Circuits

Overview

All rules a transaction must follow in order to be valid are designed and coded in the circuits. Those rules could be seen as constraints that a transaction must accomplish in order to be able to modify the state tree or the exit tree.

Circuits are built from the bottom up. Hence, small circuits are first introduced and are referenced in advanced ones for the sake of clarity.

Circuits would be splitted in three modules: - library: basic hermez circuits and structs commonly used across the rest of the circuits - withdraw: specifc circuit to allow a user to withdraw funds from hermez contract - rollup-main: main circuit that contains all the logic described in zkRollup protocol

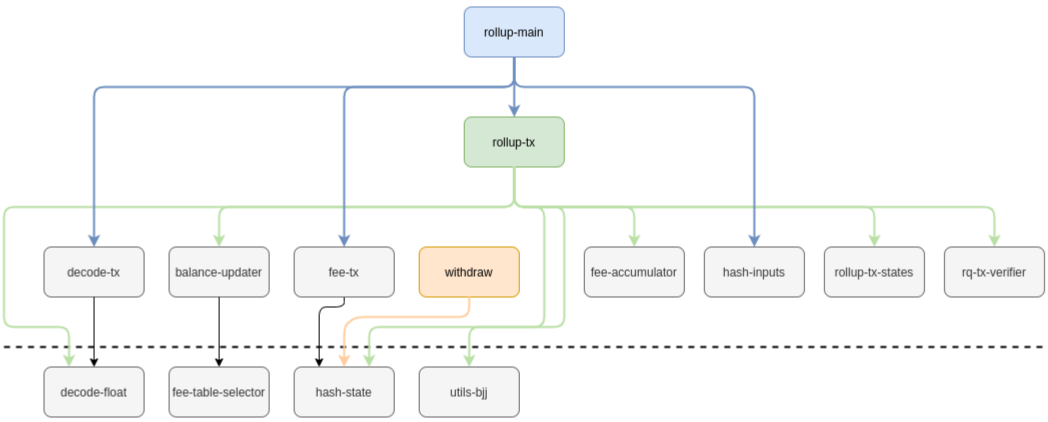
> withdraw: user could perform a withdrawal by submitting a zkProof or a merkle tree proof. Boths methods are equivalent in terms of functionality.

- Global variables:
  - `nTx` : absolute maximum of L1 or L2 transactions allowed
  - `nLevels` : merkle tree depth
  - `maxL1Tx` : absolute maximum of L1 transaction allowed
  - `maxFeeTx` : absolute maximum of fee transactions allowed

circuit organization

- Library:
  - hash-state
  - decode-float
  - fee-table-selector
  - utils-bjj
- Source:
  - decode-tx
  - fee-accumulator
  - rq-tx-verifier
  - hash-inputs
  - fee-tx
  - balance-updater
  - rollup-tx-states
  - rollup-tx
  - rollup-main
- withdraw

Dependencies



Assumptions

L1 transactions

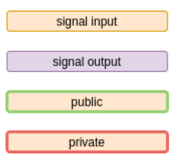
Some assumptions has to take into account in L1 transactions. Those are performed by users which interact with the smart contract. Hence, smart contract perform checks and force some parameters that are assumed in the circuit implementation: - `tokenID` must exist - `loadAmount` < 2^128 - `amount` < 2^192 - if `toIdx == 0` then `amount == 0` - if `fromIdx == 0` then `fromBjj-compressed != 0` - if `fromIdx > INITIAL_IDX` then `fromBjj-compressed == 0`

A summary is shown in the next table with all the L1 transactions assumptions: - `UP` : user parameter - `ME` : must exist

Transaction type	toIdx	tokenID	amountF	loadAmountF	fromIdx	fromBjj-compressed	fromEthAddr
createAccount	0	UP, ME	0	0	0	UP (!=0)	msg.sender
createAccountDeposit	0	UP, ME	0	UP < 2^128	0	UP (!=0)	msg.sender
createAccountDepositTransfer	UP, ME	UP, ME	UP < 2^192	UP < 2^128	0	UP (!=0)	msg.sender
deposit	0	UP, ME	0	UP < 2^128	UP, ME	0	msg.sender
depositTransfer	UP, ME	UP, ME	UP < 2^192	UP < 2^128	UP, ME	0	msg.sender
forceTransfer	UP, ME	UP, ME	UP < 2^192	0	UP, ME	0	msg.sender
forceExit	1	UP, ME	UP < 2^192	0	UP, ME	0	msg.sender

> All L1 transactions are further explained here

Legend



It should be note that `public` and `private` signals will be highlighted only in top layer circuits: - withdraw - rollup-main

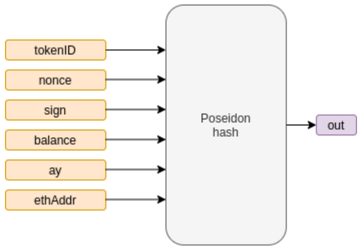
Library

hash-state

Description

Gets the inputs of the state and computes its hash as described here

Schematic



Inputs

Input	type	Description
tokenID	uint32	token identifier
nonce	uint40	nonce
sign	boolean	babyjubjub sign
balance	uint192	amount available
ay	field	babyjubjub y coordinate
ethAddr	uint160	ethereum address

Outputs

Output	type	Description
out	field	state hash

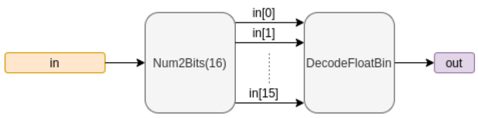
decode-float

Description

Gets an input representing a `float16` format and decode it to a large integer value as described here

- Steps:
  - get the 16 less significant bits
  - compute exponent
  - compute half exponent flag
  - compute mantissa
  - compute final large integer

Schematic



Inputs

Input	type	Description
in	uint16	float16 encode

Outputs

Output	type	Description
out	field	float16 decode

fee-table-selector

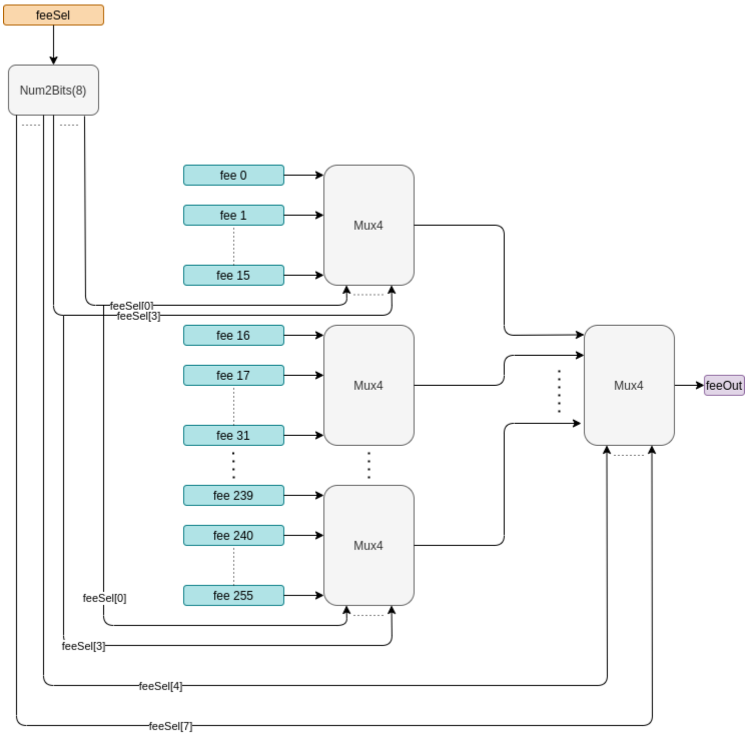
Description

Selects the fee to apply in a transaction given its selector index.

> It should be noted that `fee X` are values hardcoded in the circuit that will match the fee factor shifted

- Steps:
  - get the fee selector
  - selects the output fee

Schematic



Inputs

Input	type	Description
feeSel	uint8	fee Selector

Outputs

Output	type	Description
feeOut	field	feeSelected * 2^{79}

> 79 bits has been chosen in order to optimize precision at the time to compute fees. 79 bits is the minimum bits to achieve enough precision according fee table values

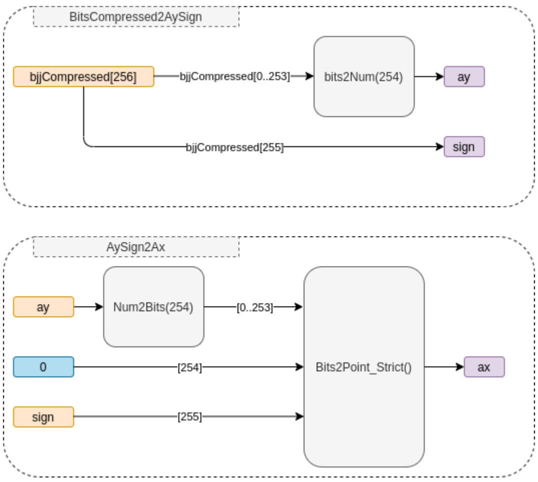
utils-bjj

Description

Implements two functionalities to be used for further circuits:

- BitsCompressed2AySign
  - gets the `bjjCompressed[256]` in bits and retrieve `ay` and `sign` to be inserted into the account state
- AySign2Ax
  - gets the `ay` and `sign` and computes de `ax` coordinate

Schematic



Input

- BitsCompressed2AySign

Input	type	Description
bjjCompressed[256]	boolean array	babyjubjub point compressed

- AySign2Ax

Input	type	Description
ay	field	babyjubjub y coordinate
sign	boolean	babyjubjub sign

Ouput

- BitsCompressed2AySign

Output	type	Description
ay	field	babyjubjub y coordinate
sign	boolean	babyjubjub sign

- AySign2Ax

Output	type	Description
ax	field	babyjubjub x coordinate

Source

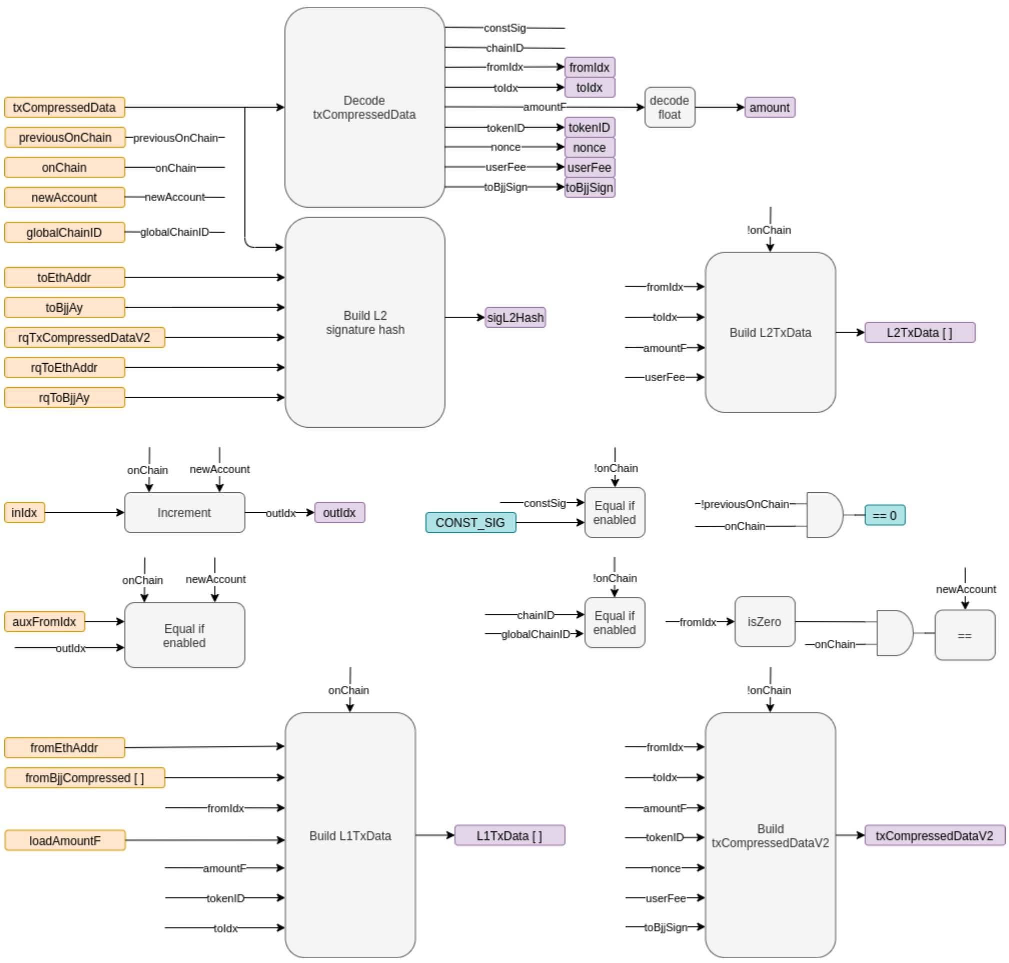
decode-tx

Description

Take the transaction data, decodes it and build data strcuctures to be used in further circuits. Besides, it does checks on transactions fields. It is listed below all the built data and all the checks that this circuit performs.

- Decoders/Build
    - decodes `txCompressedData` as specified here
    - builds `txCompressedDataV2` as specified here
    - builds L2 data availability `L2TxData` as specificied here
    - builds message to sign by L2 transactions `sigL2Hash` as specified here
    - build L1 data `L1TxData` as specified here
- Checks
    - L1 transactions must be processed before L2 transactions
    - only switching from L1 to L2 is allowed
    - checks `newAccount` is set to true only when it is an L1 transaction and `fromIdx` is 0
    - `idx` to be assigned to a new account creation is incremented and checked only if the transaction involves an account creation
    - checks `chainID` transaction field matches `globalChainID` forced by the smart contract
    - checks `signatureConstant` transaction field matches the hardcoded value `CONST_SIG` set in the circuit
- Global variables:
    - `nLevels`

Schematic



Inputs

Input	type	Description
previousOnChain	bool	dtermines if previous transaction is L1
txCompressedData	uint241	encode transaction fields together
toEthAddr	uint160	ethereum address receiver
toBjjAy	field	bayjubjub y coordinate receiver
rqTxCompressedDataV2	uint193	requested encode transaction fields together version 2
rqToEthAddr	uint160	requested ethereum address receiver

Input	type	Description
rqToBjjAy	field	requested babyjubjub y coordinate
fromEthAddr	uint160	ethereum address sender
fromBjjCompressed[256]	boolean array	babyjubjub compressed sender
loadAmountF	uint16	amount to deposit from L1 to L2 encoded as float16
globalChainID	uint16	global chain identifier
onChain	bool	determines if the transacion is L1 or L2
newAccount	bool	determines if transaction creates a new account
auxFromIdx	uint48	auxiliary index to create accounts
inIdx	uint48	old last index assigned

Outputs

Output	type	Description
L2TxData	array boolean	L2 data availability
txCompressedDataV2	uint193	encode transaction fields together version 2
L1TxData	array boolean	L1 data
outIdx	uint48	old last index assigned
fromIdx	uint48	index sender
toIdx	uint48	index receiver
amount	uint192	amount to transfer from L2 to L2
tokenID	uint32	token identifier
nonce	uint40	nonce
userFee	uint8	user fee selector
toBjjSign	boolean	babyjubjub sign receiver
sigL2Hash	field	hash L2 data to sign

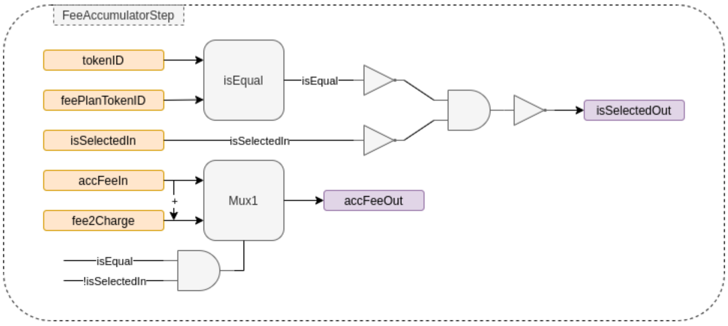
fee-accumulator

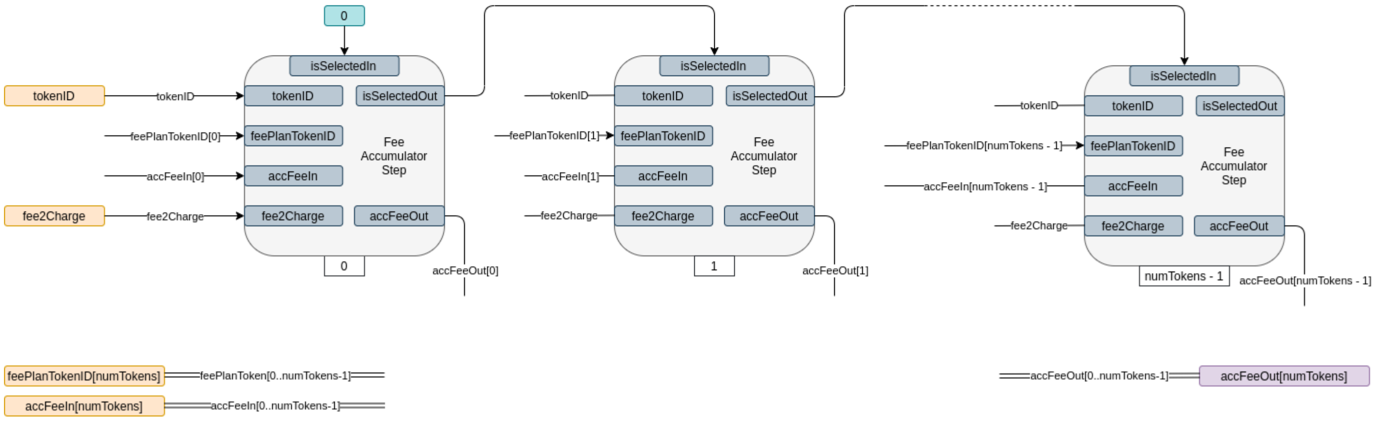
Description

Updates the fees accumulated by each transaction given its fee.

- Definitions:
  - `tokenID` : token to update
  - `feePlanTokenID[numTokens]` : array of all the tokenID that fees will be accumulated
  - `accFeeIn[numTokens]` : initial array of all fees accumulated
  - `fee2Charge` : effective fee charged in a transaction
  - `accFeeOut[numTokens]` : final array of all fees accumulated
- Steps:
  - find the position on the array `feePlanTokenID[numTokens]` where its element matches the current transaction `tokenID`
  - if no match found, no fee would be accumuated and `accFeeIn[0..numTokens] == accFeeOut[0..numTokens]`
  - if a match is found:
  - accumulate the fee `fee2Charge` inside its position `i` on `accFeeOut[i]`
  - avoid accumulate fees once the match is found
- Global variables:
  - `maxFeeTx`

Schematic





Inputs

Input	type	Description
tokenID	uint32	tokenID transaction
fee2Charge	uint192	fee charged
feePlanTokenID[maxFeeTx]	uint40 array	all tokens eligible to accumulate fees
accFeeIn[maxFeeTx]	uint192 array	initial fees accumulated

Outputs

Output	type	Description
accFeeOut[maxFeeTx]	uint192 array	final fees accumulated

rq-tx-verifier

Description

Required transaction offset `rqTxOffset` is the relative index of the transaction that would be linked. This implementation adds atomics swaps support since one transaction is linked to another by this relative index meaning that a transaction can only be processed if the linked transaction is processed too.

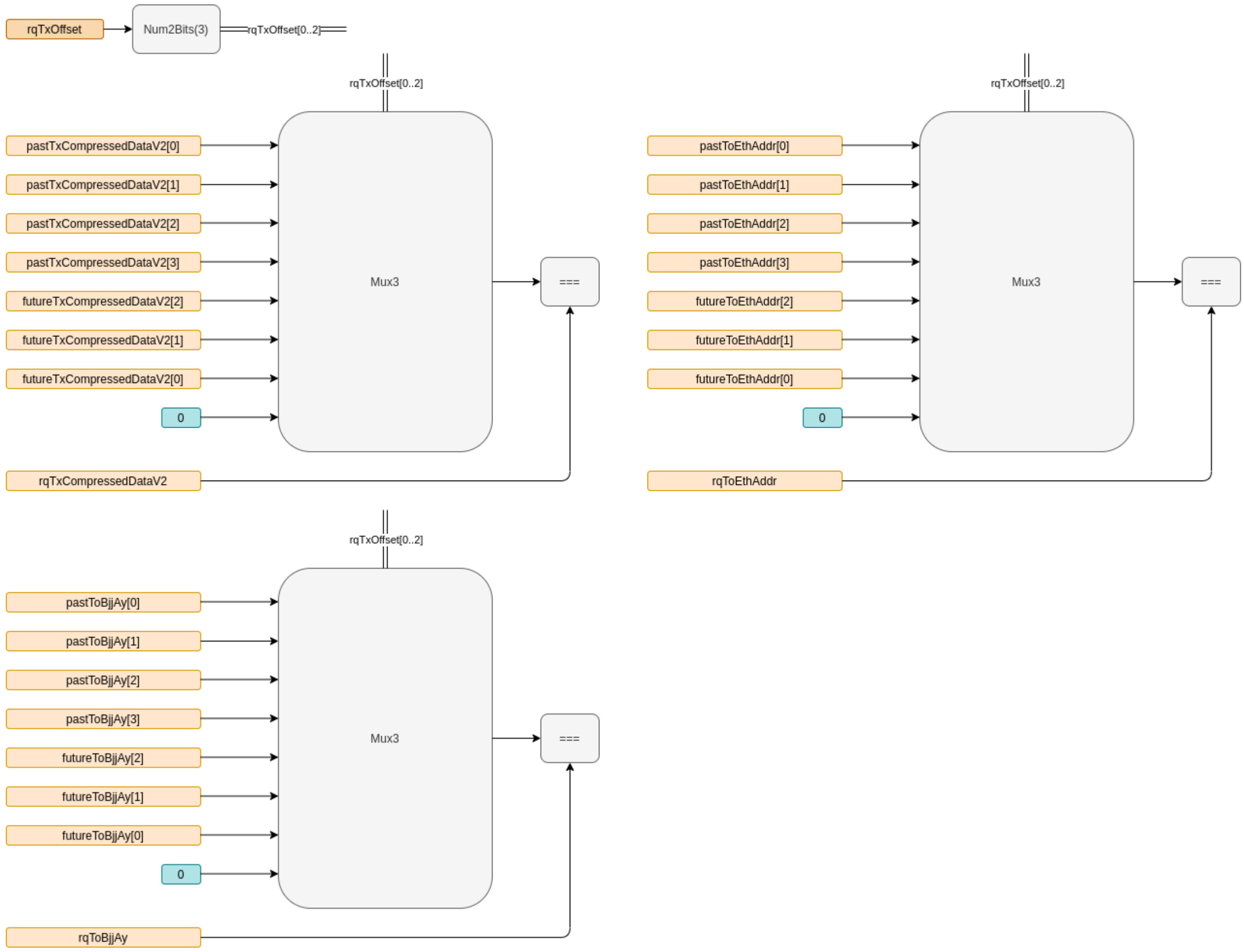
Next circuit aims to check the past and future data transactions to match the required data signed.

Data to be signed in order to link transactions can be found here

> Note that setting `rqTxOffset` to 0 means that no transaction is linked

- Steps:
  - get data of future/past transactions
  - get relative index and current required data
  - check required data matched the future/past transaction

Schematic



Input

Input	type	Description
futureTxCompressedDataV2[3]	uint192 array	future transactions txCompressedDataV2
pastTxCompressedDataV2[4]	uint192 array	past transactions txCompressedDataV2
futureToEthAddr[3]	uint160 array	future transactions toEthAddr
pastToEthAddr[4]	uint160 array	past transactions toEthAddr
futureToBjjAy[3]	field array	future transactions toBjjAy
pastToBjjAy[4]	field array	past transactions toBjjAy
rqTxCompressedDataV2	uint192	requested encode transaction fields together version 2
rqToEthAddr	uint160	requested ethereum address receiver
rqToBjjAy	field	requested babyjubjub y coordinate
rqTxOffset	uint3	relative linked transaction

Output

None

hash-inputs

Description

Take all the pretended public inputs and hash them all together to build a single public input for the circuit. The pretended public inputs will turn into private inputs of the circuit.

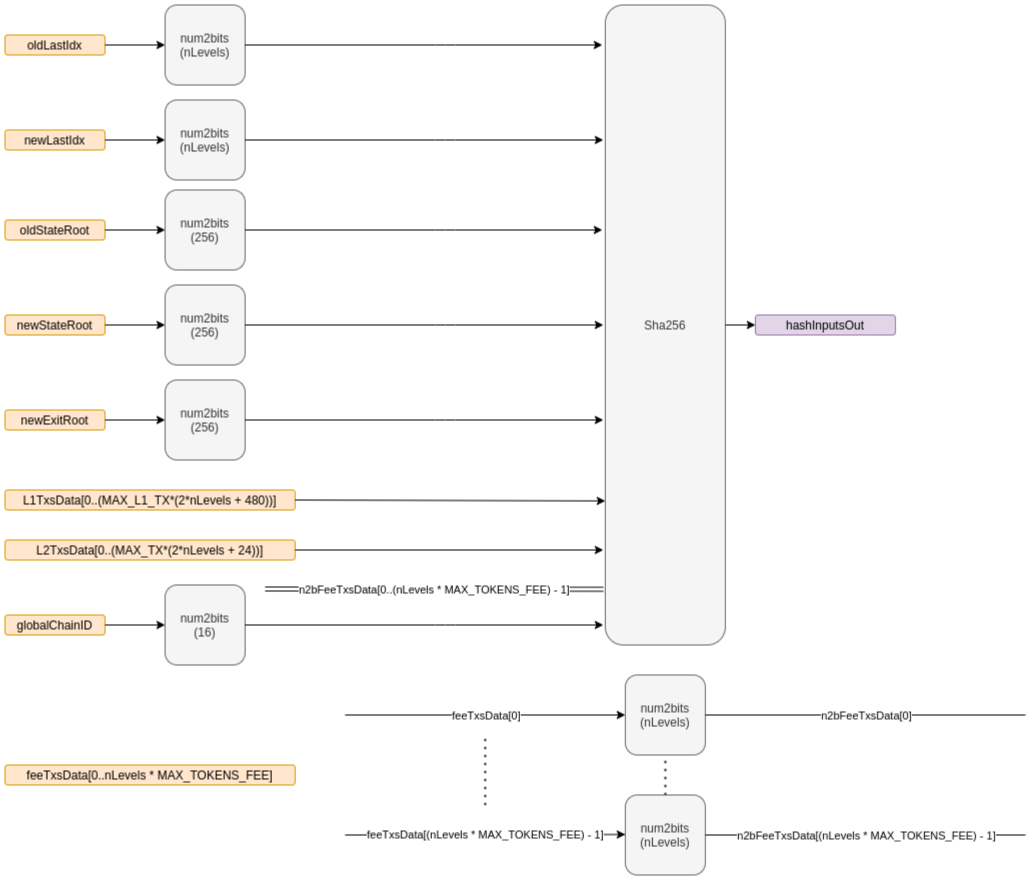
Note that this single input will be built by the smart contract. Therefore, proof must match all the data hashed in the `input hash` which is built inside the circuit from private signals.

> checkout here definition of global settings

Specification for computing `hashInputs` can be found here

- Global variables:
  - `nLevels`
  - `nTx`
  - `maxL1Tx`
  - `maxFeeTx`

Schematic



Inputs

Input	type	Description
oldLastIdx	uint48	old last merkle tree index created
newLastIdx	uint48	new last merkle tree index created
oldStateRoot	field	old state root
newStateRoot	field	new state root
newExitRoot	field	new exit root
L1TxsData[maxL1Tx * (2*nLevels + 32 + 16 + 16 + 256 + 160)]	boolean array	bits L1 data
L2TxsData[nTx * (2*nLevels + 16 + 8)]	boolean array	bits L2 transaction data-availability
feeTxsData[maxFeeTx]	nLevels array	all index accounts to receive accumulated fees
globalChainID	uint16	global chain identifier

Ouputs

Output	type	Description
hashInputsOut	field	sha256 hash of pretended public inputs

fee-tx

Description

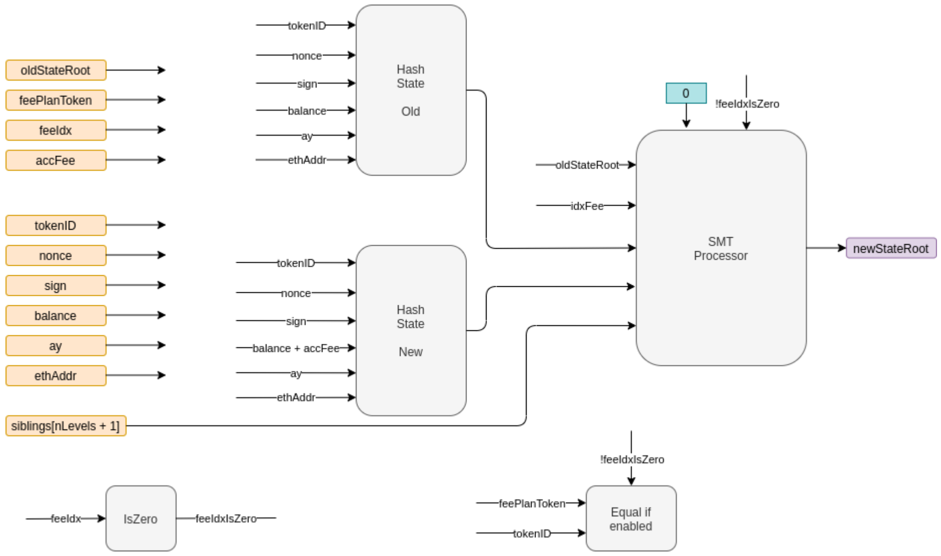
This circuit handles each fee transaction. Fee transaction takes the accumulate fees for a given `tokenID` and updates the recipient where the fees are wanted to be paid. It checks account existence with the old state root, process the account update and compute the new state root.

`TokenID` must match between fee accumulated and recipient account in order to not update wrong recipients.

Besides, if coordinator does not fulfill all the possible recipient to receive fees, fee transaction could be a NOP transaction by setting the recipient to the null index (`IDX 0`)

- Steps:
  - check if `idxFee` is zero
  - `NOP` transaction if `idxFee` is zero. Otherwise:
  - check match `planTokenID` and `tokenID` for updating the state
  - compute merkle tree processor function (`UPDATE` or `NOP`)
  - compute old state value (old account balance)
  - compute new state value (old account balance + accumulate fee)
  - merkle tree processor to compute account update and get new state root
- Global variables:
  - `nLevels`

Schematic



Inputs

Input	type	Description
oldStateRoot	field	old state root
feePlanToken	uint32	token identifier of fees accumulated
feeIdx	uint48	merkle tree index to receive fees
accFee	uint192	accumulated fees to transfer
tokenID	uint32	tokenID of leaf feeIdx
nonce	uint40	nonce of leaf feeIdx
sign	bool	sign of leaf feeIdx
balance	uint192	balance of leaf feeIdx
ay	field	ay of leaf feeIdx
ethAddr	uint160	ethAddr of leaf feeIdx
siblings[nLevels + 1]	field array	siblings merkle proof

Outputs

Output	type	Description
newStateRoot	field	new state root

balance-updater

Description

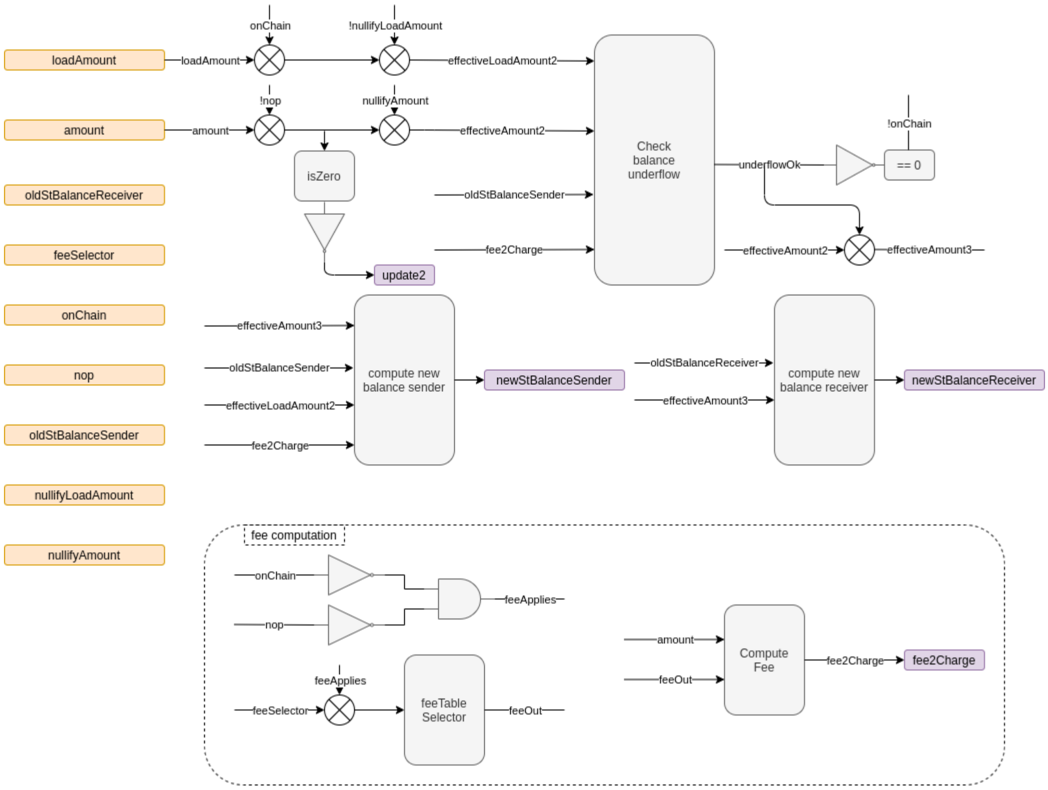
This circuit checks if there is enough balance in the sender account to do the transfer to the receiver account.

It computes the new balances for the sender and the receiver. Besides, returns the fee that will be charged and if the amount to transfer is 0 (`update2` signal). These signals will be used in further circuits.

It should be noted that in L1 tx, no errors are allowed but the circuit needs to process them. Hence, in case it is not enough balance on the sender account, it will process the transaction as a 0 amount transfer. In case of an L2 tx, the protocol does not allow to do a transaction if there is not enough balance on the sender account.

- The following assumptions has been taken:
  - smart contract filters `loadAmount` above 2^128
  - smart contract filters `amount` above 2^192
  - circuit reserves 192 bits for the balance of an account
  - overflow applies only if more than 2^64 transactions are done
  - assume overflow is not feasible
- Steps:
  - compute fee to be applied(`fee2Charge`)
  - compute effective amount (`effectiveAmount1` and `effectiveAmount2`)
  - check underflow (`txOk`)
  - compute new balances from sender and receiver (`newStBalanceSender` and `newStBalanceReceiver`)

Schematic



Inputs

Input	type	Description
oldStBalanceSender	field	initial sender balance
oldStBalanceReceiver	field	initial receiver balance
amount	uint192	amount to transfer from L2 to L2
loadAmount	uint192	amount to deposit from L1 to L2
feeSelector	uint8	user selector fee
onChain	bool	determines if the transacion is L1 or L2
nop	bool	determines if the transfer amount and fees are considered 0
nullifyLoadAmount	bool	determines if loadAmount is considered to be 0
nullifyAmount	bool	determines if amount is considered to be 0

Outputs

Output	type	Description
newStBalanceSender	uint192	final balance sender
newStBalanceReceiver	uint192	final balance receiver
update2	bool	determines if processor 2 performs a NOP transaction
fee2Charge	uint192	effective transaction fee

rollup-tx-states

Description

This circuit is a subset of the `rollup-tx` circuit. It has been splitted for clarity.

Transaction states are computed depending on transactions type. All transaction types can be found here

> Note that L1 coordinator transactions are treated as L1 user `createAccountDeposit` inside the circuit. Circuit does not differentiate transactions taking into account its source, either launched by user o by coordinator.

Sender and receiver accounts have their own merkle tree processors inside the circuit in order to perform actions on their leafs: - sender: processor 1 - receiver: processor 2

The following table summarizes all the processor actions:

func[0]	func[1]	Function
0	0	NOP
0	1	UPDATE
1	0	INSERT
1	1	DELETE

Therefore, given the transaction type, it is needed to specify certain signals that would be used in `rollup-tx` circuit: - `s1` : determine processor 1 functionality - `s2` : determine processor 2 functionality - `key1` : set key to be used in processor 1 - `key2` : set key to be used in processor 2 - `P1_fnc0` and `P1_fnc1` : selectors for processor 1 - `P2_fnc0` and `P2_fnc1` : selectors for processor 2 - `isExit` : determines if the transaction is an exit type - `verifySignEnable` : enable babyjubjub signature checker - `nop` : transaction is processed as a NOP transaction - `checkToEthAddr` : enable `toEthAddr` check - `checkToBjj` : enable `toBjjAy` and `toBjjSign` check

Following truth table determines how to set the above signals depending on transaction inputs:

> Note that italics make reference to outputs, regular makes reference to inputs

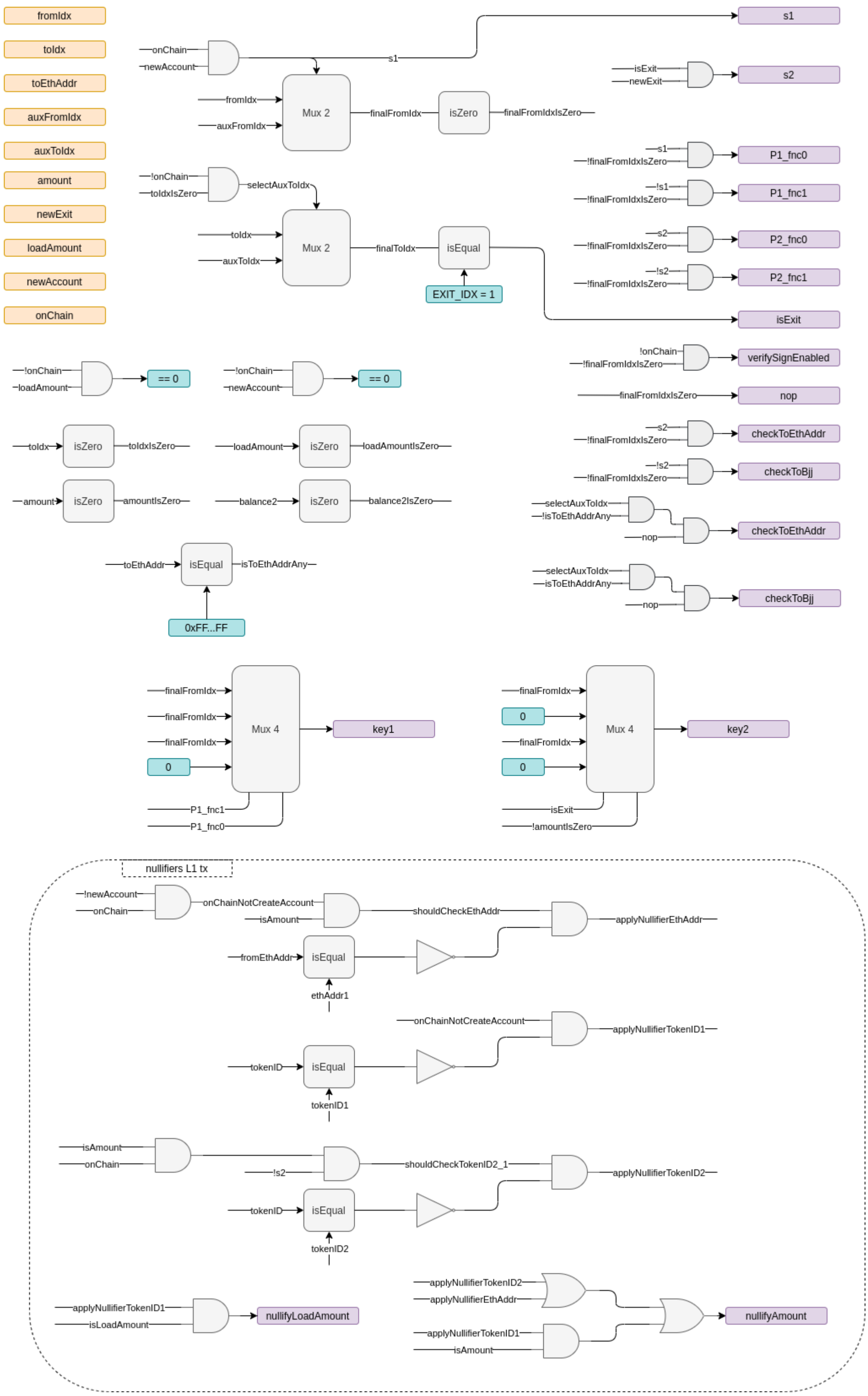
Transaction type	fromIdx	auxFromIdx	toIdx	auxToIdx	toEthAddr	onChain	newAccount	loadAmount	amount	newExit	*s1*	*s2*	*processor 1*	*processor 2*	*isExit*	*verifySig*
createAccount	0	key1	0	0	0	1	1	0	0	0	1	0	INSERT	UPDATE	0	0
createAccountDeposit	0	key1	0	0	0	1	1	X	0	0	1	0	INSERT	UPDATE	0	0
createAccountDepositTranfer	0	key1	key2	0	0	1	1	X	X	0	1	0	INSERT	UPDATE	0	0
deposit	key1	0	0	0	0	1	0	X	0	0	0	0	UPDATE	UPDATE	0	0
depositTransfer	key1	0	key2	0	0	1	0	X	X	0	0	0	UPDATE	UPDATE	0	0
forceTransfer	key1	0	key2	0	0	1	0	0	X	0	0	0	UPDATE	UPDATE	0	0
forceExit	key1 - key2	0	1	0	0	1	0	0	X	0: UPDATE, 1: INSERT	0	X: UPDATE, 0: INSERT	UPDATE	EXIT INSERT - UPDATE	1	0
transfer	key1	0	key2	0	0	0	0	0	X	0	0	0	UPDATE	UPDATE	0	1
exit	key1 - key2	0	1	0	0	0	0	0	X	0: UPDATE, 1: INSERT	0	X: UPDATE, 0: INSERT	UPDATE	EXIT INSERT - UPDATE	1	1
transferToEthAddr	key1	0	0	key2	ANY_ETH_ADDR != 0xF..F	0	0	0	X	0	0	0	UPDATE	UPDATE	0	1
transferToBjj	key1	0	0	key2	ANY_ETH_ADDR == 0xF..F	0	0	0	X	0	0	0	UPDATE	UPDATE	0	1
nop	0	0	0	0	0	0	0	0	0	0	0	0	NOP	NOP	0	0

L1 invalid transactions should not be allowed but the circuit needs to process them even if they are not valid. In order to do so, the circuit performs a zero `loadAmount \ amount` update if L1 transaction is not valid. Therefore, circuit nullifies `loadAmount \ amount` if L1 invalid transaction is detected. Next table sets when to apply `nullifyLoadAmount \ nullifyAmount` depending L1 transaction type:

> Note that `nullifyLoadAmount \ nullifyAmount` fileds are set to 1 only if `checks` are not succesfull

Transaction type	newAccount	isLoadAmount	isAmount	checkEthAddr	checkTokenID1	checkTokenID2	*nullifyLoadAmount*	*nullifyAmount*
createAccount	1	0	0	0	0	0	0	0
createAccountDeposit	1	1	0	0	0	0	0	0
createAccountDepositTransfer	1	1	1	0	0	1	0	1
deposit	0	1	0	0	1	0	1	0
depositTransfer	0	1	1	1	1	1	0	1
forceTransfer	0	0	1	1	1	1	0	1
forceExit	0	0	1	1	1	1 if newExit = 0	0	1

Schematic



Inputs

Input	type	Description
fromIdx	uint48	index sender
toIdx	uint48	index receiver
toEthAddr	uint160	ethereum address receiver
auxFromIdx	uint48	auxiliary index to create accounts
auxToIdx	uint48	auxiliary index when signed index receiver is set to null
amount	uint192	amount to transfer from L2 to L2
newExit	bool	determines if the transaction create a new account in the exit tree
loadAmount	uint192	amount to deposit from L1 to L2

Input	type	Description
newAccount	bool	determines if transaction creates a new account
onChain	bool	determines if the transacion is L1 or L2
fromEthAddr	uint160	ethereum address sender
ethAddr1	uint160	ethereum address of sender leaf
tokenID	uint32	tokenID signed in the transaction
tokenID1	uint32	tokenID of the sender leaf
tokenID2	uint32	tokenID of the receiver leaf

Outputs

Output	type	Description
s1	bool	processor 1 state
s2	bool	processor 2 state
key1	uint48	processor 1 key
key2	uint48	processor 2 key
P1_fnc0	bool	processor 1 bit 0 functionality
P1_fnc1	bool	processor 1 bit 1 functionality
P2_fnc0	bool	processor 2 bit 0 functionality
P2_fnc1	bool	processor 2 bit 1 functionality
isExit	bool	determines if the transaction is an exit
verifySignEnabled	bool	determines if the eddsa signature needs to be verified
nop	bool	determines if the transaction should be considered as a NOP transaction
checkToEthAddr	bool	determines if receiver ethereum address needs to be checked
checkToBjj	bool	determines if receiver babyjubjub needs to be checked
nullifyLoadAmount	bool	determines if loadAmount is considered to be 0
nullifyAmount	bool	determines if amount is considered to be 0

rollup-tx

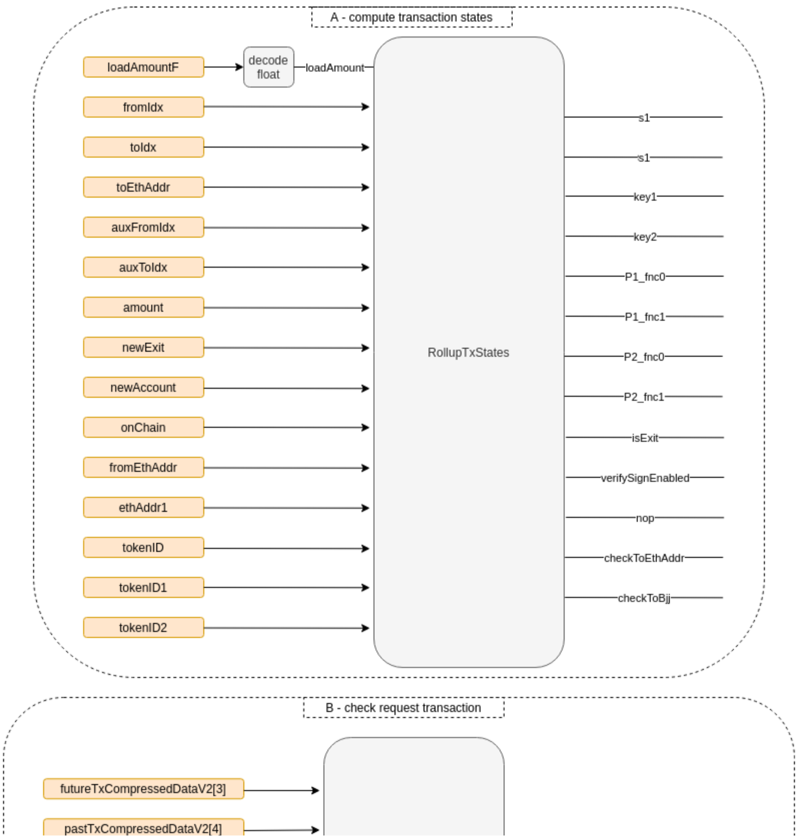
Description

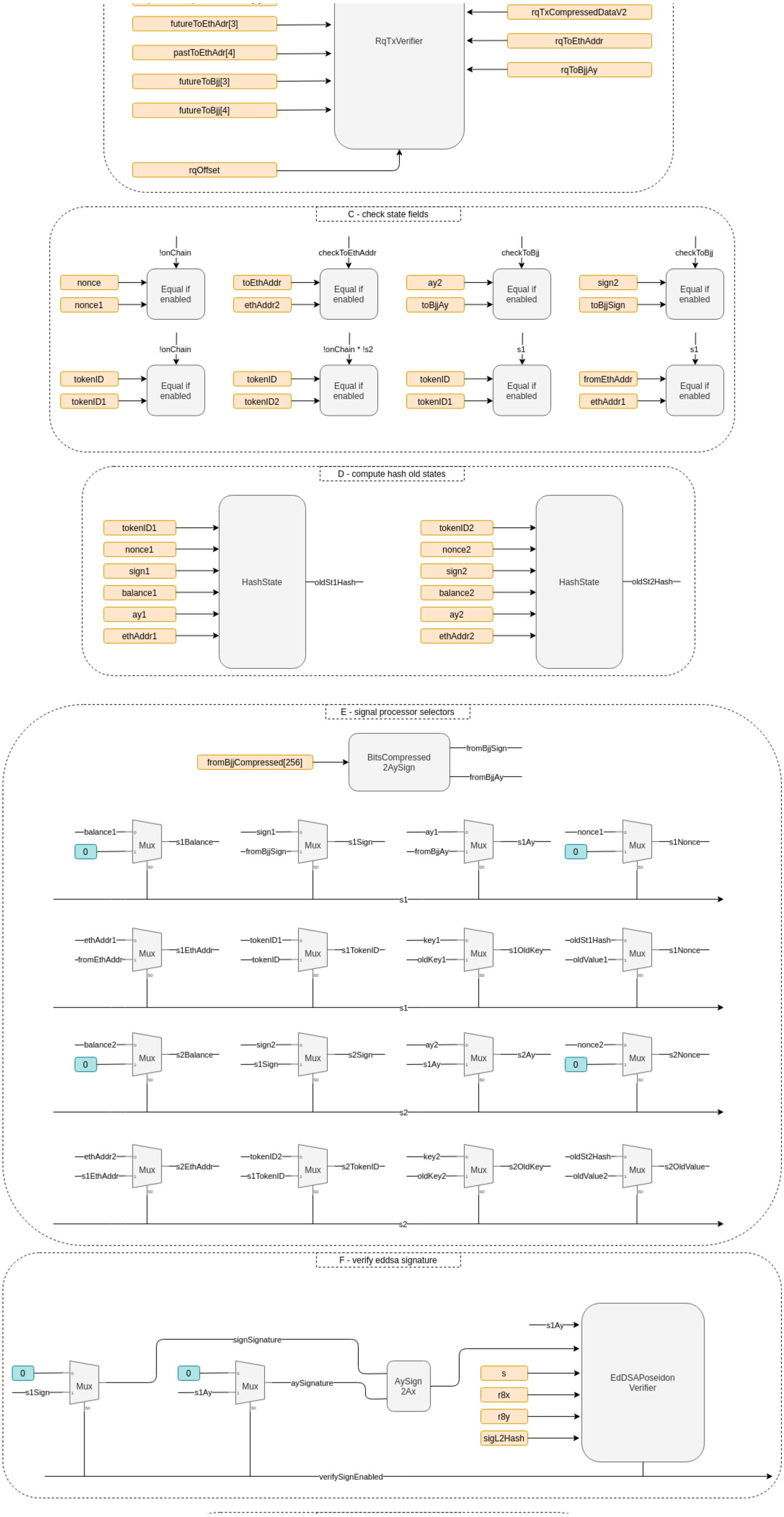
This circuit includes all the rules given a transaction. Hence, `rollup-tx` includes the previous specified circuits: - `rollup-tx-states` - `rq-tx-verifier` - `balance-updater` - `fee-accumulator`

For the sake of clarity, this circuit could be splitted internally into phases: - A: compute transaction states - B: check request transaction - C: checks state fields - D: compute hash old states - E: signal processor selectors - F: verify eddsa signature - G: update balances - H: accumulate fess - I: compute hash new states - J: smt processors - K: select output roots

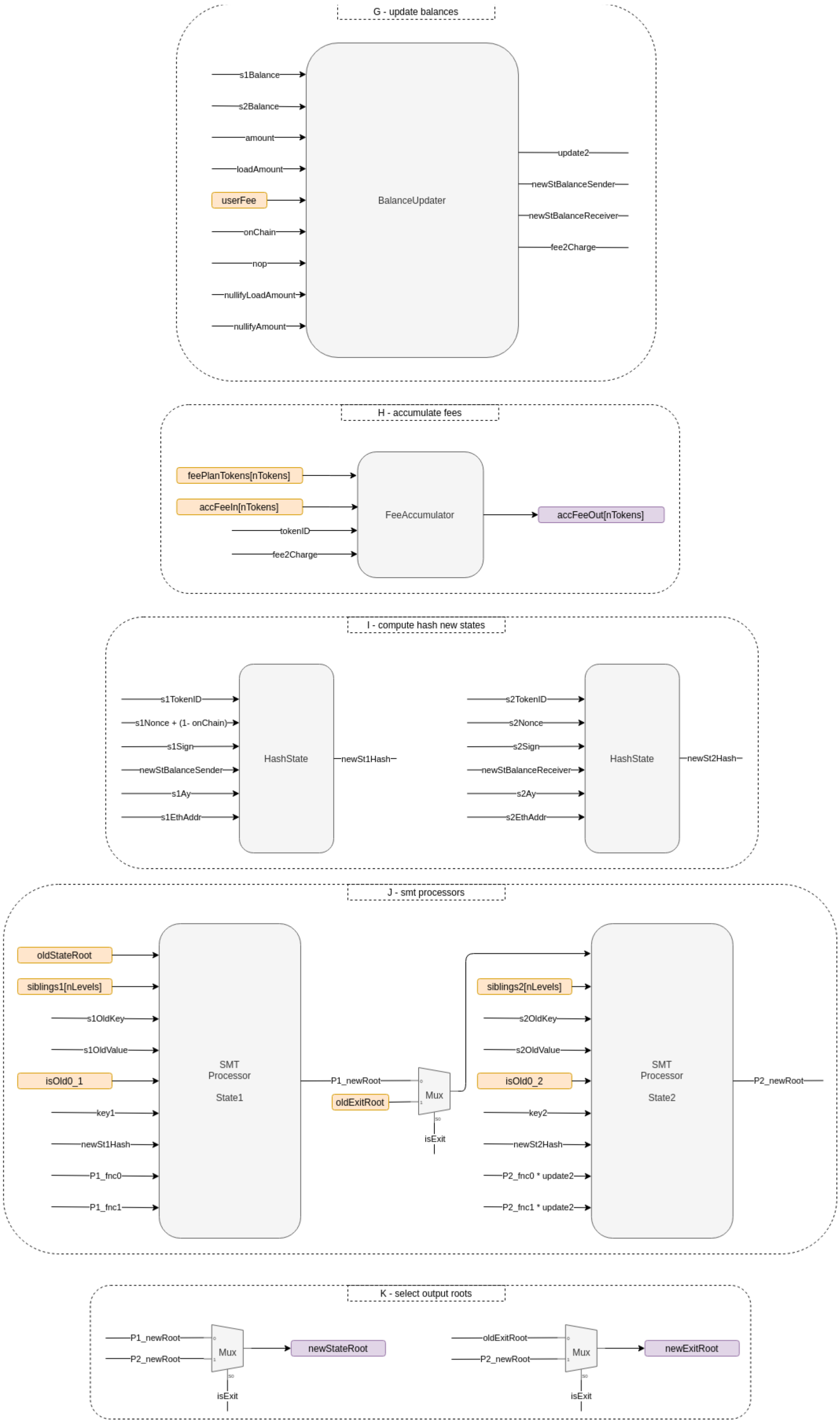
- Global variables:
  - `nLevels`
  - `maxFeeTx`

Schematic





futureToEthAdr[3]
pastToEthAdr[4]
futureToBjj[3]
futureToBjj[4]
RqTxVerifier
rqTxCompressedDataV2
rqToEthAddr
rqToBjjAy
rqOffset
C - check state fields
!onChain
nonce
nonce1
Equal if enabled
checkToEthAddr
toEthAddr
ethAddr2
checkToBjj
ay2
toBjjAy
sign2
toBjjSign
tokenID
tokenID1
!onChain * !s2
tokenID2
s1
fromEthAddr
ethAddr1
D - compute hash old states
tokenID1
nonce1
sign1
balance1
ay1
ethAddr1
HashState
oldSt1Hash
tokenID2
nonce2
sign2
balance2
ay2
ethAddr2
oldSt2Hash
E - signal processor selectors
fromBjjCompressed[256]
BitsCompressed 2AySign
fromBjjSign
fromBjjAy
balance1
Mux
s1Balance
sign1
fromBjjSign
s1Sign
ay1
fromBjjAy
s1Ay
nonce1
s1Nonce
0
s1
ethAddr1
fromEthAddr
s1EthAddr
tokenID1
tokenID
s1TokenID
key1
oldKey1
s1OldKey
oldSt1Hash
oldValue1
balance2
s2Balance
sign2
s1Sign
s2Sign
ay2
s1Ay
s2Ay
nonce2
s2Nonce
s2
ethAddr2
s1EthAddr
s2EthAddr
tokenID2
s1TokenID
s2TokenID
key2
oldKey2
s2OldKey
oldSt2Hash
oldValue2
s2OldValue
F - verify eddsa signature
s1Sign
signSignature
aySignature
AySign 2Ax
s1Ay
s
r8x
r8y
sigL2Hash
EdDSAPoseidon Verifier
verifySignEnabled



Inputs

Input	type	Description
feePlanTokens[maxFeeTx]	uint32 array	all tokens eligible to accumulate fees
accFeeIn[maxFeeTx]	uint192 array	initial fees accumulated
futureTxCompressedDataV2[3]	uint193 array	future transactions txCompressedDataV2
pastTxCompressedDataV2[4]	uint193 array	past transactions toEthAddr
futureToEthAddr[3]	uint160 array	future transactions toEthAddr

Input	type	Description
pastToEthAddr[4]	uint160 array	past transactions toEthAddr
futureToBjjAy[3]	field array	future transactions toBjjAy
pastToBjjAy[4]	field array	past transactions toBjjAy
fromIdx	uint48	index sender
auxFromIdx	uint48	auxiliary index to create accounts
toIdx	uint48	index receiver
auxToIdx	uint48	auxiliary index when signed index receiver is set to null
toBjjAy	field	bayjubjub y coordinate receiver
toBjjSign	bool	babyjubjub sign receiver
toEthAddr	uint160	ethereum address receiver
amount	uint192	amount to transfer from L2 to L2
tokenID	uint32	tokenID signed in the transaction
nonce	uint40	nince signed in the transaction
userFee	uint16	user fee selector
rqOffset	uint3	relative linked transaction
onChain	bool	determines if the transacion is L1 or L2
newAccount	bool	determines if transaction creates a new account
rqTxCompressedDataV2	uint193	requested encode transaction fields together version 2
rqToEthAddr	uint160	requested ethereum address receiver
rqToBjjAy	field	requested babyjubjub y coordinate
sigL2Hash	field	hash L2 data to sign
s	field	eddsa signature field
r8x	field	eddsa signature field
r8y	field	eddsa signature field
fromEthAddr	uint160	ethereum address sender
fromBjjCompressed[256]	boolean array	babyjubjub compressed sender
loadAmountF	uint16	amount to deposit from L1 to L2 encoded as float16
tokenID1	uint32	tokenID of the sender leaf
nonce1	uint40	nonce of the sender leaf
sign1	bool	sign of the sender leaf
balance1	uint192	balance of the sender leaf
ay1	field	ay of the sender leaf
ethAddr1	uint160	ethAddr of the sender leaf
siblings1[nLevels + 1]	field array	siblings merkle proof of the sender leaf
isOld0_1	bool	flag to require old key - value
oldKey1	uint48	old key of the sender leaf
oldValue1	field	old value of the sender leaf
tokenID2	uint32	tokenID of the receiver leaf
nonce2	uint40	nonce of the receiver leaf
sign2	bool	sign of the receiver leaf
balance2	uint192	balance of the receiver leaf
ay2	field	ay of the receiver leaf
ethAddr2	uint160	ethAddr of the receiver leaf
siblings2[nLevels + 1]	field array	siblings merkle proof of the receiver leaf
isOld0_2	bool	flag to require old key - value
oldKey2	uint48	old key of the sender leaf
oldValue2	field	old value of the sender leaf
oldStateRoot	field	initial state root
oldExitRoot	field	initial exit root

Ouputs

Output	type	Description

Output	type	Description
accFeeOut[maxFeeTx]	uint192 array	final fees accumulated
newStateRoot	field	final state root
newExitRoot	field	final exit root

rollup-main

Description

Join all transactions and process them. This includes decode all possible transactions, process them and distribute all the fees trhough fee transactions.

It is important to note that the templates included in this main circuit are pretended to be computed in parallel. Meaning that the output of the very first transaction could be computed as its output it is not necessary to compute the next transaction. Then, all transactions could be computed in parallel. In order to achieve that, it is needed to supply intermediate signals to allow modules parallelization.

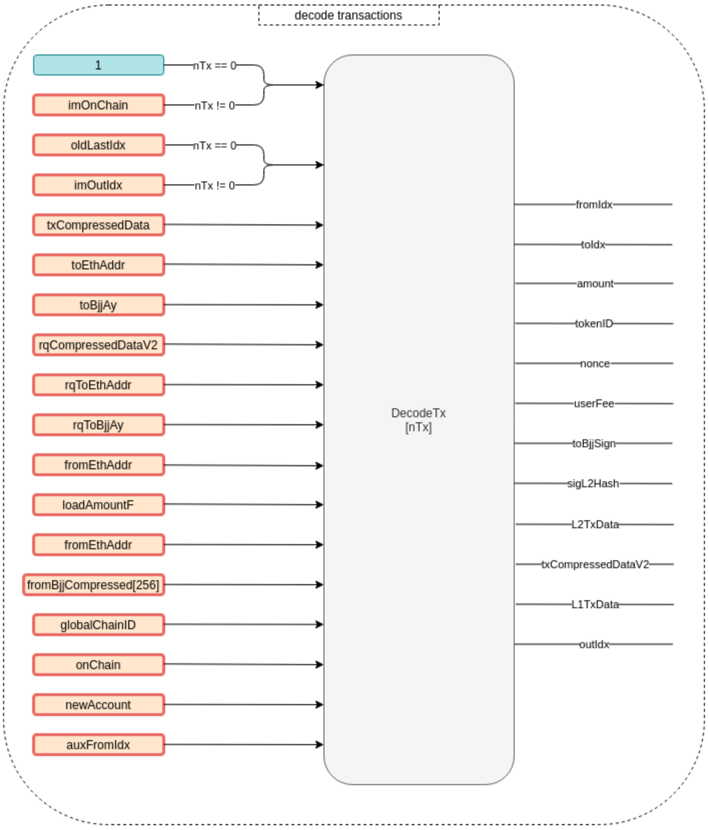
All signals prefixed with `im` are intermediary signals. Note that in circuit phases, there are specific phases to check integrity of intermediary signals. This adds constraints to the circuit, since it is needed to provided transactions output in advance, but it allows high parallelization at the time to compute the witness.

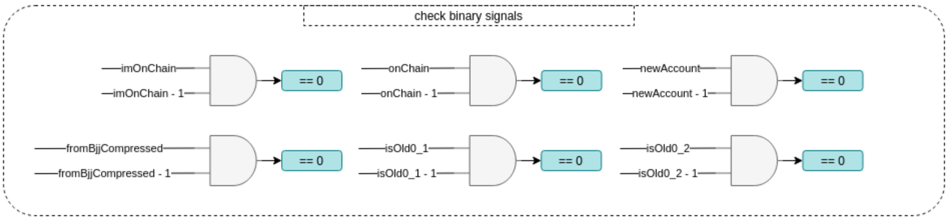
Note that there is only one piblic input, `hashGlobalInputs`, which is a sha256 hash of all the pretended public inputs of the circuit. This is done in order to save gas in the contract by just passing one public input.

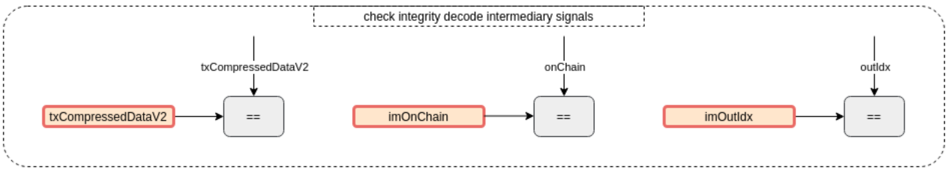
- Global variables:
  - `nTx`
  - `nLevels`
  - `maxL1Tx`
  - `maxFeeTx`

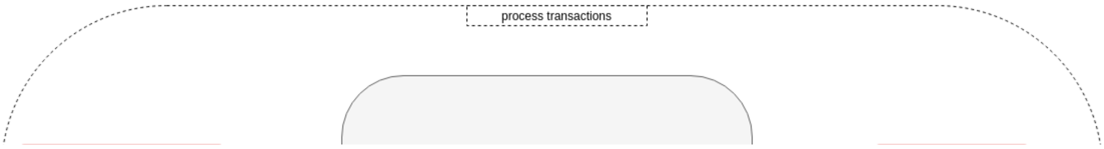
Main circuit could be splitted in the following phases: - A: decode transactions - B: check binary signals - C: check integrity decode intermediary signals - D: process transactions - E: check integrity transactions intermediary signals - F: process fee transactions - G: check integrity fee transactions intermediary signals - H: compute global hash input

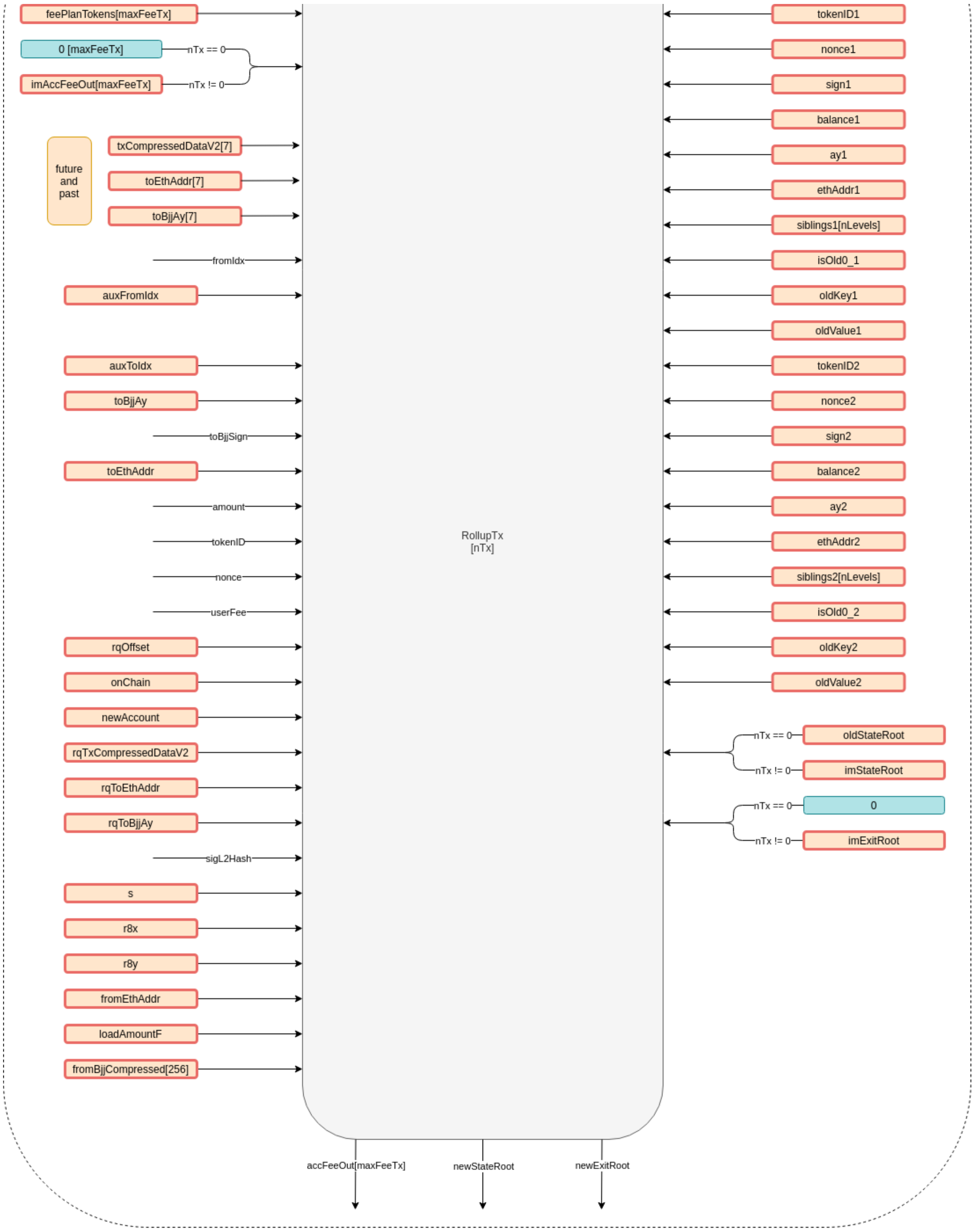
Schematic

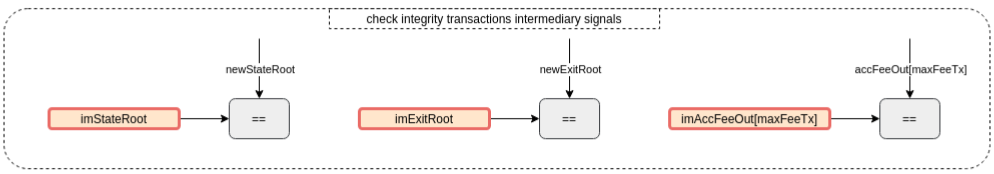


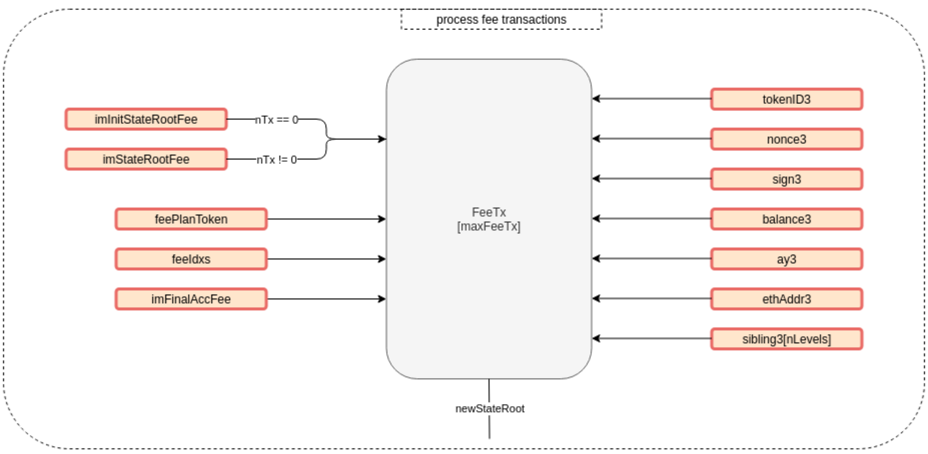


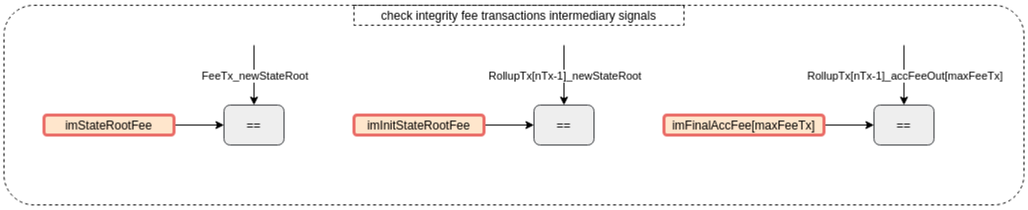


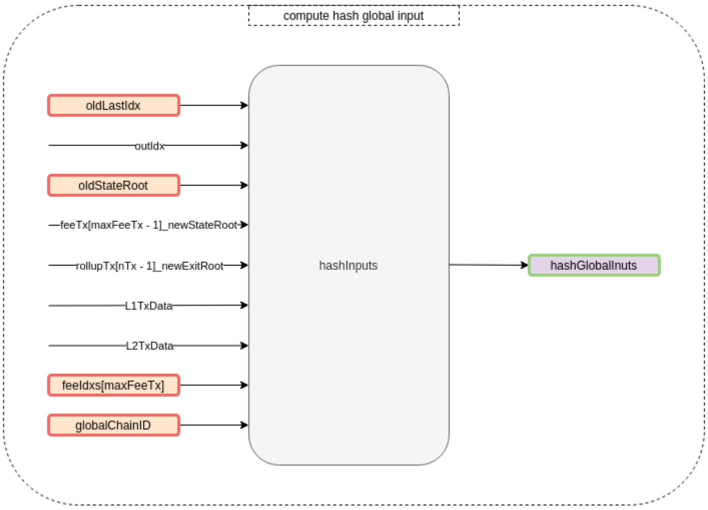



feePlanTokens[maxFeeTx]
0 [maxFeeTx]
nTx == 0
imAccFeeOut[maxFeeTx]
nTx != 0
future and past
txCompressedDataV2[7]
toEthAddr[7]
toBjjAy[7]
fromIdx
auxFromIdx
auxToIdx
toBjjAy
toBjjSign
toEthAddr
amount
tokenID
nonce
userFee
rqOffset
onChain
newAccount
rqTxCompressedDataV2
rqToEthAddr
rqToBjjAy
sigL2Hash
s
r8x
r8y
fromEthAddr
loadAmountF
fromBjjCompressed[256]
RollupTx
[nTx]
tokenID1
nonce1
sign1
balance1
ay1
ethAddr1
siblings1[nLevels]
isOld0_1
oldKey1
oldValue1
tokenID2
nonce2
sign2
balance2
ay2
ethAddr2
siblings2[nLevels]
isOld0_2
oldKey2
oldValue2
nTx == 0
oldStateRoot
nTx != 0
imStateRoot
nTx == 0
0
nTx != 0
imExitRoot
accFeeOut[maxFeeTx]
newStateRoot
newExitRoot


check integrity transactions intermediary signals
newStateRoot
imStateRoot
==
newExitRoot
imExitRoot
==
accFeeOut[maxFeeTx]
imAccFeeOut[maxFeeTx]
==


process fee transactions
imInitStateRootFee
nTx == 0
imStateRootFee
nTx != 0
feePlanToken
feeIdxs
imFinalAccFee
FeeTx
[maxFeeTx]
tokenID3
nonce3
sign3
balance3
ay3
ethAddr3
sibling3[nLevels]
newStateRoot





Inputs

Input	type	Description
oldLastIdx	uint48	old last index assigned
oldStateRoot	field	initial state root
globalChainID	uint16	global chain identifier
feeIdxs[maxFeeTx]	uint40 array	merkle tree indexes to receive fees
feePlanTokens[maxFeeTx]	uint32 array	tokens identifiers of fees accumulated
imOnChain[nTx-1]	boolean array	intermediary signals: decode transaction output onChain flag
imOutIdx[nTx-1]	uint40 array	intermediary signals: decode transaction final index assigned
imStateRoot[nTx-1]	field array	intermediary signals: transaction final state root
imExitRoot[nTx-1]	field array	intermediary signals: transaction final exit root
imAccFeeOut[nTx-1][maxFeeTx]	uint192 array	intermediary signals: transaction final accumlate fees
imStateRootFee[maxFeeTx - 1]	field array	intermediary signals: transaction fee final state root
imInitStateRootFee	field	intermediary signals: final state root of all rollup transactions
imFinalAccFee[maxFeeTx]	field array	intermediary signals: final fees accumulated of all rollup transactions
txCompressedData[nTx]	uint241 array	encode transaction fields together
txCompressedDataV2[nTx]	uint193 array	encode transaction fields together version 2
fromIdx[nTx]	uint48 array	index sender
auxFromIdx[nTx]	uint48 array	auxiliary index to create accounts
toIdx[nTx]	uint48 array	index receiver
auxToIdx[nTx]	uint48 array	auxiliary index when signed index receiver is set to null
toBjjAy[nTx]	field array	bayjubjub y coordinate receiver
toEthAddr[nTx]	uint160 array	ethereum address receiver
onChain[nTx]	bool array	determines if the transacion is L1 or L2
newAccount[nTx]	bool array	determines if transaction creates a new account
rqTxCompressedDataV2[nTx]	uint193 array	requested encode transaction fields together version 2
rqToEthAddr[nTx]	uint160 array	requested ethereum address receiver
rqToBjjAy[nTx]	field array	requested babyjubjub y coordinate
s[nTx]	field array	eddsa signature field
r8x[nTx]	field array	eddsa signature field
r8y[nTx]	field array	eddsa signature field
loadAmountF[nTx]	uint16 array	amount to deposit from L1 to L2 encoded as float16

Input	type	Description
fromEthAddr[nTx]	uint160 array	ethereum address sender
fromBjjCompressed[nTx][256]	boolean array	babyjubjub compressed sender
tokenID1[nTx]	uint32 array	tokenID of the sender leaf
nonce1[nTx]	uint40 array	nonce of the sender leaf
sign1[nTx]	bool array	sign of the sender leaf
balance1[nTx]	uint192 array	balance of the sender leaf
ay1[nTx]	field array	ay of the sender leaf
ethAddr1[nTx]	uint160 array	ethAddr of the sender leaf
siblings1[nTx][nLevels + 1]	field array	siblings merkle proof of the sender leaf
isOld0_1[nTx]	bool array	flag to require old key - value
oldKey1[nTx]	uint48 array	old key of the sender leaf
oldValue1[nTx]	field array	old value of the sender leaf
tokenID2[nTx]	uint32 array	tokenID of the receiver leaf
nonce2[nTx]	uint40 array	nonce of the receiver leaf
sign2[nTx]	bool array	sign of the receiver leaf
balance2[nTx]	uint192 array	balance of the receiver leaf
ay2[nTx]	field array	ay of the receiver leaf
ethAddr2[nTx]	uint160 array	ethAddr of the receiver leaf
siblings2[nTx][nLevels + 1]	field array	siblings merkle proof of the receiver leaf
isOld0_2[nTx]	bool array	flag to require old key - value
oldKey2[nTx]	uint48 array	old key of the sender leaf
oldValue2[nTx]	field array	old value of the sender leaf
tokenID3[maxFeeTx]	uint32 array	tokenID of leafs feeIdxs
nonce3[maxFeeTx]	uint40 array	nonce of leafs feeIdxs
sign3[maxFeeTx]	bool array	sign of leafs feeIdxs
balance3[maxFeeTx]	uint192 array	balance of leafs feeIdxs
ay3[maxFeeTx]	field array	ay of leafs feeIdxs
ethAddr3[maxFeeTx]	uint160 array	ethAddr of leafs feeIdxs
siblings3[nLevels + 1]	field array array	siblings merkle proof of leafs Idxs

Outputs

Output	type	Description
hashGlobalInputs	field	hash of all pretended input signals

Withdraw

Description

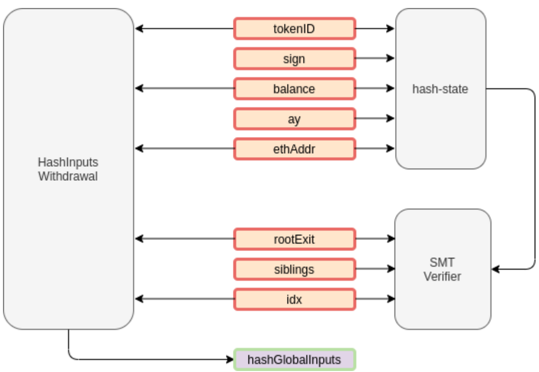
This circuit is used to prove that a leaf exist on the exit tree. If its existence is proved, user will be able to withdraw funds from the hermez contract. All pretended public inputs are hashed together as described here.

- Steps:
  - compute hash-state
  - verify state exist in the exit tree root given the siblings
  - compute `hashGlobalInputs`

> It should be noted that this circuit is heavily attach with the smart contract implementation

- Global variables
  - `nLevels`

Schematic



Inputs

Input	type	Description

Input	type	Description
root exit	field	exit tree root
ethAddr	uint160	ethereum address
tokenID	uint32	token identifier
balance	uint192	balance
idx	uint48	merkle tree index
sign	boolean	babyjubjub sign
ay	field	babyjubjub y coordinate
siblingsState[nLevels + 1]	field array	siblings merkle proof

Outputs

Output	type	Description
hashGlobalInputs	field	hash of all pretended input signals