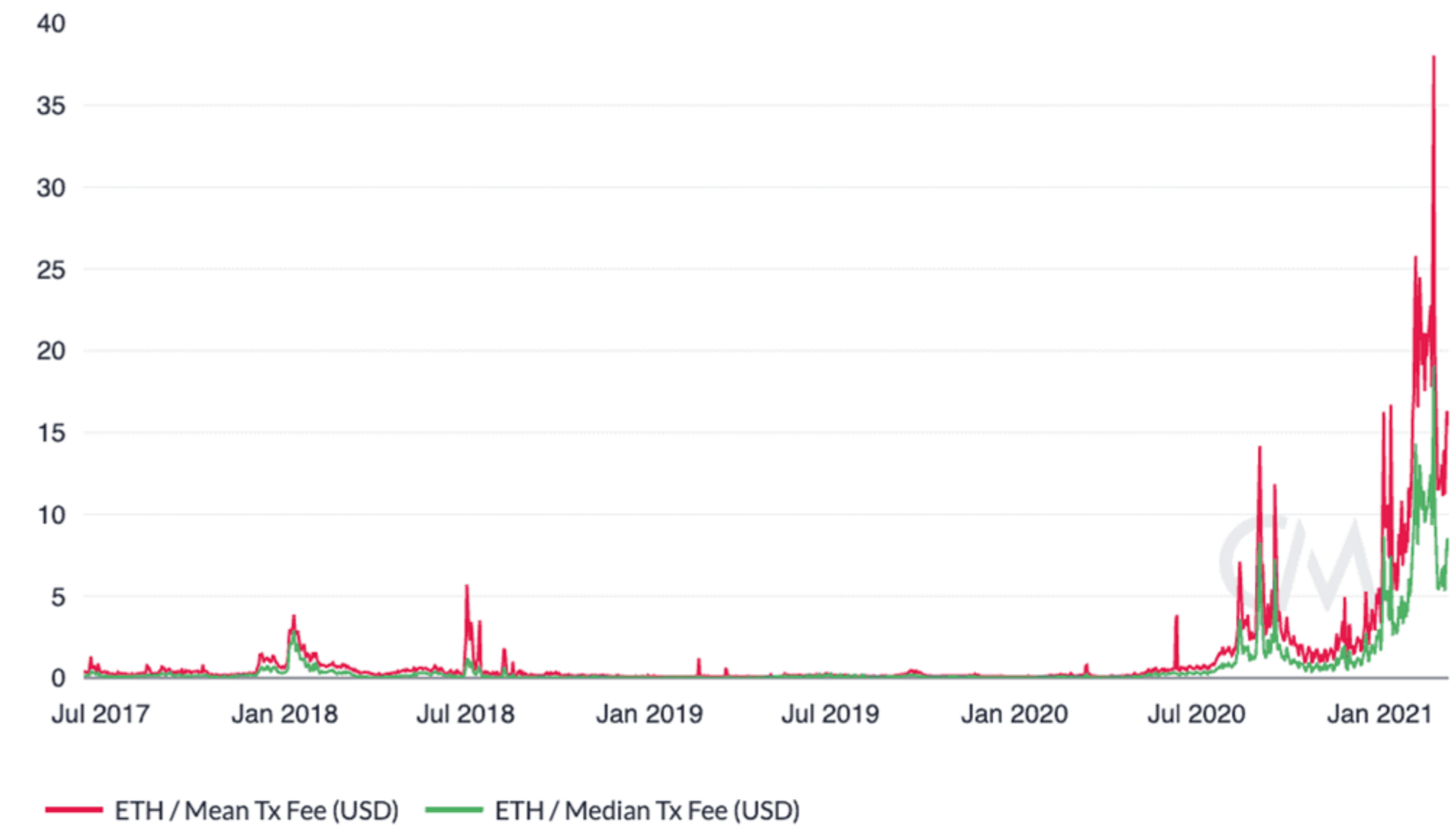
Bad Design Decisions → Big Consequences

Blockchain-related hack events by year (2018 - Q3 2021)



Source: hacked.slowmist.io

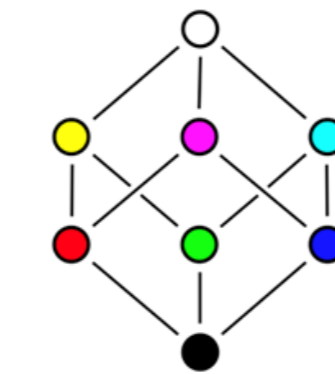
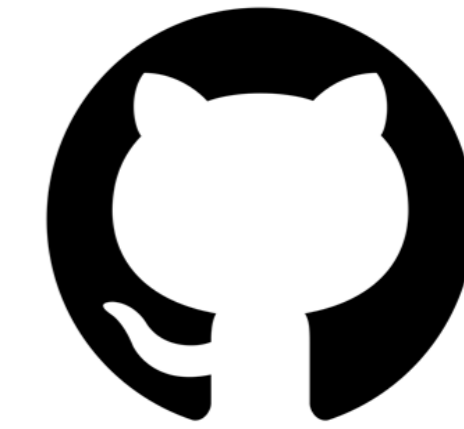
ETH Mean & Median Fee, USD



Source: COINMETRICS

Alternative Design?

- Better data organization
- No global consensus
- Non-masking Fault Tolerance
- No prevention but detect, recover, resolve



CRDT



Inspiration: Make them Accountable

Malicious Peers and Accountability

MALICIOUS PEER

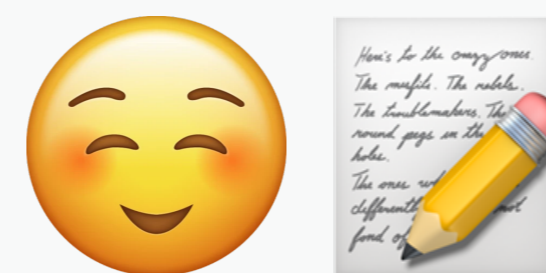


Changed Protocol P'



Deviates from the Protocol.
Can produce any result

CORRECT PEER



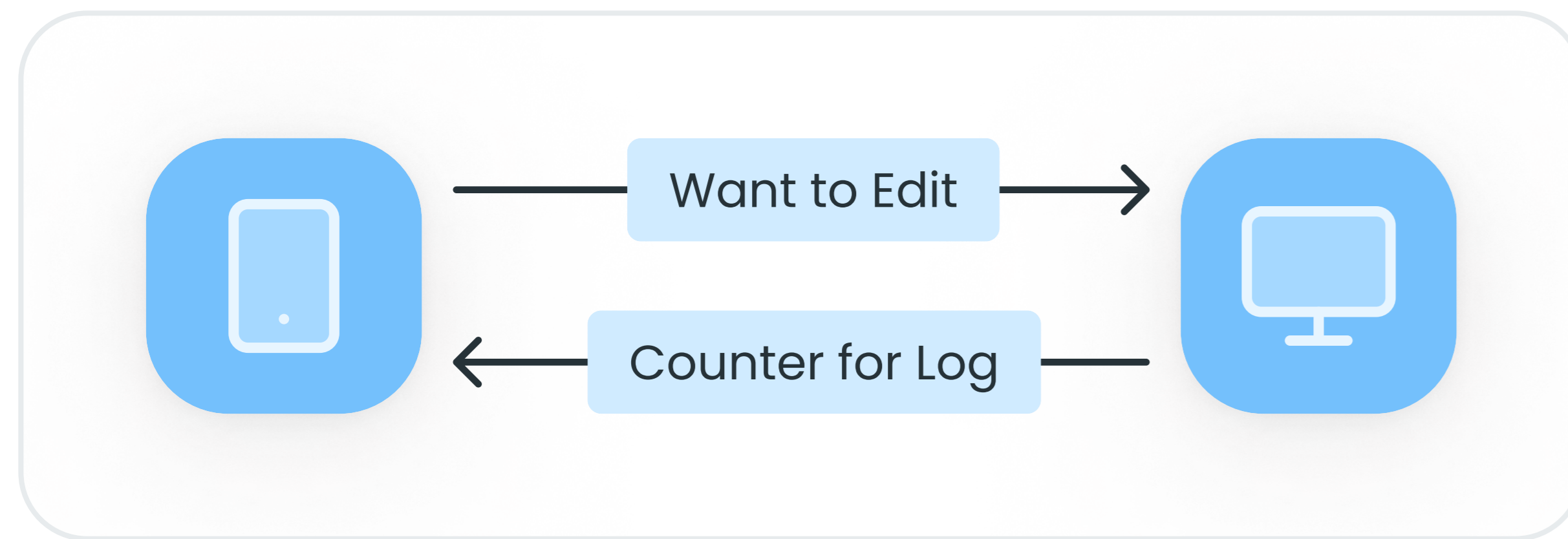
Protocol P



Acts as expected

**But we need to
define rules!**

Wikipedia Case: Data



• (cur prev)	16:48, 31 October 2012	WhatamIdoing (talk contribs)	m	• • (16,289 bytes) (+1)	• • (Typo)
• (cur prev)	16:47, 31 October 2012	WhatamIdoing (talk contribs)		• • (16,288 bytes) (+599)	• • (Once again, with feeling)
• (cur prev)	23:45, 28 October 2012	WhatamIdoing (talk contribs)		• • (15,689 bytes) (+133)	• • (→ See also: AIV)
• (cur prev)	20:43, 24 September 2012	WhatamIdoing (talk contribs)		• • (15,556 bytes) (+370)	• • (Expand lead)
• (cur prev)	18:19, 11 September 2012	The wub (talk contribs)		• • (15,186 bytes) (-33)	• • (rm {{Leave feedback}}, has article feedback tool nc
• (cur prev)	16:36, 25 July 2012	John of Reading (talk contribs)		• • (15,219 bytes) (-11,036)	• • (Reverted 1 edit by Ace JeRze (talk): Rv mispl
• (cur prev)	16:13, 25 July 2012	Ace JeRze (talk contribs)		• • (26,255 bytes) (+11,036)	
• (cur prev)	20:47, 5 June 2012	Arcandam (talk contribs)		• • (15,219 bytes) (+5)	• • (vector)
• (cur prev)	22:42, 5 May 2012	Sefid par (talk contribs)		• • (15,214 bytes) (+44)	• • (Undid revision 490861562 by Sefid par (talk))
• (cur prev)	22:41, 5 May 2012	Sefid par (talk contribs)		• • (15,170 bytes) (-44)	• • (faou
• (cur prev)	09:33, 10 April 2012	ElphiBot (talk contribs)	m	• • (15,214 bytes) (+32)	• • (r2.7.2) (Robot: Adding no:Hjelp:Revisjonshistorikk)
• (cur prev)	07:16, 22 March 2012	JAnDbot (talk contribs)	m	• • (15,182 bytes) (0)	• • (r2.5.4) (Robot: Modifying sr:Помоћ:Историја измена,
• (cur prev)	11:04, 7 March 2012	John of Reading (talk contribs)		• • (15,182 bytes) (+1)	• • (→ Overview: rv to old description of the edit summ
• (cur prev)	22:42, 3 March 2012	PrimeHunter (talk contribs)		• • (15,181 bytes) (+105)	• • (→ Overview: clarificatio
• (cur prev)	10:29, 3 March 2012	John of Reading (talk contribs)		• • (15,076 bytes) (+246)	• • (→ Overview: Filled in one of the missing explai
• (cur prev)	09:56, 3 March 2012	John of Reading (talk contribs)		• • (14,830 bytes) (+336)	• • (→ Overview: New screenshot and some change
• (cur prev)	16:48, 2 March 2012	5Q5 (talk contribs)		• • (14,494 bytes) (+10)	• • (Outdated flag. Needs a mew screenshot with the new green

- Nice Linear History of edits per Page
- Linear Log per User
- Vandalism, malicious actions are transparent

Wikipedia Case: Governance

Your edit was reverted.

Please see WP:SmarterThanYou



The user page of the guy who reverted you

LordByron00 undid the revision by PubliusCornelius11
PubliusCornelius11 reverted the edit by LordByron00
LordByron00 undid the revision by PubliusCornelius11
PubliusCornelius11 reverted the edit by LordByron00

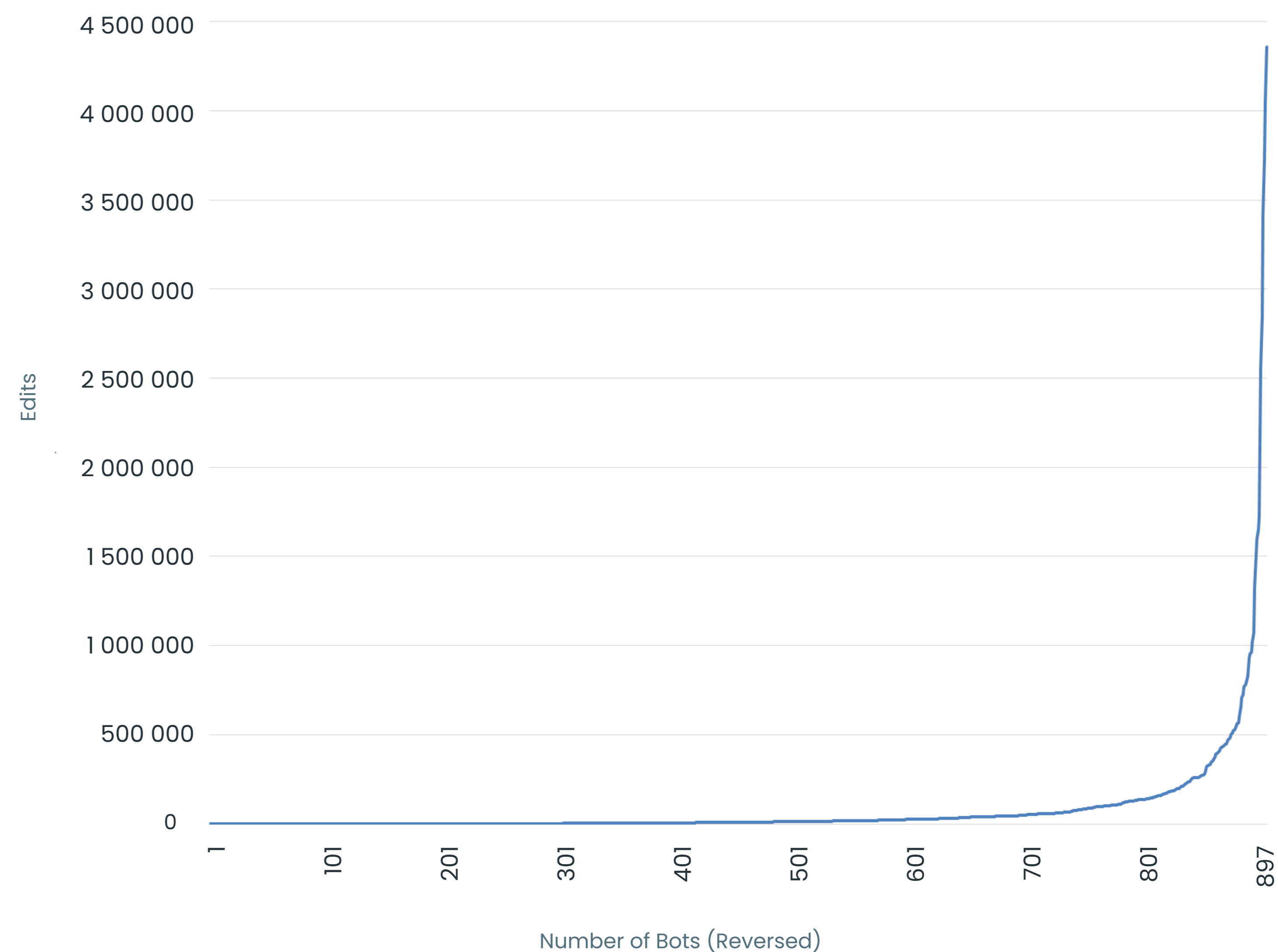
I'm having a hard time seeing good faith here.

Blocked

**You are currently unable
to edit Wikipedia.**

**You are still able to view pages, but you are
not currently able to edit, move, or create them.**

Edit Distribution of All Bots



How Can We Enable Such Collaboration?

Consistency and Convergence



Eventual
Delivery



Strong
Convergence



Causal
Consistency

Accountability Goals



Accuracy



Unanimity

Design Decisions



1.
Explicit Causality



2.
Resolving Conflicts



3.
Validity Rules



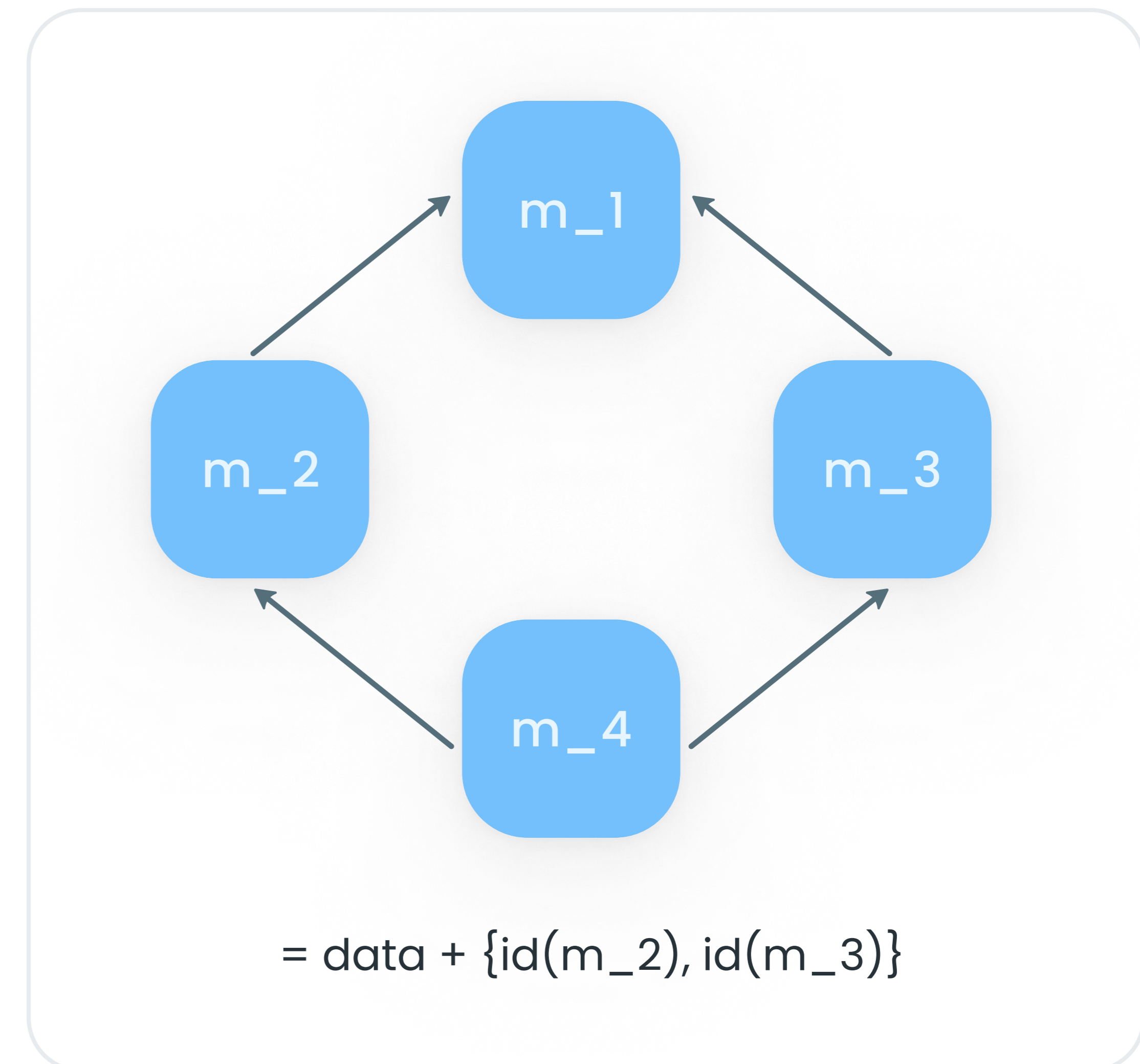
4.
Reconciliation

1. Explicit Causality

- Embed the dependencies in the message, via set of hashes
- Inverted Lamport's 'happens-before'
- Preserve Linear Log where you can



Rule: Any new message "continues" pervious

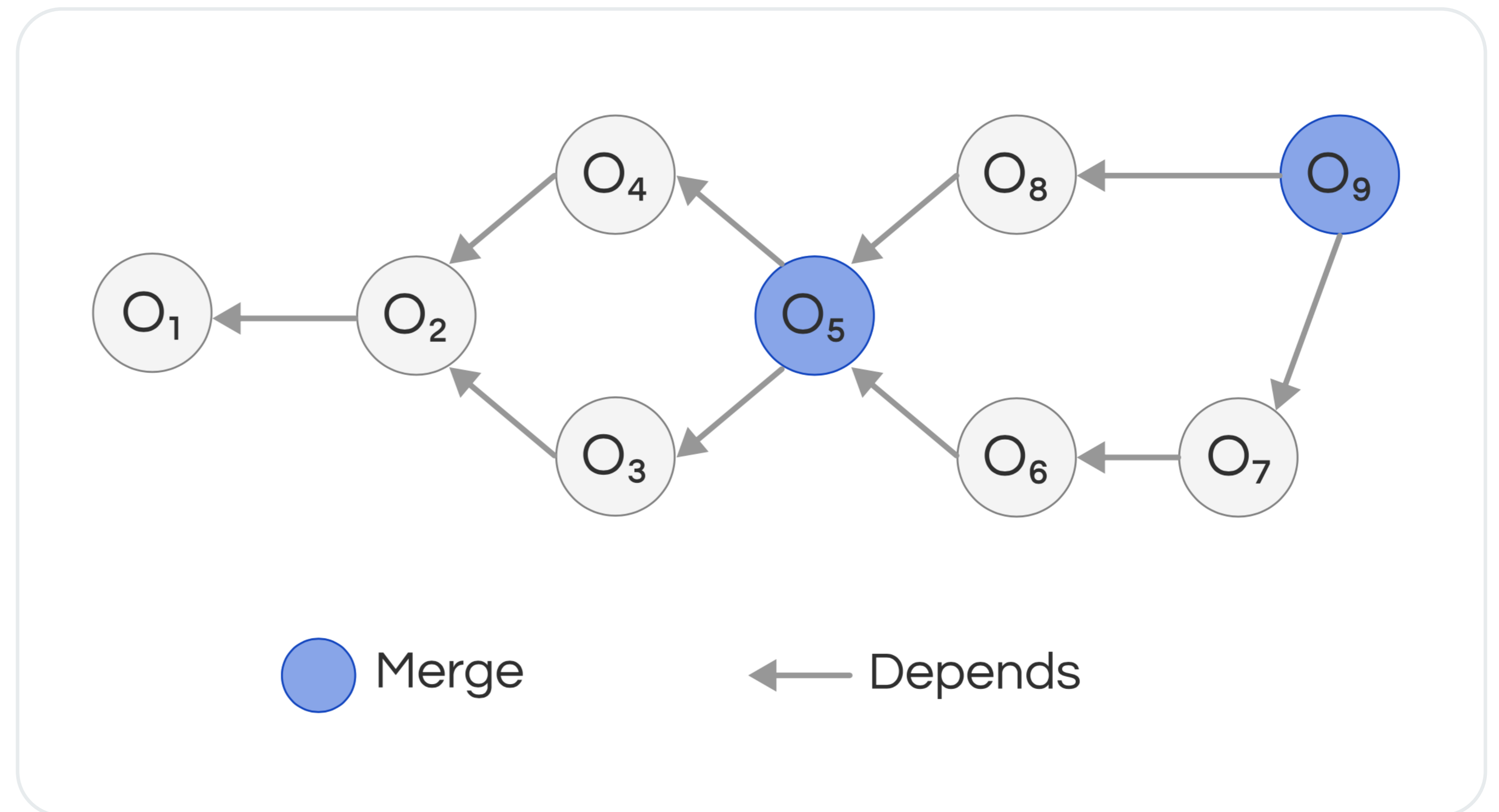


2. Resolving Divergence

- Special operation: 'Merge'
- If you link multiple → Should merge first
- Correct peer pre-agree on the merge policies



Rule: Resolve divergence with pre-agreed policy



3. Validity Rules

- Function 'Valid' against the state or messages
- Check message against local knowledge, no coordination required
- Examples: no double spend, no slur



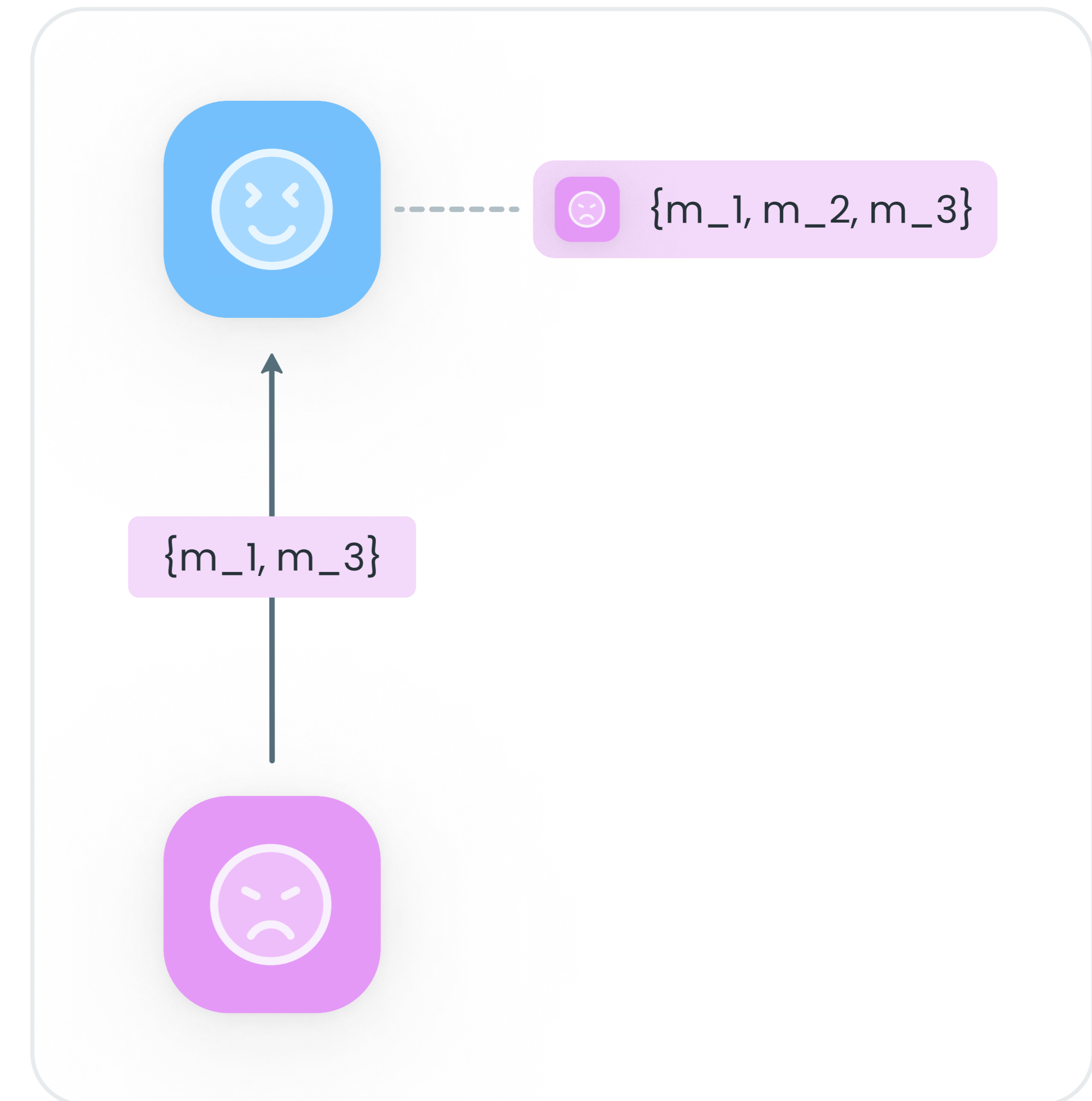
Rule: Never break pre-defined validity rules

4. Message Set Reconciliation

- 1996: Anti-Entropy
- 2011: Set reconciliation with Bloom Filters
- New: Compare against known last known set and check if node is hiding something



Rule: Report all messages



Accountable Protocols – Strong Foundation

- Expose peers that violate the rules
- Suspect peers that ignore requests
- Periodically gossip status to others



As a Result

- All observable malicious are exposed
- You only need 2 correct nodes to function

Q&A



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