An informal description of the endorsement protocol of Hyperledger Fabric

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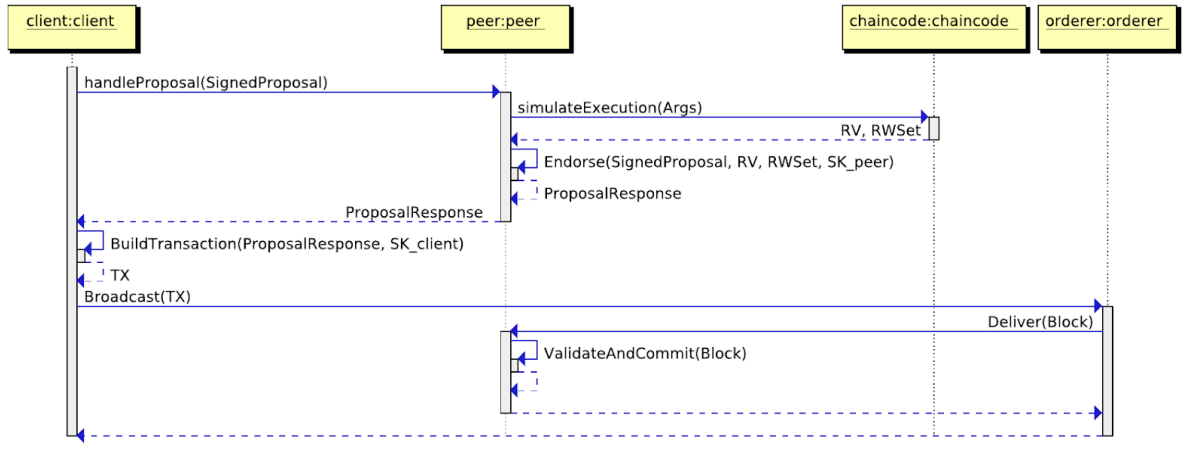
This document describes the protocol used in fabric to modify state. The protocol operates as shown in the figure below.



The flow involves the following steps:

1. The client sends a `SignedProposal` to the peer
2. The peer invokes the appropriate chaincode supplying the arguments provided by the client and obtains a `RWSet` (i.e. a proposed update of the world state) and a return value
3. The peer endorses the execution and its results, creates a `ProposalResponse` and sends it back to the client
4. The client creates a transaction and sends it for ordering
5. The ordering server orders the transaction
6. The peer receives an ordered block, validates it and commits it

Step 1

Initially the client creates a `SignedProposal` message, which is defined as follows

```
SignedProposal {
      Proposal Proposal {
            ChannelHeader ChannelHeader {
                  ChannelId string
                  ChaincodeName string
                  ChaincodeVersion string
                  TxId string
            }

            SignatureHeader SignatureHeader {
                  Creator []byte
                  Nonce []byte
            }

            Args [][]byte
      }

      Signature []byte
}
```

Notable fields include:

- `ChannelId` Is the name of the fabric channel that is the target of this transaction; a channel is a way of creating more than one logical instance of a ledger/world state and chaincode namespace within a single physical instance of fabric.
- `ChaincodeName` and `ChaincodeVersion` are the name and version of the chaincode that is being invoked by this proposal.
- `TxId` Is the transaction identifier, computed as the hash of `SignatureHeader`.
- `Creator` is the serialized identity of the client.
- `Nonce` is an array of random bytes.
- `Args` is the set of arguments for this chaincode invocation.
- `Signature` is a signature of the client over the `Proposal`.

Step 2

In this step, the peer contacts the chaincode docker container and requests it to execute based on the supplied arguments (`Args`). The chaincode executes and may perform `GetState` calls to read the current world state. Any call to modify world state (`PutState` or `DeleteState`) does not affect world state; it is instead added to the `RWSet` that keeps track of the changes to the world state that this proposal would require if committed. The chaincode returns to the peer the `RWSet` and a return value.

Step 3

The peer uses the proposal, its signing key and the results of the chaincode execution to generate a `ProposalResponse` message, which is defined as follows

```
ProposalResponse {
      ProposalResponsePayload ProposalResponsePayload {
            ProposalHash []byte
            ChaincodeName string
            ChaincodeVersion string
            RWSet []byte
            RV []byte
      }

      Endorsement Endorsement {
            Endorser []byte
            Signature []byte
      }
}
```

Notable fields include:

- `ProposalHash` is the hash of the `Proposal` message.
- `Endorser` is the serialized identity of the peer.
- `Signature` is a signature over `ProposalResponsePayload` and `Endorser`.

Step 4

The client uses the ProposalResponse and its signing key to create a `Transaction` message, which is defined as follows

```
Transaction {
      Payload Payload {
            ChannelHeader ChannelHeader {
                  ChannelId string
                  ChaincodeName string
                  ChaincodeVersion string
                  TxId string
            }

            SignatureHeader SignatureHeader {
                  Creator []byte
                  Nonce []byte
            }

            TransactionAction TransactionAction {
```

```
                Args [][]byte

                ProposalResponsePayload ProposalResponsePayload {
                      ProposalHash []byte
                      ChaincodeName string
                      ChaincodeVersion string
                      RWSet []byte
                      RV []byte
                }

                Endorsements []Endorsement {
                      Endorser []byte
                      Signature []byte
                }
          }
      }

      Signature []byte
}
```

Notable fields include:

- `ChannelHeader` and `SignatureHeader` are supposed to be the same as in the `Proposal` message.
- Args is supposed to be the set of arguments originally supplied to the chaincode invocation.
- `ProposalResponsePayload` comes from the field of the same name in the `ProposalResponse` message.
- The `Endorsements` array is filled from the field of the same name in the `ProposalResponse` message. Note that more than one endorsement can be collected from as many `ProposalResponse` messages.

Step 5

The orderer uses its internal algorithms to create an ordered sequence of transactions.

Step 6

The peer receives a `Block` message from the orderer, which is defined as follows

```
Block {
      BlockHeader BlockHeader {
            Number       uint64
            PreviousHash []byte
            DataHash     []byte
      }
```

```
      OrdererSignature OrdererSignature {
            SignatureHeader SignatureHeader {
                  Creator []byte
                  Nonce []byte
            }

            Signature       []byte
      }

      Transactions []Transaction {
            Payload Payload {
                  ChannelHeader ChannelHeader {
                        ChannelId string
                        ChaincodeName string
                        ChaincodeVersion string
                        TxId string
                  }

                  SignatureHeader SignatureHeader {
                        Creator []byte
                        Nonce []byte
                  }

                  TransactionAction TransactionAction {
                        Args [][]byte

                        ProposalResponsePayload ProposalResponsePayload {
                              ProposalHash []byte
                              ChaincodeName string
                              ChaincodeVersion string
                              RWSet []byte
                              RV []byte
                        }

                        Endorsements []Endorsement {
                              Endorser []byte
                              Signature []byte
                        }
                  }
            }

            Signature []byte
      }
}
```

Notable fields include:

- `Number` is a block counter.
- `PreviousHash` is the hash of the previous block.
- `DataHash` is the hash of the data portion of this block.
- `OrdererSignature` contains a signature from the orderer over BlockHeader and `OrdererSignature.SignatureHeader`.
- `Transactions` is an array of `Transaction` messages.

The peer performs a number of security checks, including:

- There is no other committed transaction in the ledger with the same `TxId`.
- The `Endorsements` array complies with the endorsement policy of the specified chaincode on the specified channel.
- Each of the signatures in `Endorsements[i].Signature` is a valid signature from `Endorsements[i].Endorser` over `ProposalResponsePayload` and `Endorser`
- `ProposalHash` is the hash of the concatenation of `Payload.ChannelHeader`, `Payload.SignatureHeader` and `Payload.TransactionAction.Args`.

Appendix

Sequence diagram sources (http://sdedit.sourceforge.net)

```
client:client
peer:peer
chaincode:chaincode
orderer:orderer

client:ProposalResponse=peer.handleProposal(SignedProposal)
peer:RV, RWSet=chaincode.simulateExecution(Args)
peer:ProposalResponse=peer.Endorse(SignedProposal, RV, RWSet, SK_peer)

client:TX=client.BuildTransaction(ProposalResponse, SK_client)&
client:orderer.Broadcast(TX)
orderer:peer.Deliver(Block)
peer:peer.ValidateAndCommit(Block)
```