

Heterogeneous sharding can be used to allow higher gas transactions on certain shards without affecting other shards' collation frequency.

Under the current Phase 1 implementation, we have collation body sizes of each shard fixed at 1MB. By allowing different shards different (but fixed) collation sizes, we can allow higher gas transactions on certain shards, without altering period length.

Instead of altering period length, we can instead grant notaries the ability to submit collation headers up to  $\text{floor}(\text{collation\_size}/1\text{MB}) - 1$  periods ahead.

Additionally, we need to reward notaries proportional to the collation size of the shard they have been assigned to to account for the additional time to download and vote on the collation.

We also need to set the notary burst overhead to be proportional to the collation size as well in order to give notaries time to download and vote on collation headers.

The main issue at hand is whether this interferes with random sampling from the notary registry and consequently allows coordinated attacks on shards.

Another concern of heterogeneous sharding is dealing with preferences for accounts on certain shards. A contract that doesn't require high gas transactions would be better off on a low collation body size shard that will be verified every period. Assuming cross shard transactions, however, this should not be a problem, as we can model the shard properties and determine the appropriate collation sizes for an appropriate distribution of shards. For example, the example above suggests that we most likely would want to keep a significant majority of shards at the 1Mb size such that they can be verified every period.

Determining the properties of shards also raises larger questions about governance over the properties of shards.