Lite Client Protocol

In addition to the native IBC connections, we also provide a lite client for anyone who requested data from our oracle to verify the validity of the result they received. An instance of this client exists on each of the blockchains to which Band has integrated.

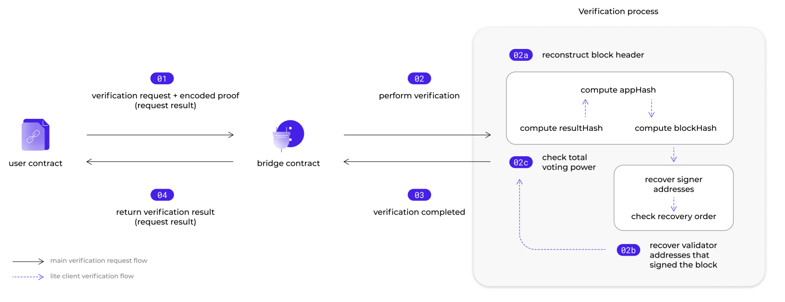
When someone submits a verification request to our lite client, they must also send in the encoded result they got from BandChain oracle. This is because the result is not just the data they requested, but also contains information on the request itself as well as the associated

to prove that the data the user requested exists on BandChain, thus verifying the oracle result’s validity.

The lite client's verification process checks for 3 conditions:

1. that the proof received in the request can be used to construct a valid block header
2. that using the constructed block header, it can recover a valid set of validator addresses who signed on the block
3. that those validators have sufficient total voting power relative to the system total

The diagram below illustrates the above steps.



Header from the Oracle

Data Proof

The proof that BandChain's oracle returns is a packet called `result` which encodes the information from both the oracle request sent to BandChain and the oracle response aggregated from reports submitted by validators assigned to this request. Some of the information includes

- The identifier of the oracle script requested,
- The number of validators that are requested to respond to this request,
- The number of validators that actually responded to the request,
- The timestamp of when the request was sent and when it was resolved to a final result
- The actual final result itself if the request was successful.

For a full detailed breakdown of the packet's contents, please see our GitHub repository ↗.

The steps that make up this process are as follows:

- Use the proof sent to construct the oracle store's root hash
- Combine the oracle store hash with the hashes of the other stores in our application to compute the appHash
- Finally, use the appHash, in combination with other block information hashes, to compute the blockHash

Constructing the Oracle Store's Root Hash

Oracle Store Tree Contents

BandChain's oracle system resides in an `oracle` Cosmos module ↗, also known as the `oracle` store. Each of these stores can then be represented as an iAVL tree ↗, where the bottom or leaves of these store trees contains the byte representation of the data in that module. In our case of the `oracle` store root, the only piece of

packet.

As mentioned previously, the `result` packet contains information related to both the request that the user made to our oracle, such as the oracle script identifier and the number of requested validators, and the corresponding oracle response composed from validators' reports, such as the actual number of validators that responded to the request as well as the actual result value itself.

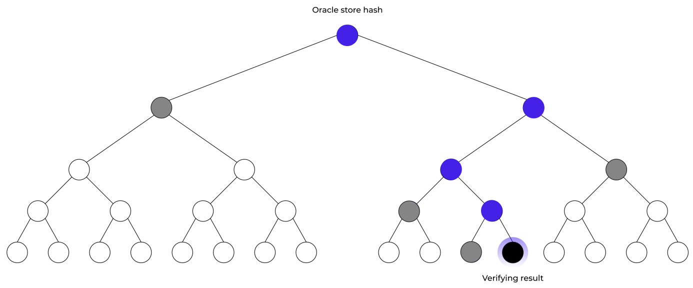
This `result` packet is what the lite client essentially returns to the requester upon successful validation. By also returning contextual information on the request and response, in addition to the actual result value itself, we aim to give as much information as possible for the user to use in their application or for any further validation they might want to perform.

Constructing the oracle store leaf node

Using the `result`, we can create an intermediary hash value called the `dataHash` by encoding then hashing the `result`. If we then the data node was updated), and the request ID of the request, we arrive at the leaf node of the oracle store tree, also known as the `resultHash`.

After we have the leaf node, we then need to use that node to gradually climb up the tree to reach the store's root node. To help us do so, we use an additional piece of information in the proof; the `merklePaths`.

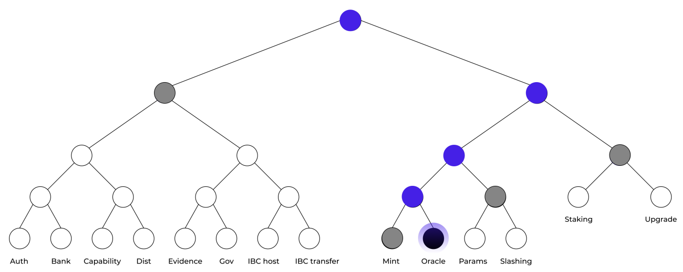
Computing the oracle store root hash



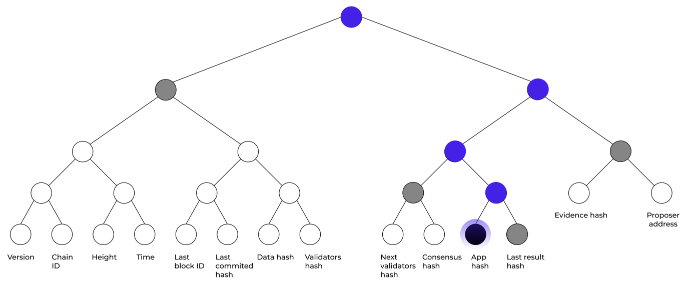
Shown in the figure above, the left node of the `result` we want to verify is represented by the black node. The `merklePaths` we mentioned is a Merkle proof that shows how the `dataHash` leaf node we just computed is part of the larger

"Merkle paths" from the leaf to the root of the tree. Each merkle path contains the sibling hash for each step represented by the gray nodes. With a node hash and a corresponding merkle path, we can get the parent hash of the node hash and the sibling hash in the merkle path. Hence, we can the use these Merkle paths to compute the parent hash of our `dataHash`. If we then repeat this process, we can gradually climb up the store tree, finally getting the oracle store root hash we want. In the above figure, all parent hashes computed along the tree climbing process starting from the black node are represented by blue nodes.

Computing the appHash and the blockHash



the other stores in our application to compute the `appHash`. Since all the stores are stored in a form of tree, we can use the same climbing process to reach the root of this tree or the `appHash`. Note that the starting point now is the oracle store hash which is the only black node as depicted in the figure above.



We can then use that `appHash` to finally compute the `blockHash` using the very same method.

Recovering Signer Addresses

After we have constructed a `blockHash`, we can

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who signed on this block using Ethereum's ecrecover ↗ opcode. To ensure that the addresses we extracted are valid, we verify that each address we extract is unique.

As we recover each signer, we also add each extracted validator's voting power to a counting tally, which we will use in the next step.

Checking Total Voting Power

Once we have extracted all of the validators and ensure that the extracted order is correct, we proceed to check if the tallied voting power is sufficient. Specifically, we check that the tallied value is at least two-thirds of the system's total voting power. This threshold check is to ensure that we reach consensus.

If the tallied voting power exceeds the two-third threshold, we have successfully proven that the proof is valid. Our lite client can then decode the result and return it to the requester to either use