NEAR

How NEAR’s Sharding Works

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Agenda

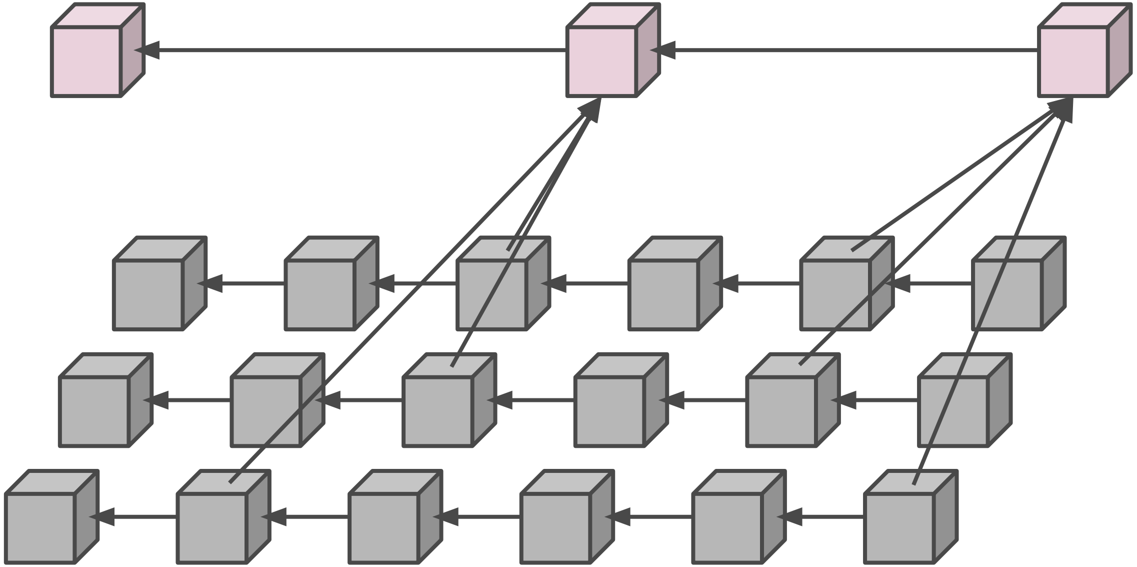
1. What is Sharding
2. Challenges of Sharding
3. The Nightshade Design
4. NEAR’s Sharding Roadmap

Sharding

- No sharding: every node processes all the transactions and validates all the state.
- Sharding
    - The network is divided into shards
    - In each shard, every node only validates the shard’s state and processes transactions related to this shard.

Sharding Overview

Main Chain
a.k.a.
Beacon Chain
Relay Chain
Hub

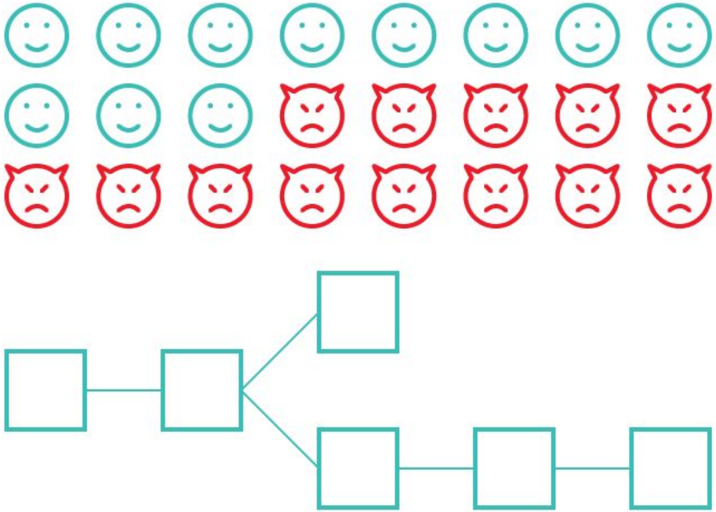


Shard Chains
a.k.a.
Parachains
Zones

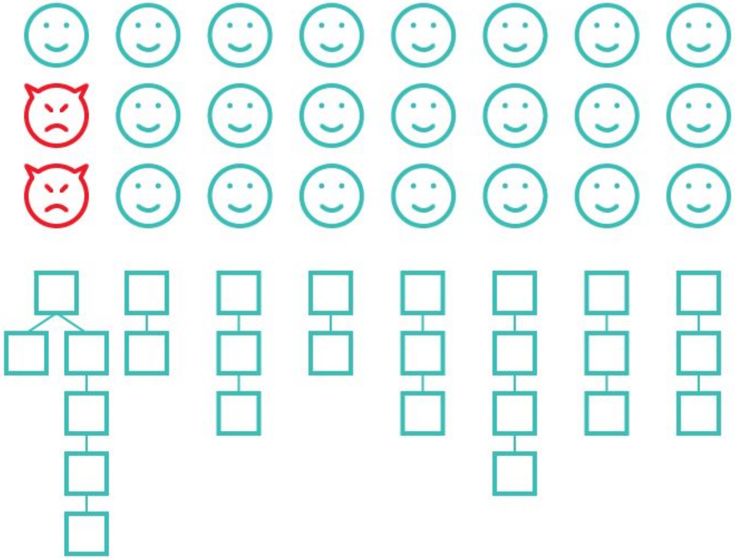
Challenges of Sharding

Corrupting Validators

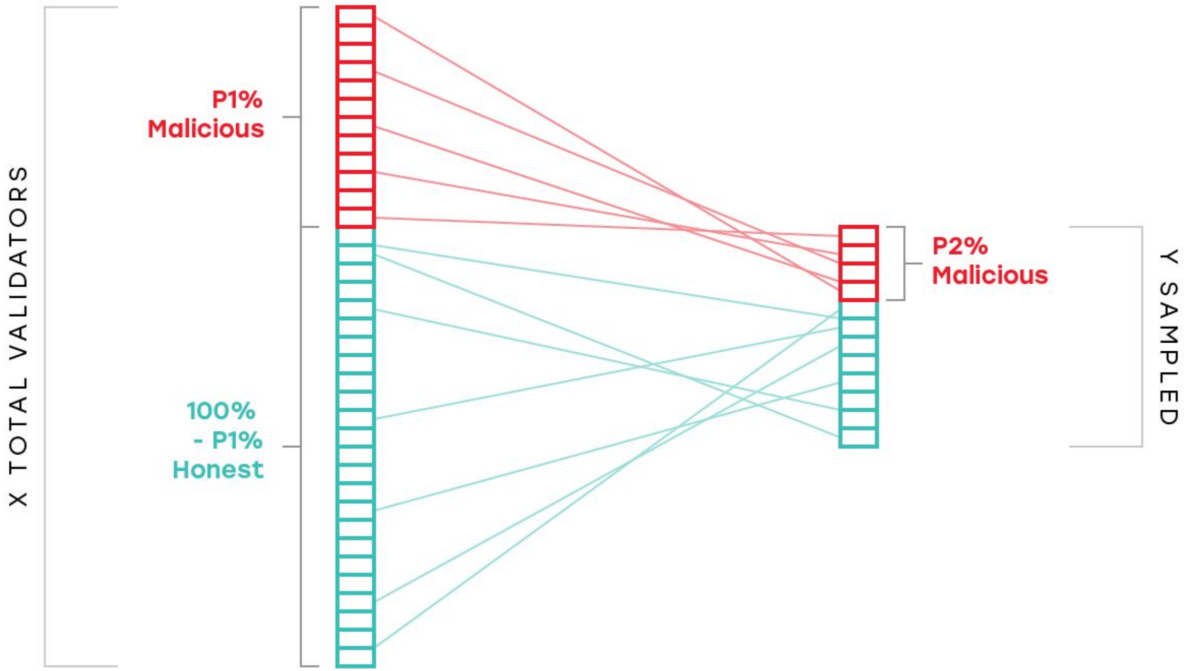
X validators building one chain.
Need to corrupt 0.51x



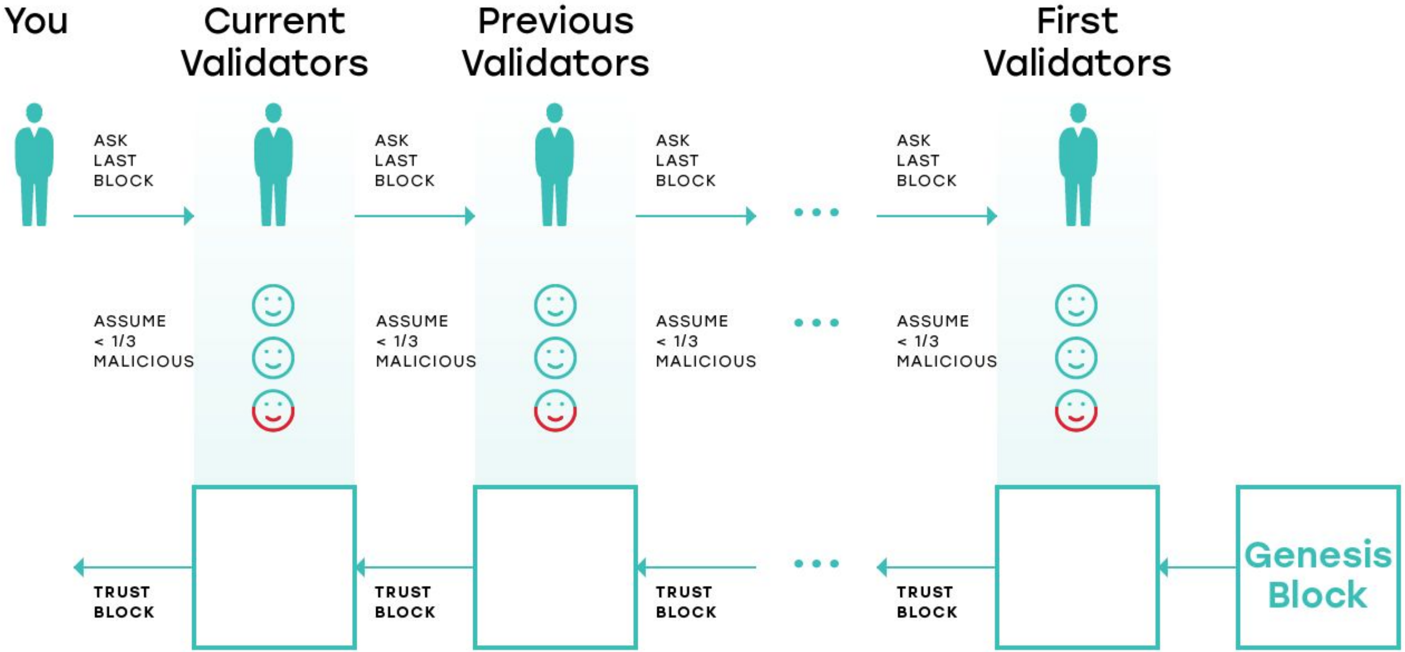
X validators building 10 chains
Need to corrupt 0.051x



Sampling Validators



Sampling Validators



Malicious Behavior

Forking

Invalid State Transitions

Invalid State Transition

Transaction X

From:	**Alice**
To:	**Bob**
Amt:	**10**

Block A (Valid)

State Before:	**Alice: 10, Bob: 0**
Transactions:	**X**
State After:	**Alice: 0, Bob: 10**

Block A’ (Invalid)

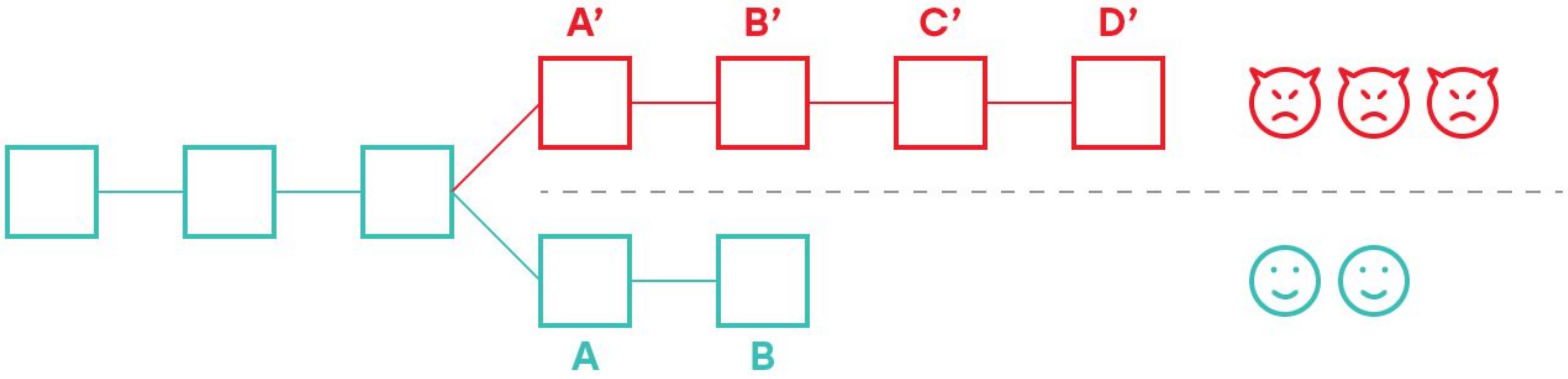
State Before:	**Alice: 10, Bob: 0**
Transactions:	**X**
State After:	**Alice: 0, Bob: 1000**

Malicious Behavior **without** Sharding

✓ Forking

✗ Invalid State Transitions

Malicious Behavior **without** Sharding

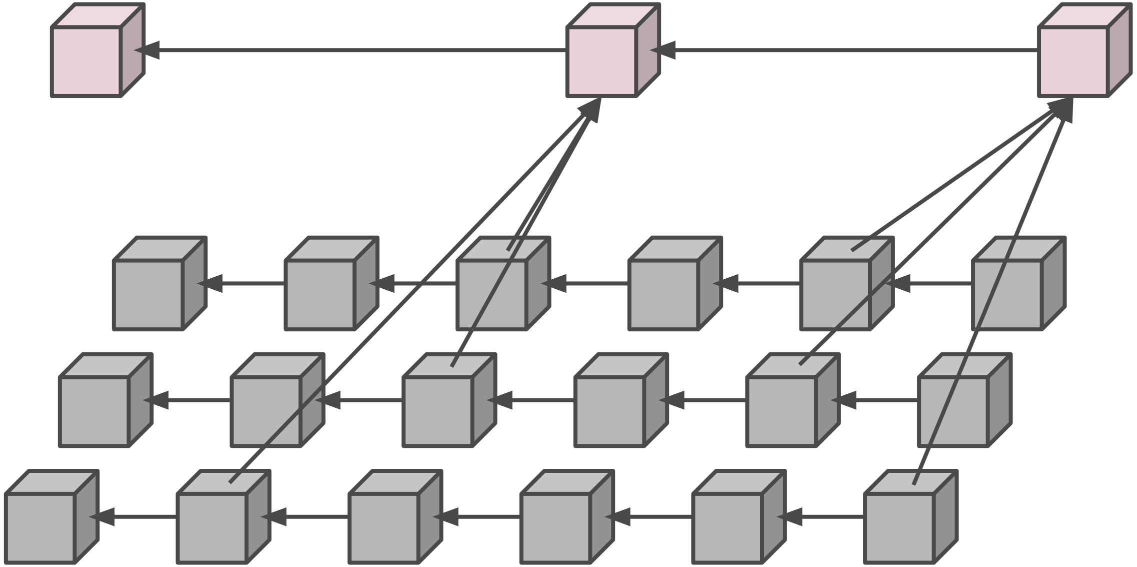


Malicious Behavior **with** Cross-Shard Transactions

- ✓ Forking
- ✓ Invalid State Transitions

Cross-shard Communication

Main Chain
a.k.a.
Beacon Chain
Relay Chain
Hub

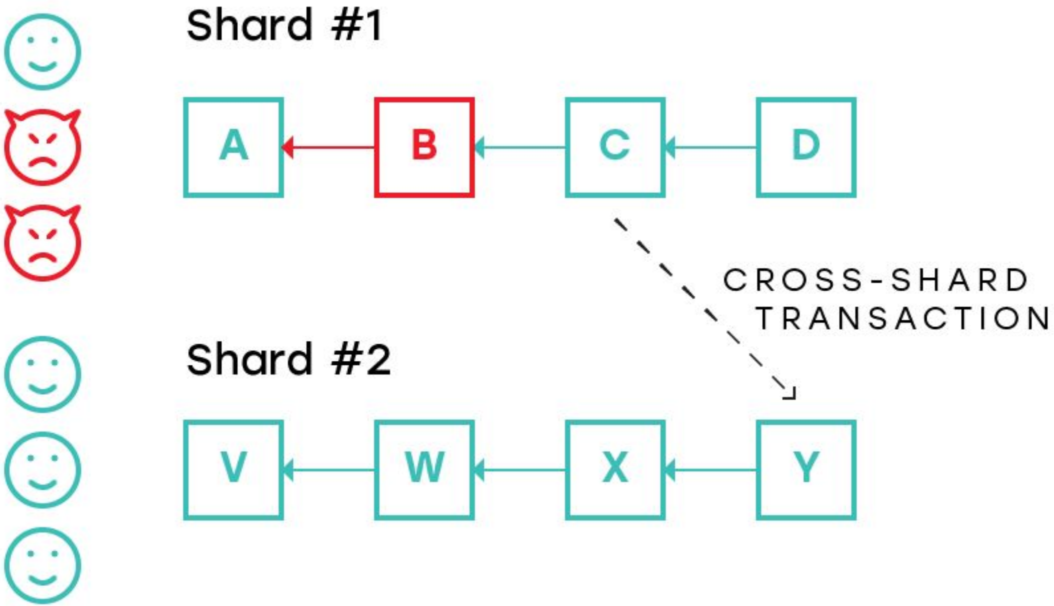


Shard Chains
a.k.a.
Parachains
Zones

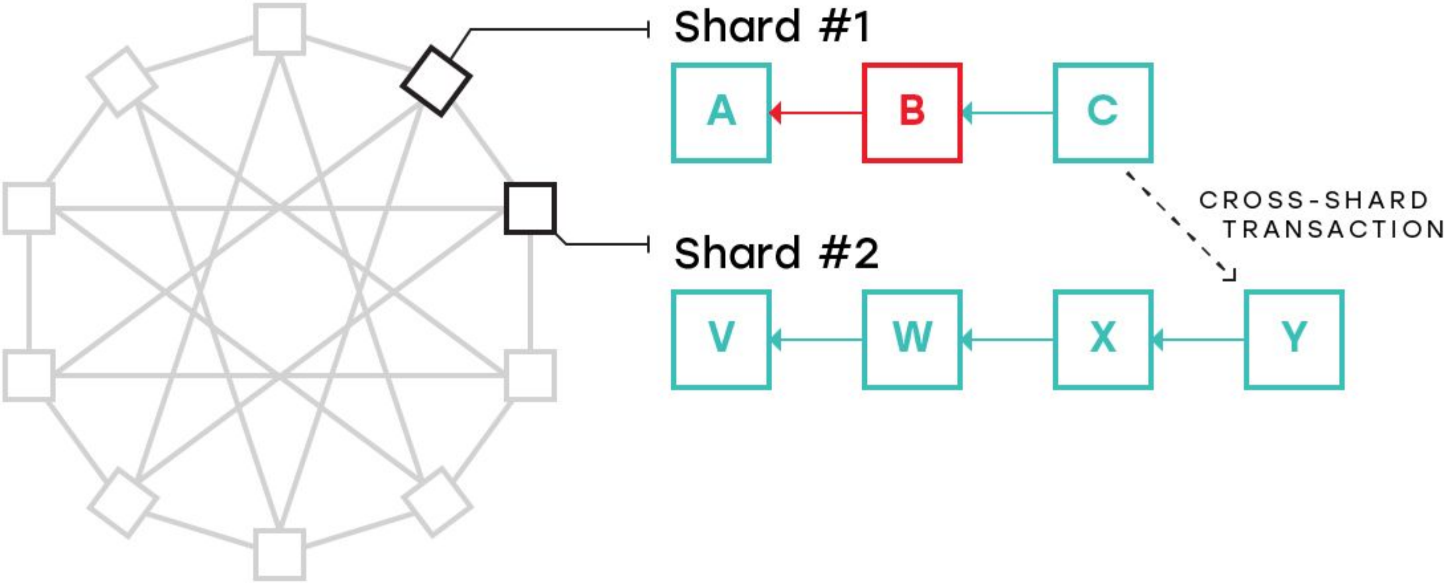
Cross-shard Communication: Receipts

- Alice from Shard#1 sends money to Bob on Shard#2;
- A tx that debits Alice’s account is executed on Shard#1;
- A proof of execution (Receipt) is created and sent to Shard#2;
- A tx that credits Bob’s account is executed on Shard#2.

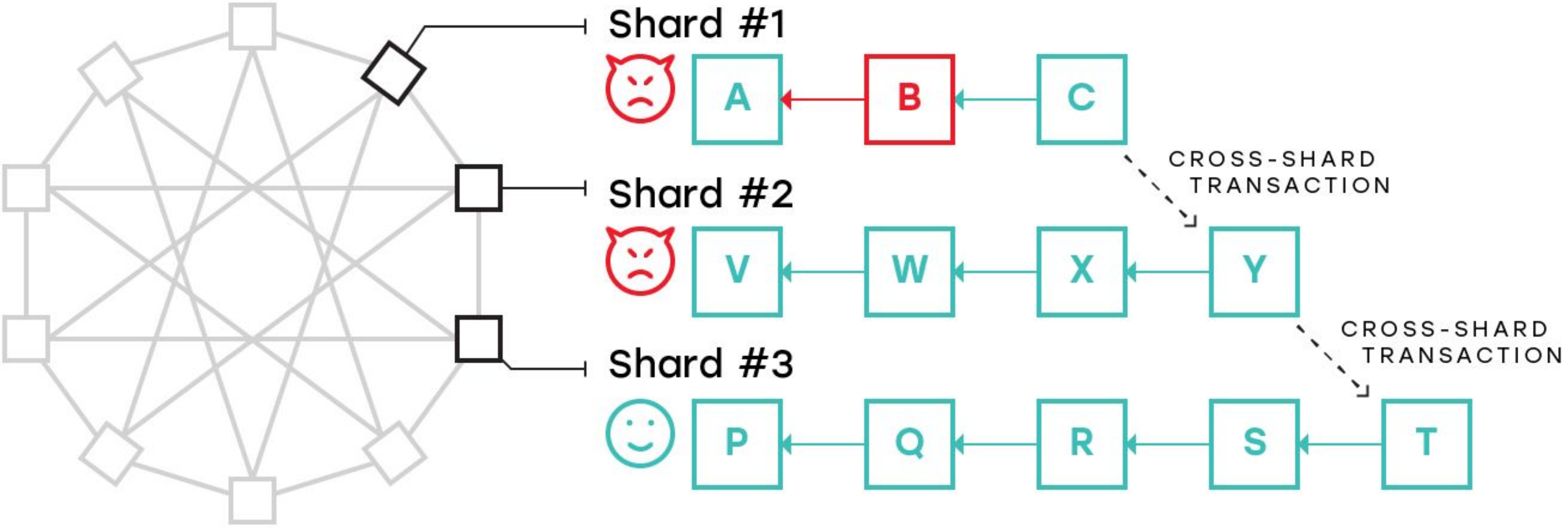
State Validity



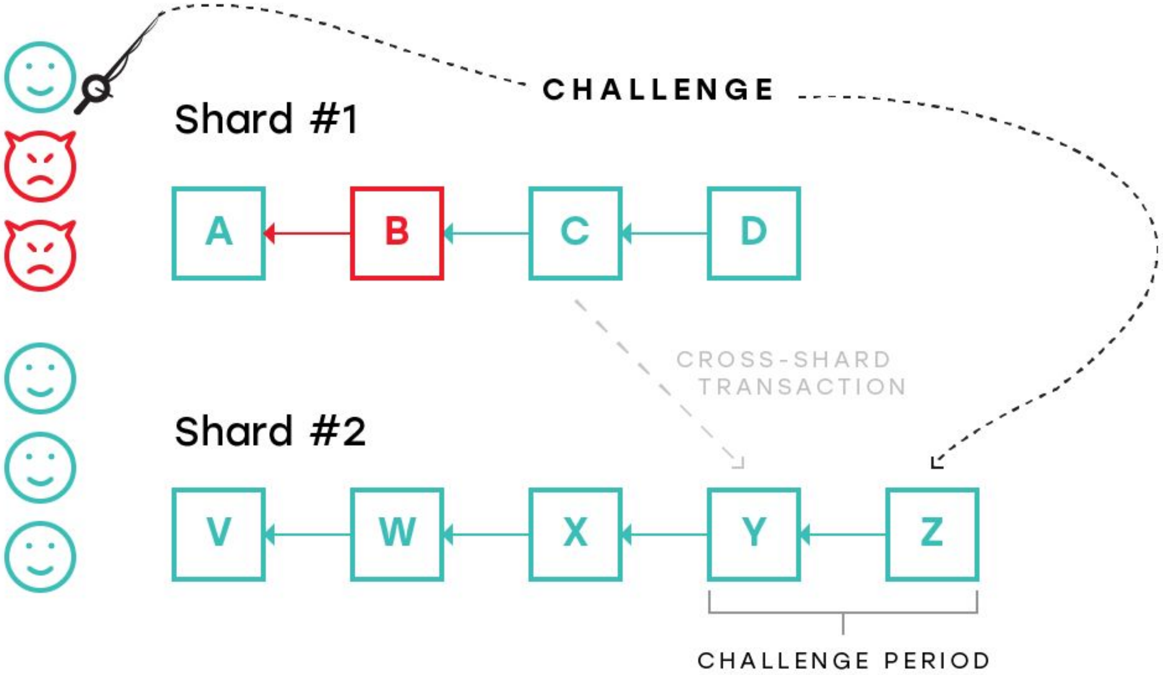
State Validity



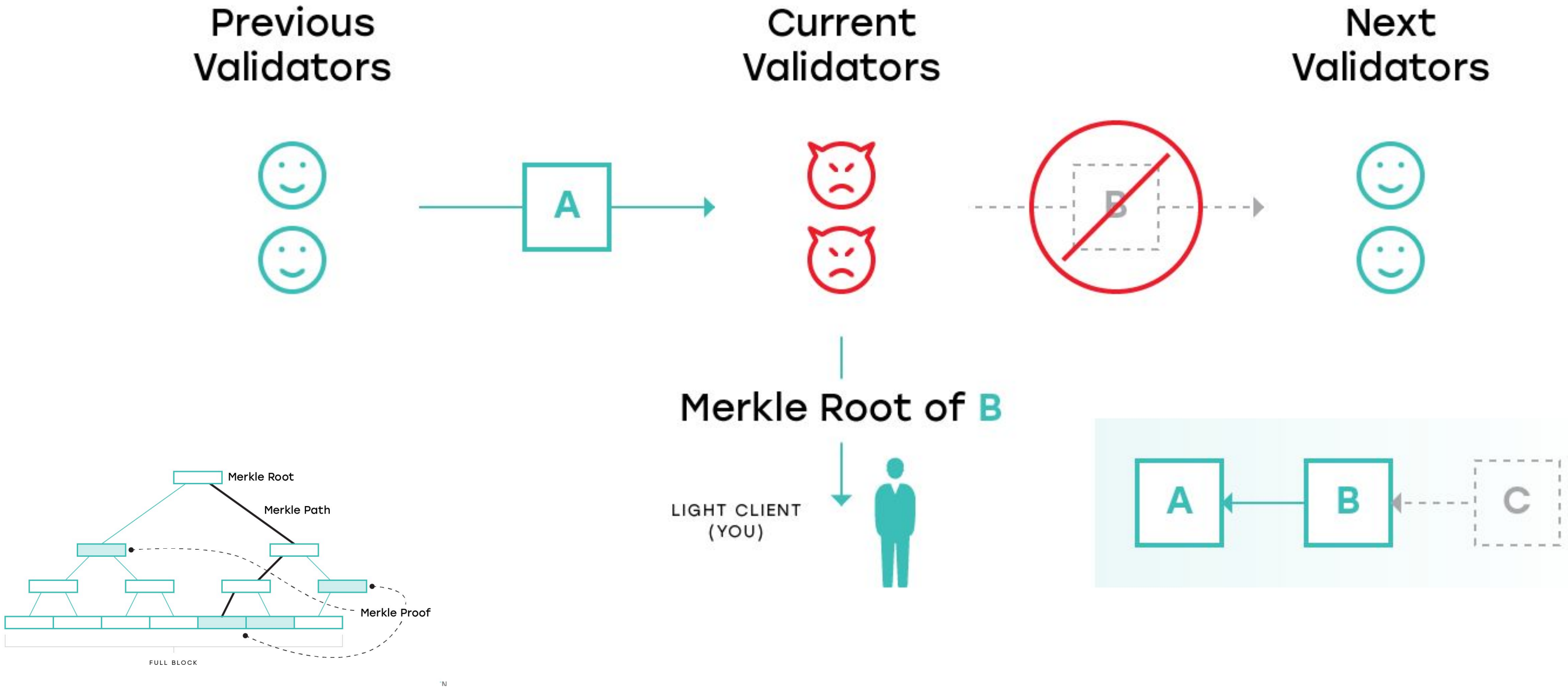
State Validity



Fisherman


CHALLENGE
Shard #1
A
B
C
D
CROSS-SHARD TRANSACTION
Shard #2
V
W
X
Y
Z
CHALLENGE PERIOD

Data Availability



Data Availability

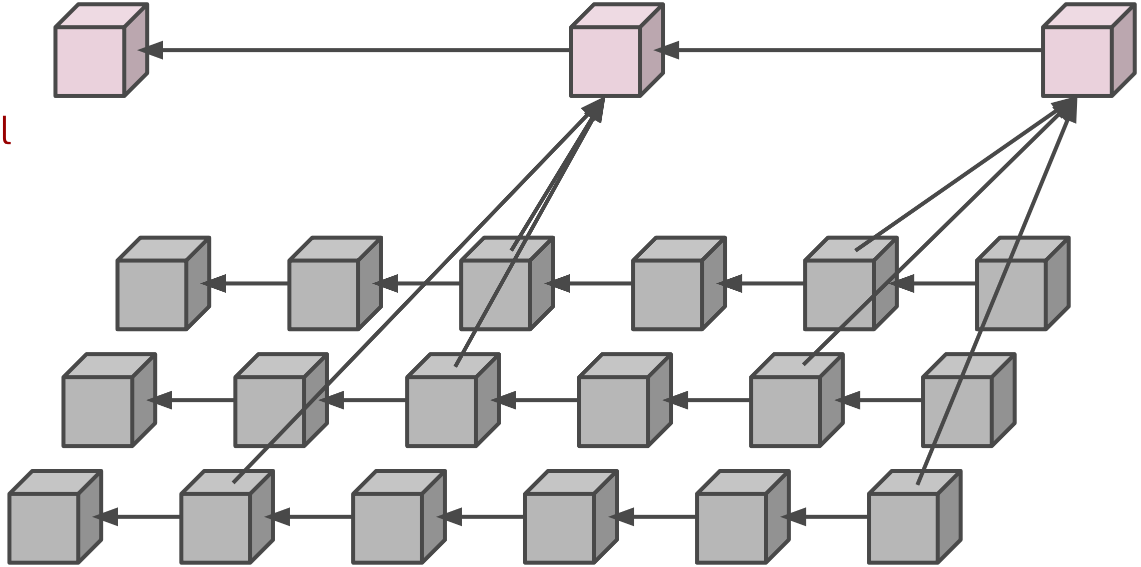
Main Chain

Light Client

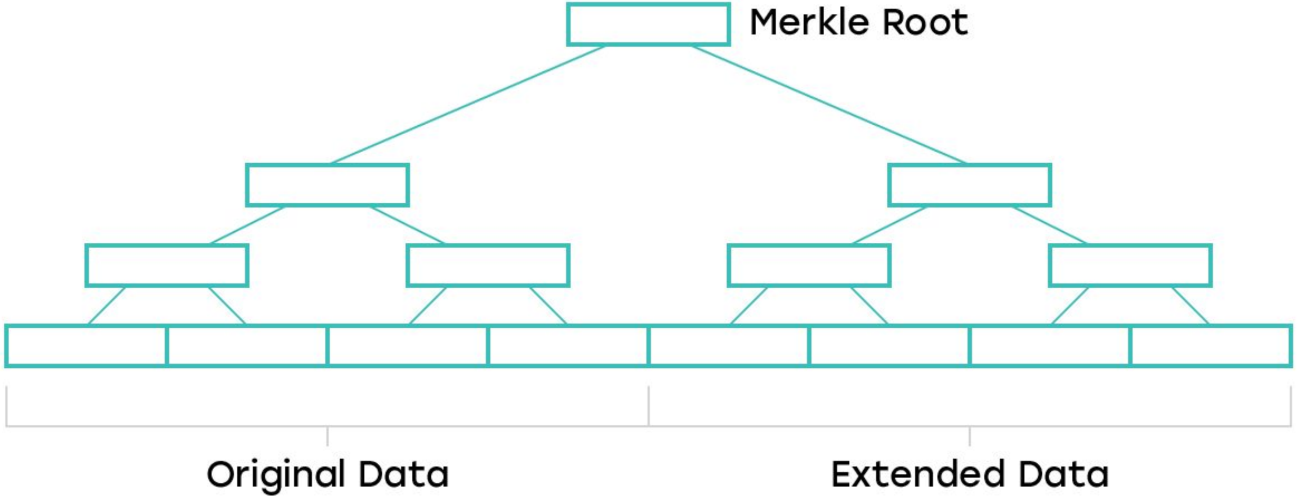
Can't download all the blocks from shard chains

Shard Chains

Full Nodes



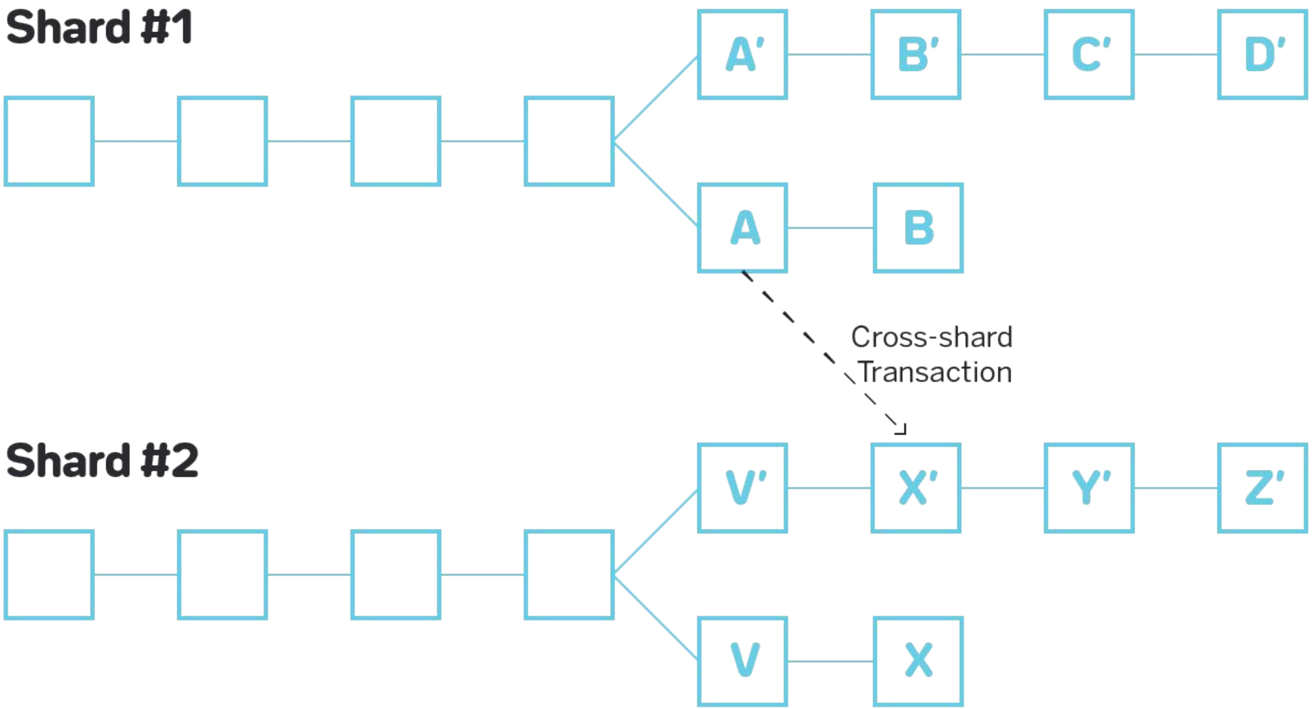
Data Availability



Any n out on 2n are sufficient to reconstruct

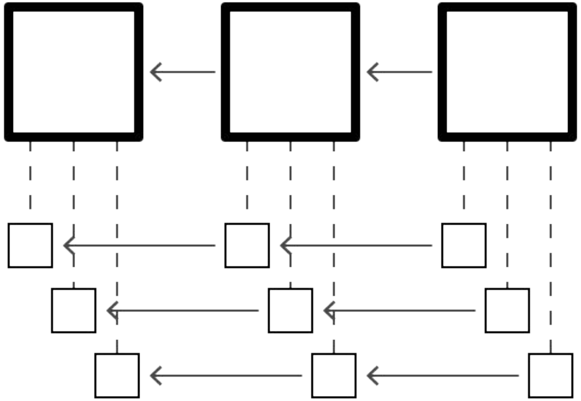
NEAR’s Sharding Design: Nightshade

From Shard Chains to Shard Chunks



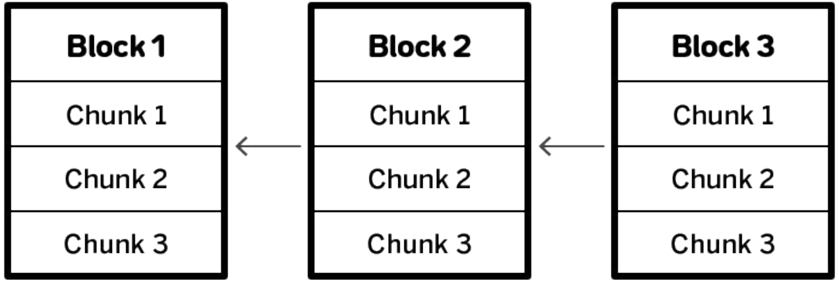
From Shard Chains to Shard Chunks

Beacon Chain



Shard Chains

Nightshade



Block 1

Chunk 1

Chunk 2

Chunk 3

Block 2

Chunk 1

Chunk 2

Chunk 3

Block 3

Chunk 1

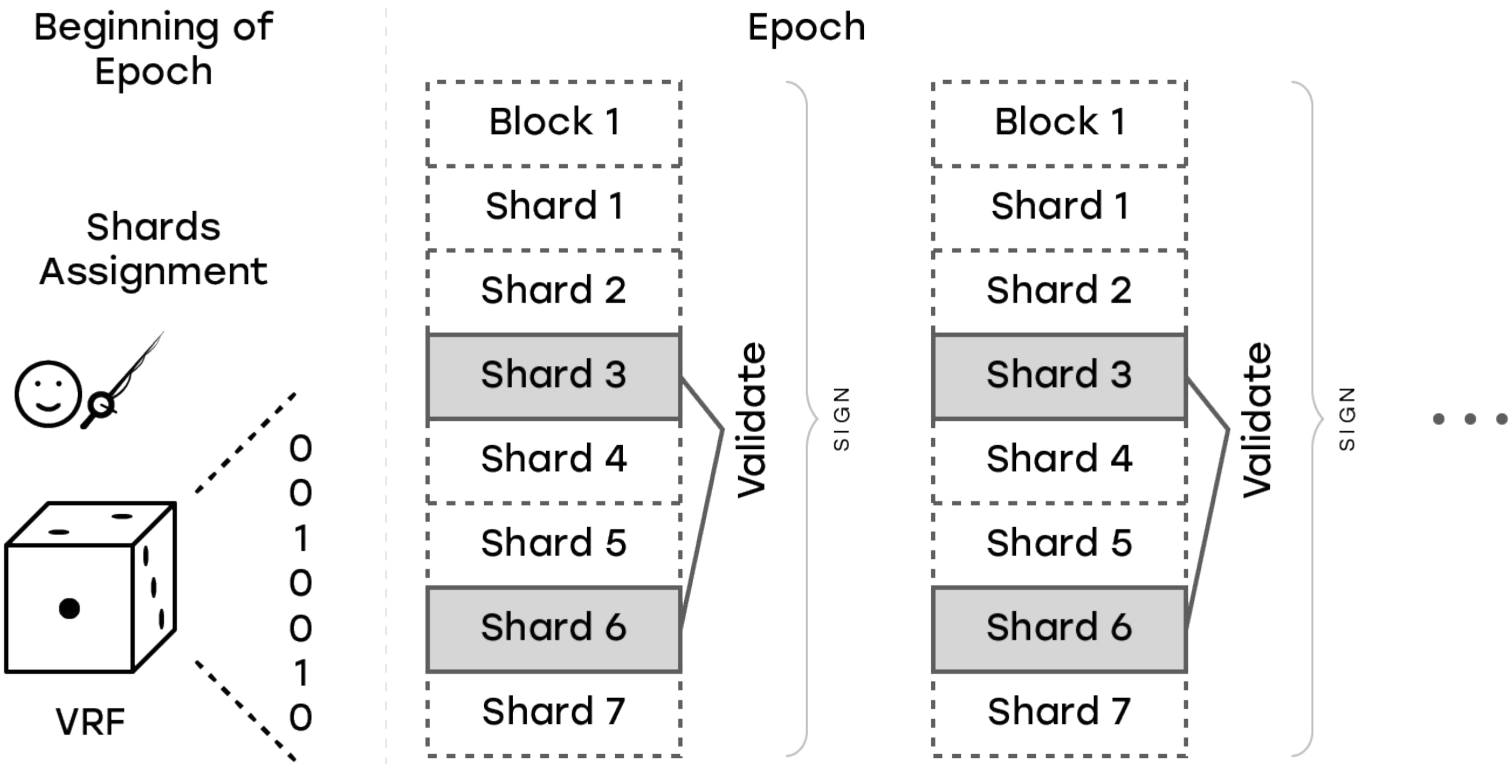
Chunk 2

Chunk 3

Many things become easier

- Atomicity between shards
- Fast cross-shard transactions
- Data availability

Hidden Validators



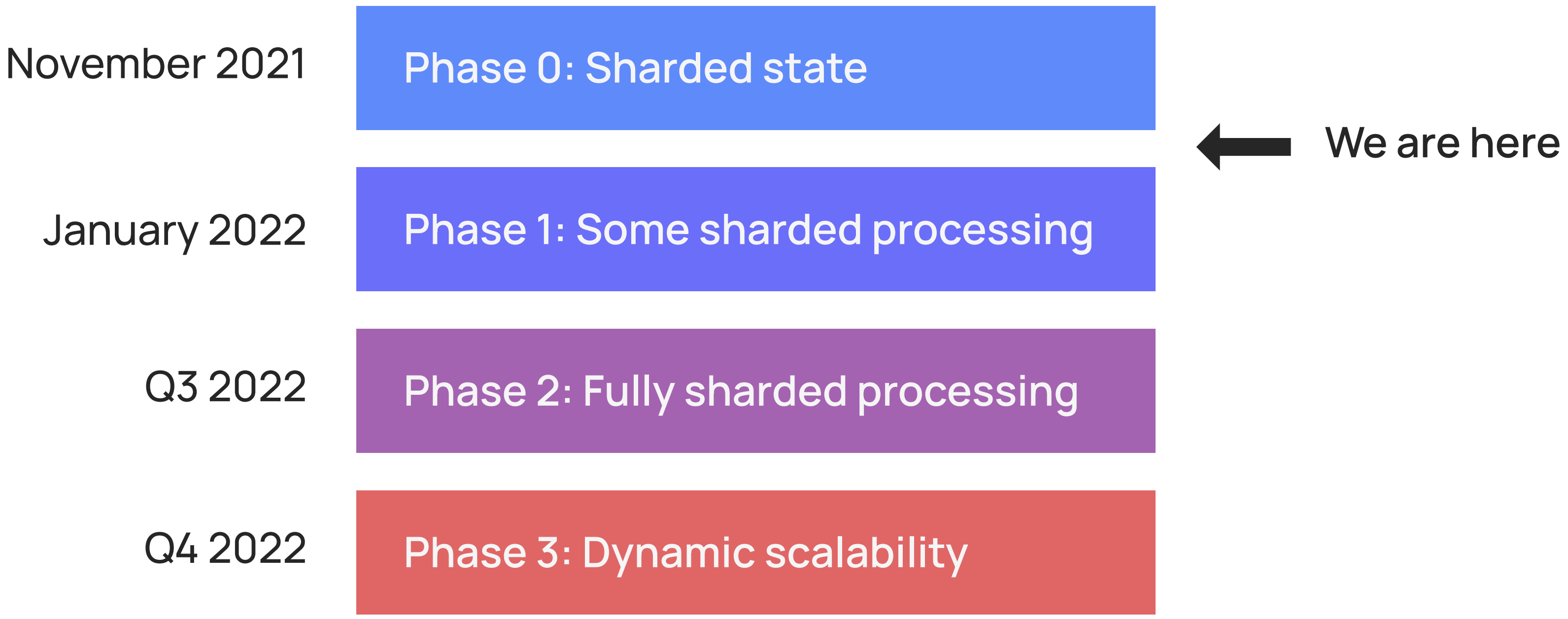
Check out near.ai/nightshade for more details!

Sharding is here.

Testnet: Oct 18

Mainnet: Nov 15

Sharding Roadmap



November 2021

Phase 0: Sharded state

We are here

January 2022

Phase 1: Some sharded processing

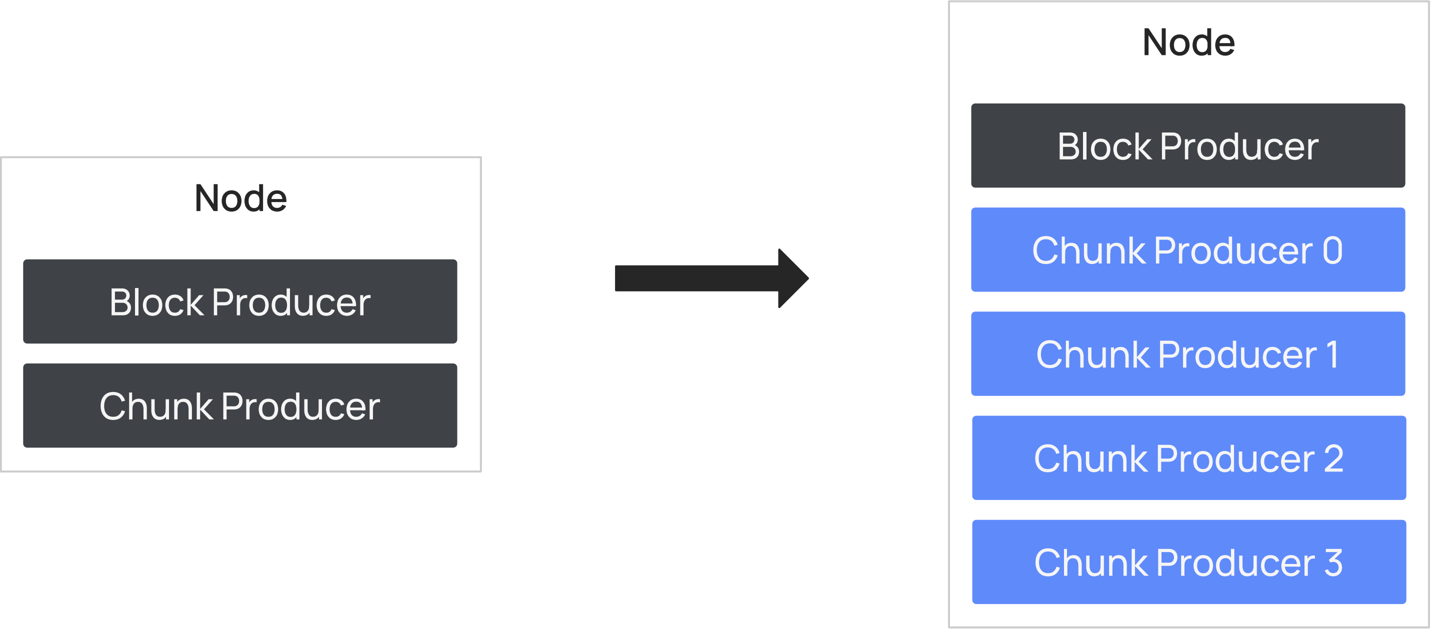
Q3 2022

Phase 2: Fully sharded processing

Q4 2022

Phase 3: Dynamic scalability

Phase 0: Sharded State



Node

Block Producer

Chunk Producer

Node

Block Producer

Chunk Producer 0

Chunk Producer 1

Chunk Producer 2

Chunk Producer 3

Phase 0: Sharded State
What it Means for the Builders?

- NO DEVX CHANGES!
- Intra-shard and inter-shard contract calls are exactly the same;

Phase 0: Sharded State

NEP-241

Epoch T-2	Epoch T-1	Epoch T
Validators learn that sharding starts at T.	Prepare states of shards for epoch T. Both old and new states are maintained.	Use prepared states.

Phase 0: Sharded State
NEP-241

Epoch T-2	Epoch T-1	Epoch T
1 Shard	Still 1 Shard...	4 Shards

- Definition of shard 0 changes
- Unique shard id = shard id AND layout id .

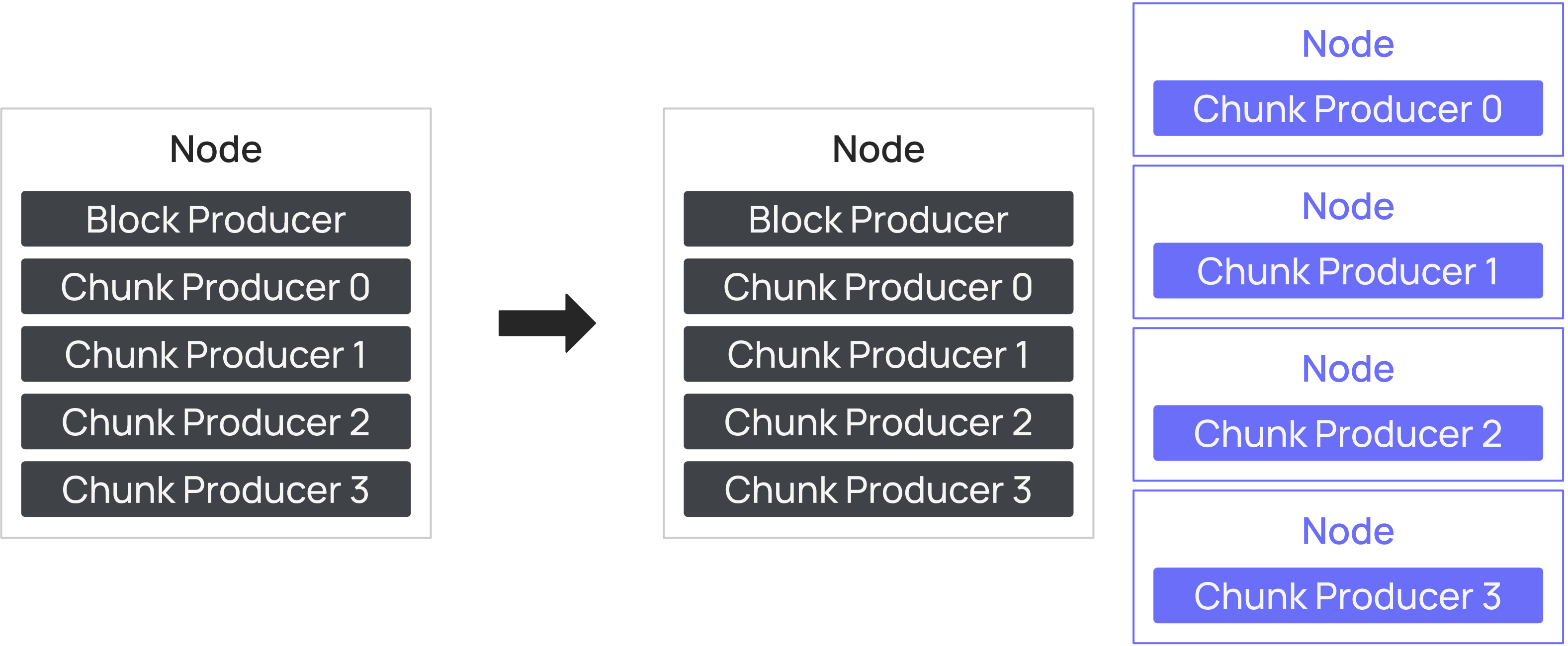
  Allows more resharding in the future!

Phase 0: Sharded State
NEP-241

Epoch T-2	Epoch T-1	Epoch T
1 Shard	Still 1 Shard...	4 Shards

- Epoch T-1 is a tricky one
- It computes transactions/receipts in non-sharded order
- But computes sharded state

Phase 1: Some Sharded Processing



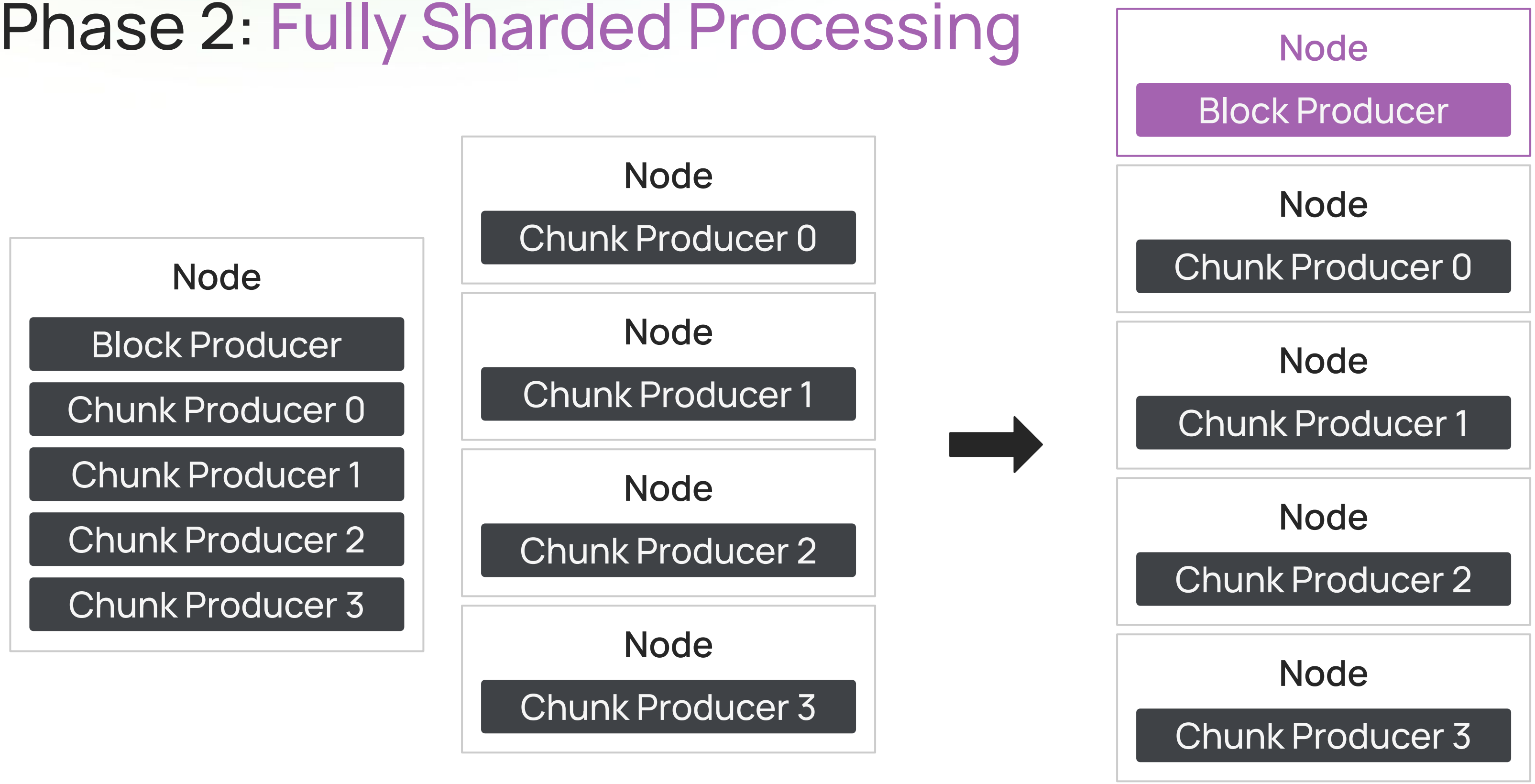
Phase 1: Some Sharded Processing
What it Means for the Builders?

- NO DEVX CHANGES (You’ll see this frequently :))

Other planned protocol changes:

- New gas injector – 4-5x higher TPS;
- Gas price auction – shards won’t interfere with each other;
- New state design – cheaper contract IO;
- Low-level state optimizations – even cheaper contract IO.

Phase 2: Fully Sharded Processing



Phase 2: Fully Sharded Processing
What it Means for the Community?

- Sharded State and Processing. Now THIS is Sharding!
- No major bottlenecks – The sky is the limit
- Automatic resharding based on usage – shards won’t capsize

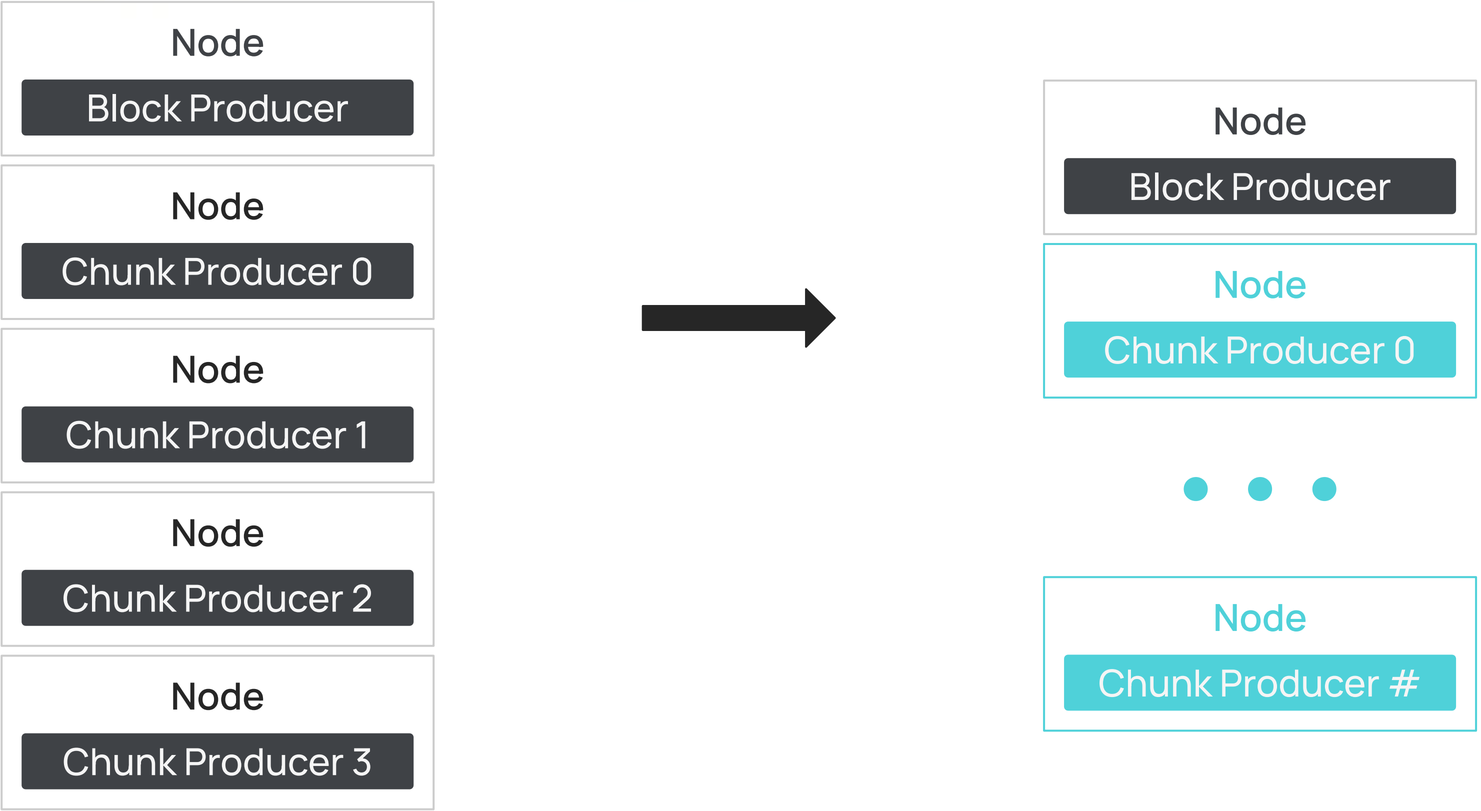
Phase 2: Fully Sharded Processing
What it Means for the Builders?

- Challenges can revert some state. Be careful;

Other planned protocol changes:

- Transactions will attach NEAR – no need to guesstimate gas;
- Synchronous execution – in case you’ll be missing it.

Phase 3: Dynamic Scalability



Phase 3: Dynamic Scalability
What it Means for the Community?

- It will adjust itself. No need to vote on #shards;
- Fully self-sustaining system

The Future is NEAR