Audit

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Chapter 1

Introduction

The present document is an official submission to the 13^{th} contest of the ForMet sub-governance: *13 Radiance-DEX Phase 0 Formal Verification* `https://formet.gov.freeton.org/proposal?isGlobal=false&proposalAddress=0%3A07783c48e8789fa1163699e9e3071a47`

The specification was: *The contestants shall provide the informal audit of the central Radiance-DEX smart contracts (*`DEXClient`*,* `DEXConnector`*,* `DEXPair`*,* `DEXRoot RootTokenContract`*,* `TONTokenWallet`*), hereinafter referred to as "smart contracts". where the detailed description of the "informal audit" is described below. All debot contracts are excluded from the present contest.*

and *All the source codes must be provided by the authors via* `https://t.me/joinchat/-3zDgM62gQ02OGUy` *Telegram group. The code to be audited has a hash 7d65f0d3b85e504ac33f01395b6ba0ffef9d5fe5 (branch main, link -* `https://github.com/radianceteam/dex2/commit/7d65f0d3b85e504ac33f01395b6ba0ffef9d5fe5` *)*

and finally *Contestants shall submit a document in PDF format that covers:*

- *All the errors found*
- *All the warnings found*
- *All the "bad code" (long functions, violation of abstraction levels, poor readability etc.)*

Errors and warnings should be submitted to the developers as early as possible, during the contest, so that the code can be fixed immediately.

Chapter 2

Overview

The infrastructure is composed of a set of DEX specific contracts, associated with tokens contracts (developed by Broxus, to the best of our knownledge).

The DEX contracts are :

DEXRoot: The "root" contract, used to perform global operations, such as creating "client" contracts;

DEXClient: The contract with which a user may interact with the system.

DEXPair: The contract associated with a given pair of tokens (root token contracts)

DEXConnector: A simplified interface to interact with token contracts. The goal is probably to be able to interact with different implementations/interfaces of token contracts.

The token contracts are :

RootTokenContract: The root token contract, shared by all the wallet contracts for a given token;

TONTokenWallet: The wallet contract, containing the balance associated either with a public key or (exclusive) a contract address;

Compared to `https://github.com/broxus/broxus/ton-eth-bridge-token-contracts/`, the two token contracts have only been modified to change the `ton-solidity` pragma version.

All the DEX contracts use a static `soUINT` field to be able to instanciate several ones for a given public key or other static field.

Chapter 3

General Remarks

In this chapter, we introduce some general remarks about the code, that are not specific to a specific piece of code, but whose occurrences have been found in the project in several locations.

3.1 Readability

3.1.1 Typography of Static Variables

A good coding convention is to use typography to visually discriminate static variables from other variables, for example using a prefix such as `s_`.

This issue was found everywhere in the code of DEX and token contracts.

3.1.2 Typography of Global Variables

A good coding convention is to use typography to visually discriminate global variables from local variables, for example using a prefix such as `m_` or `g_`.

This issue was found everywhere in the code of DEX and token contracts.

3.1.3 Typography of Internal Functions

A good coding convention is to use typography to visually discriminate public functions and internal functions, for example using a prefix such as `_`.

This issue was found everywhere in the code of DEX and token contracts.

3.1.4 Naming of Numbers

A good coding convention is to define constants instead of using direct numbers for errors and other meaningful numbers.

This issue was found everywhere in the code of DEX contracts (for errors in `require()` and payload opcodes), but not for token contracts.

3.1.5 Better Units for Big Numbers

A good coding convention is to use decimals of `ton` instead of default nanotons to decrease the size of integer constants.

This issue was found in all constant definitions for gas cost. Numbers like `500000000` are difficult to read, whereas the equivalent `0.5 ton` is much easier.

3.1.6 Use Method Calls instead of `tvm.encodeBody`

Using `tvm.encodeBody` makes code harder to read. Method calls are easier to read and interpret. The issue is minor as checks are still correctly performed on argument types.

This issue was found in all DEX contracts except DEXRoot.

3.2 Gas Consumption

3.2.1 Accept Methods without Checks

Public methods using `tvm.accept()` without any prior check should not exist. Indeed, such methods could be used by attackers to drain the balance of the contracts, even with minor amounts but unlimited number of messages.

This issue was found in the code the DEX contracts, especially with the `alwaysAccept()` modifier. Methods using this modifier should check the origin of the message and limit `tvm.accept()` to either the user or known contracts.

3.2.2 `require` after `tvm.accept`

Methods using `tvm.accept()` should never use `require()` after the accept. Indeed, a `require()` failing after `tvm.accept()` will cost a huge amount of gas, as all shards will execute the failing method.

This issue was found in the code of the DEX contracts. Methods should always keep calls to `require()` before `tvm.accept()`, and if it is not possible, should not fail but should *return* an error code instead.

3.2.3 Not Enough Gas for Action

If there is not enough gas (message value or balance), the compute phase may execute, but the action phase may fail. In such a case, modifications done during the compute phase are committed to the blockchain, but no message emitted.

This issue was found in the code, for example in `DEXClient.connectRoot`.

3.3 Architecture

3.3.1 No need for passing `souint` Arguments around

It looks like there is little need for passing around the `souint` arguments as the same `soUINT` static value could be used for the `DEXroot` and all other contracts derived from it. The only required modification would be to make the `drivenRoot` field of `DEXConnector` a static variable. Such a change would probably simplify the interface of many functions.

Chapter 4

Contract DEXClient

In file `DEXClient.sol`

4.1 Contract Inheritance

ITokensReceivedCallback	
IDEXClient	
IDEXConnect	

4.2 Type Definitions

4.2.1 Struct Connector

- OK

```
29  struct Connector {
30    address root_address;
31    uint256 souint;
32    bool status;
33  }
```

4.2.2 Struct Callback

- Minor Issue (readability): `payload_arg0`, `payload_arg1`, `payload_arg2` should be renamed to more explicit names

```
43  struct Callback {
44    address token_wallet;
45    address token_root;
46    uint128 amount;
47    uint256 sender_public_key;
48    address sender_address;
```

```
49      address sender_wallet;
50      address original_gas_to;
51      uint128 updated_balance;
52      uint8 payload_arg0;
53      address payload_arg1;
54      address payload_arg2;
55    }
```

4.2.3 Struct Pair

- OK

```
60    struct Pair {
61      bool status;
62      address rootA;
63      address walletA;
64      address rootB;
65      address walletB;
66      address rootAB;
67    }
```

4.3 Constant Definitions

- Minor Issue: see Better Units for Big Numbers (3.1.5)

```
23    uint128 constant GRAMS_CONNECT_PAIR = 500000000;
24    uint128 constant GRAMS_SET_CALLBACK_ADDR = 100000000;
25    uint128 constant GRAMS_SWAP = 500000000;
26    uint128 constant GRAMS_PROCESS_LIQUIDITY = 500000000;
27    uint128 constant GRAMS_RETURN_LIQUIDITY = 500000000;
```

4.4 Static Variable Definitions

- Minor Issue: see Typography of Static Variables (3.1.1)
- Minor Issue: Deployment messages are limited to 16 kB, and contain the code of the contract, the static variables and the constructor arguments. As `codeDEXConnector` is a static variable, the deployment message will contain the code of DEXClient and DEXConnector at the same time. It could become an issue in the future if their codes increase in size. If it is important to use DEXConnector code static to distinguish clients, it might be worth replacing it by a hash and use another message to initialize the variable instead.

```
18  address static public rootDEX;
19  uint256 static public soUINT;
20  TvmCell static public codeDEXConnector;
```

4.5 Variable Definitions

- Minor Issue: see Typography of Global Variables (3.1.2)

```
35  address[] public rootKeys;
36  mapping (address => address) public rootWallet;
37  mapping (address => address) public rootConnector;
38  mapping (address => Connector) connectors;
40  uint public counterCallback;
57  mapping (uint => Callback) callbacks;
69  mapping(address => Pair) public pairs;
70  address[] public pairKeys;
```

4.6 Modifier Definitions

4.6.1 Modifier alwaysAccept

- **Critical issue: Accept-All Modifier in `DEXClient`**
  See Accept Methods withtout Checks (3.2.1). This modifier should be removed.

```
73  modifier alwaysAccept {
74    tvm.accept();
75    _;
76  }
```

4.6.2 Modifier checkOwnerAndAccept

- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

```
79  modifier checkOwnerAndAccept {
80    require(msg.pubkey() == tvm.pubkey(), 102);
81    tvm.accept();
82    _;
83  }
```

4.7 Constructor Definitions

4.7.1 Constructor

- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: `counterCallback` should probably be initialized to 1 instead of 0, and keep 0 as the specific value of `getFirstCallback` when no callback is available.

```
85  constructor() public {
86    require(msg.sender == rootDEX, 103);
87    tvm.accept();
88    counterCallback = 0;
89  }
```

4.8 Public Method Definitions

4.8.1 Receive function

- OK

```
413 receive() external {
414 }
```

4.8.2 Function connectCallback

- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- **Critical issue: Accept-All Method in `DEXClient.connectCallback`**
  See No Accept-All Methods (3.2.1) The balance of the contract could be drained, by sending many `connectCallback` messages. Replace the `if` by a `require()` and perform the `tvm.accept` only afterwards.

```
181 function connectCallback(address wallet) public override
        alwaysAccept {
182   address connector = msg.sender;
183   if (connectors.exists(connector)) {
184     Connector cc = connectors[connector];
185     rootKeys.push(cc.root_address);
186     rootWallet[cc.root_address] = wallet;
187     rootConnector[cc.root_address] = connector;
188     TvmCell bodySTC = tvm.encodeBody(IDEXConnector(connector).
            setTransferCallback);
189     connector.transfer({value: GRAMS_SET_CALLBACK_ADDR, bounce:
            true, flag: 0, body:bodySTC});
190     TvmCell bodySBC = tvm.encodeBody(IDEXConnector(connector).
            setBouncedCallback);
```

```
191       connector.transfer({value: GRAMS_SET_CALLBACK_ADDR, bounce:
              true, flag: 0, body:bodySBC});
192       cc.status = true;
193       connectors[connector] = cc;
194     }
195   }
```

4.8.3 Function connectPair

- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
92   function connectPair(address pairAddr) public checkOwnerAndAccept
         returns (bool statusConnection) {
93     statusConnection = false;
94     if (!pairs.exists(pairAddr)){
95       Pair cp = pairs[pairAddr];
96       cp.status = false;
97       pairs[pairAddr] = cp;
98       pairKeys.push(pairAddr);
99       TvmCell body = tvm.encodeBody(IDEXPair(pairAddr).connect);
100      pairAddr.transfer({value:GRAMS_CONNECT_PAIR, body:body});
101      statusConnection = true;
102    }
103  }
```

4.8.4 Function connectRoot

- Minor Issue: see Not Enough Gas for Action (3.2.3). The method should check for a minimal balance in a `require()` before `tvm.accept`
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
158  function connectRoot(address root, uint256 souint, uint128
         gramsToConnector, uint128 gramsToRoot) public
         checkOwnerAndAccept returns (bool statusConnected){
159    statusConnected = false;
160    if (!rootWallet.exists(root)) {
161      TvmCell stateInit = tvm.buildStateInit({
162        contr: DEXConnector,
163        varInit: { soUINT: souint, dexclient: address(this) },
164        code: codeDEXConnector,
165        pubkey: tvm.pubkey()
166      });
167      TvmCell init = tvm.encodeBody(DEXConnector);
168      address connector = tvm.deploy(stateInit, init,
             gramsToConnector, address(this).wid);
169      Connector cr = connectors[connector];
170      cr.root_address = root;
171      cr.souint = souint;
172      cr.status = false;
173      connectors[connector] = cr;
174      TvmCell body = tvm.encodeBody(IDEXConnector(connector).
             deployEmptyWallet, root);
```

```
175         connector.transfer({value:gramsToRoot, bounce:true, body:body
                });
176         statusConnected = true;
177       }
178     }
```

4.8.5 Function createNewPair

- Minor Issue: a `require` is executed after `tvm.accept`, which may cause replication of failure and heavy gas cost. In general, we recommend to remove `tvm.accept` from modifiers, so that it can be explicitely performed after all `requires`.
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

```
356   function createNewPair(
357     address root0,
358     address root1,
359     uint256 pairSoArg,
360     uint256 connectorSoArg0,
361     uint256 connectorSoArg1,
362     uint256 rootSoArg,
363     bytes rootName,
364     bytes rootSymbol,
365     uint8 rootDecimals,
366     uint128 grammsForPair,
367     uint128 grammsForRoot,
368     uint128 grammsForConnector,
369     uint128 grammsForWallet,
370     uint128 grammsTotal
371   ) public view checkOwnerAndAccept  {
372     require (!(grammsTotal < (grammsForPair+2*grammsForConnector+2*
            grammsForWallet+grammsForRoot)) && !(grammsTotal < 5 ton)
            ,106);
373     require (!(address(this).balance < grammsTotal),105);
374     TvmCell body = tvm.encodeBody(IDEXRoot(rootDEX).createDEXpair,
            root0,root1,pairSoArg,connectorSoArg0,connectorSoArg1,
            rootSoArg,rootName,rootSymbol,rootDecimals,grammsForPair,
            grammsForRoot,grammsForConnector,grammsForWallet);
375     rootDEX.transfer({value:grammsTotal, bounce:false, flag: 1,
            body:body});
376   }
```

4.8.6 Function getAllDataPreparation

- **Critical issue: Accept-All Method in `DEXClient.getAllDataPreparation`**
  See No Accept-All Methods (3.2.1) The balance of the contract could be drained, by sending many `getAllDataPreparation` messages, especially as the return values may be expensive to serialize. Accept only for owner or use it as a get-method (executed locally, without gas).

```
215  function getAllDataPreparation() public view alwaysAccept returns
         (address[] pairKeysR, address[] rootKeysR){
216    pairKeysR = pairKeys;
217    rootKeysR = rootKeys;
218  }
```

4.8.7 Function getBalance

- OK

```
351  function getBalance() public pure responsible returns (uint128) {
352    return { value: 0, bounce: false, flag: 64 } thisBalance();
353  }
```

4.8.8 Function getCallback

- Minor Issue: there is probably no need to spend gas with `tvm.accept` since the method can be executed locally (get-method).
- Minor Issue: the method should probably fail with `require` if the callback id does not exist.

```
318  function getCallback(uint id) public view checkOwnerAndAccept
         returns (
319    address token_wallet,
320    address token_root,
321    uint128 amount,
322    uint256 sender_public_key,
323    address sender_address,
324    address sender_wallet,
325    address original_gas_to,
326    uint128 updated_balance,
327    uint8 payload_arg0,
328    address payload_arg1,
329    address payload_arg2
330  ){
331    Callback cc = callbacks[id];
332    token_wallet = cc.token_wallet;
333    token_root = cc.token_root;
334    amount = cc.amount;
335    sender_public_key = cc.sender_public_key;
```

```
336     sender_address = cc.sender_address;
337     sender_wallet = cc.sender_wallet;
338     original_gas_to = cc.original_gas_to;
339     updated_balance = cc.updated_balance;
340     payload_arg0 = cc.payload_arg0;
341     payload_arg1 = cc.payload_arg1;
342     payload_arg2 = cc.payload_arg2;
343   }
```

4.8.9 Function getConnectorAddress

- OK

```
153   function getConnectorAddress(uint256 connectorSoArg) public view
          responsible returns (address) {
154     return { value: 0, bounce: false, flag: 64 }
            computeConnectorAddress( connectorSoArg);
155   }
```

4.8.10 Function getPairData

- **Critical issue: Accept-All Method in `DEXClient.getPairData`**
  See No Accept-All Methods (3.2.1) The balance of the contract could be drained, by sending many `getPairData` messages. Accept only for owner or use it as a get-method (executed locally, without gas).
- Minor Issue: the method should probably fail if the associated pair does not exist in `pairs`

```
379   function getPairData(address pairAddr) public view alwaysAccept
          returns (
380     bool pairStatus,
381     address pairRootA,
382     address pairWalletA,
383     address pairRootB,
384     address pairWalletB,
385     address pairRootAB,
386     address curPair
387   ){
388     Pair cp = pairs[pairAddr];
389     pairStatus = cp.status;
390     pairRootA = cp.rootA;
391     pairWalletA = cp.walletA;
392     pairRootB = cp.rootB;
393     pairWalletB = cp.walletB;
394     pairRootAB = cp.rootAB;
395     curPair = pairAddr;
396   }
```

4.8.11 Function processLiquidity

- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- Minor Issue: see Naming of Constants (3.1.4). A number should be named through a constant.. The payload opcode should be a constant.
- Minor Issue: see Not Enough Gas for Action (3.2.3). The method should check the balance with `require` before performing `tvm.accept`
- Minor Issue: Repeated Code. The code could be simplified by using an internal function to perform the same computation for `rootA` and `rootB`.

```
251  function processLiquidity(address pairAddr, uint128 qtyA, uint128
         qtyB) public view checkOwnerAndAccept returns (bool
         processLiquidityStatus) {
252    processLiquidityStatus = false;
253    if (isReadyToProvide(pairAddr)) {
254      Pair cp = pairs[pairAddr];
255      address connectorA = rootConnector[cp.rootA];
256      address connectorB = rootConnector[cp.rootB];
257      TvmBuilder builderA;
258      builderA.store(uint8(2), address(this), rootWallet[cp.rootAB
             ]);
259      TvmCell payloadA = builderA.toCell();
260      TvmBuilder builderB;
261      builderB.store(uint8(2), address(this), rootWallet[cp.rootAB
             ]);
262      TvmCell payloadB = builderB.toCell();
263      TvmCell bodyA = tvm.encodeBody(IDEXConnector(connectorA).
             transfer, cp.walletA, qtyA, payloadA);
264      TvmCell bodyB = tvm.encodeBody(IDEXConnector(connectorB).
             transfer, cp.walletB, qtyB, payloadB);
265      connectorA.transfer({value: GRAMS_PROCESS_LIQUIDITY, bounce:
             true, body:bodyA});
266      connectorB.transfer({value: GRAMS_PROCESS_LIQUIDITY, bounce:
             true, body:bodyB});
267      processLiquidityStatus = true;
268    }
269  }
```

4.8.12 Function processSwapA

- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- Minor Issue: see Naming of Constants (3.1.4). A number should be named through a constant.. The payload opcode should be a constant.
- Minor Issue: see Not Enough Gas for Action (3.2.3). The method should check the balance with `require` before performing `tvm.accept`
- Minor Issue: Repeated Code. Methods `processSwapA` and `processSwapB` could be simplified by using an internal function for shared code.

```
221   function processSwapA(address pairAddr, uint128 qtyA) public view
          checkOwnerAndAccept returns (bool processSwapStatus) {
222     processSwapStatus = false;
223     if (isReady(pairAddr)) {
224       Pair cp = pairs[pairAddr];
225       address connector = rootConnector[cp.rootA];
226       TvmBuilder builder;
227       builder.store(uint8(1), cp.rootB, rootWallet[cp.rootB]);
228       TvmCell payload = builder.toCell();
229       TvmCell body = tvm.encodeBody(IDEXConnector(connector).
              transfer, cp.walletA, qtyA, payload);
230       connector.transfer({value: GRAMS_SWAP, bounce:true, body:body
              });
231       processSwapStatus = true;
232     }
233   }
```

4.8.13 Function processSwapB

- Minor Issue: see Naming of Constants (3.1.4). A number should be named through a constant.. The payload opcode should be a constant.
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- Minor Issue: see Not Enough Gas for Action (3.2.3). The method should check the balance with `require` before performing `tvm.accept`

```
236   function processSwapB(address pairAddr, uint128 qtyB) public view
          checkOwnerAndAccept returns (bool processSwapStatus) {
237     processSwapStatus = false;
238     if (isReady(pairAddr)) {
239       Pair cp = pairs[pairAddr];
240       address connector = rootConnector[cp.rootB];
241       TvmBuilder builder;
242       builder.store(uint8(1), cp.rootA, rootWallet[cp.rootA]);
243       TvmCell payload = builder.toCell();
244       TvmCell body = tvm.encodeBody(IDEXConnector(connector).
              transfer, cp.walletB, qtyB, payload);
245       connector.transfer({value: GRAMS_SWAP, bounce:true, body:body
              });
246       processSwapStatus = true;
247     }
248   }
```

4.8.14 Function returnLiquidity

- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- Minor Issue: see Naming of Constants (3.1.4). A number should be named through a constant.. The payload opcode should be a constant.
- Minor Issue: see Not Enough Gas for Action (3.2.3). The method should check the balance with `require` before performing `tvm.accept`

```
272   function returnLiquidity(address pairAddr, uint128 tokens) public
          view checkOwnerAndAccept returns (bool returnLiquidityStatus
        ) {
273     returnLiquidityStatus = false;
274     if (isReadyToProvide(pairAddr)) {
275     Pair cp = pairs[pairAddr];
276     TvmBuilder builder;
277     builder.store(uint8(3), rootWallet[cp.rootA], rootWallet[cp.
            rootB]);
278     TvmCell callback_payload = builder.toCell();
279     TvmCell body = tvm.encodeBody(IDEXConnector(rootConnector[cp.
            rootAB]).burn, tokens, pairAddr, callback_payload);
280     rootConnector[cp.rootAB].transfer({value:GRAMS_RETURN_LIQUIDITY
            , body:body});
281     returnLiquidityStatus = true;
282     }
283   }
```

4.8.15 Function sendTokens

- Minor Issue: the method should use `require` instead of `if` (before doing the `tvm.accept`).
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- Minor Issue: see Naming of Constants (3.1.4). A number should be named through a constant.. The payload opcode should be a constant.
- Minor Issue: see Not Enough Gas for Action (3.2.3). The method should check the balance with `require` before performing `tvm.accept`

```
399   function sendTokens(address tokenRoot, address to, uint128 tokens
          , uint128 grams) public checkOwnerAndAccept view returns (
          bool sendTokenStatus){
400     sendTokenStatus = false;
401     if (rootConnector[tokenRoot] != address(0)) {
402       address connector = rootConnector[tokenRoot];
403       TvmBuilder builder;
404       builder.store(uint8(4), address(this), rootWallet[tokenRoot])
              ;
405       TvmCell payload = builder.toCell();
406       TvmCell body = tvm.encodeBody(IDEXConnector(connector).
              transfer, to, tokens, payload);
407       connector.transfer({value: grams, bounce:true, body:body});
408       sendTokenStatus = true;
409     }
410   }
```

4.8.16 Function setPair

- **Critical issue: Accept-All Method in `DEXClient.setPair`**
  See No Accept-All Methods (3.2.1) The balance of the contract could be drained, by sending many `setPair` messages. You should replace the `if` by a `require()` followed by `tvm.accept()`.

- Minor Issue: see Not Enough Gas for Action (3.2.3).

```
127   function setPair(address arg0, address arg1, address arg2,
          address arg3, address arg4) public alwaysAccept override {
128     address dexpair = msg.sender;
129     if (pairs.exists(dexpair)){
130       Pair cp = pairs[dexpair];
131       cp.status = true;
132       cp.rootA = arg0;
133       cp.walletA = arg1;
134       cp.rootB = arg2;
135       cp.walletB = arg3;
136       cp.rootAB = arg4;
137       pairs[dexpair] = cp;
138     }
139   }
```

4.8.17 Function tokensReceivedCallback

- **Critical issue: Accept-All Method in `DEXClient.tokensReceivedCallback`**

  See No Accept-All Methods (3.2.1)

  – The balance of the contract could be drained, by sending many unexpected `tokensReceivedCallback` messages by an attacker. The attack could be improved by sending wrong payloads, causing `slice.decode` to fail after `tvm.accept`, causing replication of failure on all shards.

  – An attacker could send many such messages also to include incorrect receipts in the `callbacks` mapping, and remove correct ones by sending more than 10 such messages.

  – Fix:Accept only when sender is one of the wallets of this dexclient or use the `msg.value` gas.

```
286   function tokensReceivedCallback(
287     address token_wallet,
288     address token_root,
289     uint128 amount,
290     uint256 sender_public_key,
291     address sender_address,
292     address sender_wallet,
293     address original_gas_to,
294     uint128 updated_balance,
295     TvmCell payload
296   ) public override alwaysAccept {
297     Callback cc = callbacks[counterCallback];
298     cc.token_wallet = token_wallet;
299     cc.token_root = token_root;
300     cc.amount = amount;
301     cc.sender_public_key = sender_public_key;
302     cc.sender_address = sender_address;
```

```
303     cc.sender_wallet = sender_wallet;
304     cc.original_gas_to = original_gas_to;
305     cc.updated_balance = updated_balance;
306     TvmSlice slice = payload.toSlice();
307     (uint8 arg0, address arg1, address arg2) = slice.decode(uint8,
            address, address);
308     cc.payload_arg0 = arg0;
309     cc.payload_arg1 = arg1;
310     cc.payload_arg2 = arg2;
311     callbacks[counterCallback] = cc;
312     counterCallback++;
313     if (counterCallback > 10){delete callbacks[getFirstCallback()
            ];}
314   }
```

4.9 Internal Method Definitions

4.9.1 Function computeConnectorAddress

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
142   function computeConnectorAddress(uint256 souint) private inline
          view returns (address) {
143     TvmCell stateInit = tvm.buildStateInit({
144       contr: DEXConnector,
145       varInit: { soUINT: souint, dexclient: address(this) },
146       code: codeDEXConnector,
147       pubkey: tvm.pubkey()
148     });
149     return address(tvm.hash(stateInit));
150   }
```

4.9.2 Function getFirstCallback

- Minor Issue: if no callback is present, the function returns 0. This value could be reserved for this usage by setting `counterCallback` to 1 in the constructor.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
121   function getFirstCallback() private view returns (uint) {
122     optional(uint, Callback) rc = callbacks.min();
123     if (rc.hasValue()) {(uint number, ) = rc.get();return number;}
            else {return 0;}
124   }
```

4.9.3 Function getQuotient

- Minor Issue: This internal function is unused.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
109  function getQuotient(uint128 arg0, uint128 arg1, uint128 arg2)
         private inline pure returns (uint128) {
110    (uint128 quotient, ) = math.muldivmod(arg0, arg1, arg2);
111    return quotient;
112  }
```

4.9.4 Function getRemainder

- Minor Issue: This internal function is unused.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
115  function getRemainder(uint128 arg0, uint128 arg1, uint128 arg2)
         private inline pure returns (uint128) {
116    (, uint128 remainder) = math.muldivmod(arg0, arg1, arg2);
117    return remainder;
118  }
```

4.9.5 Function isReady

- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
198  function isReady(address pair) private inline view returns (bool)
         {
199    Pair cp = pairs[pair];
200    Connector ccA = connectors[rootConnector[cp.rootA]];
201    Connector ccB = connectors[rootConnector[cp.rootB]];
202    return cp.status && rootWallet.exists(cp.rootA) && rootWallet.
           exists(cp.rootB) && rootConnector.exists(cp.rootA) &&
           rootConnector.exists(cp.rootB) && ccA.status && ccB.status;
203  }
```

4.9.6 Function isReadyToProvide

- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.
- Minor Issue: Repeated Code. This function could easily be derived from `isReady` with the additional check of `rootWallet.exists(cp.rootAB)`

```
206   function isReadyToProvide(address pair) private inline view
          returns (bool) {
207     Pair cp = pairs[pair];
208     Connector ccA = connectors[rootConnector[cp.rootA]];
209     Connector ccB = connectors[rootConnector[cp.rootB]];
210     return cp.status && rootWallet.exists(cp.rootA) && rootWallet.
            exists(cp.rootB) && rootWallet.exists(cp.rootAB) &&
            rootConnector.exists(cp.rootA) && rootConnector.exists(cp.
            rootB) && ccA.status && ccB.status;
211   }
```

4.9.7 Function thisBalance

- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
346   function thisBalance() private inline  pure returns (uint128) {
347     return address(this).balance;
348   }
```

Chapter 5

Contract DEXConnector

In file `DEXConnector.sol`

5.1 Contract Inheritance

IExpectedWalletAddressCallback	
IDEXConnector	

5.2 Constant Definitions

- Minor Issue: see Better Units for Big Numbers (3.1.5)

```
19  uint128 constant GRAMS_TO_ROOT = 500000000;
20  uint128 constant GRAMS_TO_NEW_WALLET = 250000000;
```

5.3 Static Variable Definitions

- Minor Issue: see Typography of Static Variables (3.1.1)
- Minor issue: why is `drivenRoot` not a static variable ? it looks like there is only one possible `DEXConnector` for a given pair of `DEXClient` and `RootTokenContract`. Using `drivenRoot` as a static would also make the need to pass `souint` around useless, since the same `souint` could be used everywhere, from the `DEXRoot` to all the clients, pairs and connectors created from it.
- Minor issue: the name `dexclient` is misleading. In `DEXPair.connectRoot`, connectors are created for DEXPair passing `this` as `dexclient`, i.e. an address of type `DEXPair`. Maybe use `owner_address` ?

```
15  uint256 static public soUINT;
16  address static public dexclient;
```

5.4 Variable Definitions

- Minor Issue: see Typography of Global Variables (3.1.2)

```
22  address public drivenRoot;
23  address public driven;
24  bool public statusConnected;
```

5.5 Modifier Definitions

5.5.1 Modifier alwaysAccept

- **Critical issue: Accept-All Modifier in `DEXConnector`**
  See Accept Methods withtout Checks (3.2.1). This modifier should be removed.

```
27  modifier alwaysAccept {
28    tvm.accept();
29    _;
30  }
```

5.5.2 Modifier checkOwnerAndAccept

- Minor Issue: see Naming of Constants (3.1.4). A number should be named through a constant.

```
32  modifier checkOwnerAndAccept {
33    // Check that message from contract owner.
34    require(msg.sender == dexclient, 101);
35    tvm.accept();
36    _;
37  }
```

5.6 Constructor Definitions

5.6.1 Constructor

- OK

```
39  constructor() public checkOwnerAndAccept {
40      statusConnected = false;
41  }
```

5.7 Public Method Definitions

5.7.1 Receive function

- OK

```
129   receive() external {
130   }
```

5.7.2 Function burn

- Minor Issue: this method should check `require(statusConnected,..)`
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
116   function burn(uint128 tokens, address callback_address, TvmCell
          callback_payload) public override {
117     require(msg.sender == dexclient, 101);
118     tvm.rawReserve(address(this).balance - msg.value, 2);
119     TvmCell body = tvm.encodeBody(IBurnableByOwnerTokenWallet(
            driven).burnByOwner, tokens, 0, dexclient, callback_address
            , callback_payload);
120     driven.transfer({value: 0, bounce:true, flag: 128, body:body});
121   }
```

5.7.3 Function deployEmptyWallet

- Minor Issue: if this method is called twice with different roots, the second one may still be executed before `statusConnected` is set in `expectedWalletAddressCallback`. It's a minor issue, as only the second call will finally set `driven` with the value associated with the second `drivenRoot`, as `drivenRoot` is correctly checked in `expectedWalletAddressCallback`. The only drawback is a potential small loss in gas. Anyway, this would not be possible if `drivenRoot` was a static global variable of the contract.
- Minor Issue: It would probably be better to use `require(!statusConnected,..)` instead of `if(!statusConnected)..` to fail in case of called twice.
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
60  function deployEmptyWallet(address root) public override {
61    require(msg.sender == dexclient, 101);
62    require(!(msg.value < GRAMS_TO_ROOT * 2), 103);
63    tvm.rawReserve(address(this).balance - msg.value, 2);
64    if (!statusConnected) {
65      drivenRoot = root;
66      TvmCell bodyD = tvm.encodeBody(IRootTokenContract(root).
            deployEmptyWallet, GRAMS_TO_NEW_WALLET, 0, address(this),
             dexclient);
67      root.transfer({value:GRAMS_TO_ROOT, bounce:true, body:bodyD})
            ;
68      TvmCell bodyA = tvm.encodeBody(IRootTokenContract(root).
            sendExpectedWalletAddress, 0, address(this), address(this
            ));
69      root.transfer({value:GRAMS_TO_ROOT, bounce:true, body:bodyA})
            ;
70      dexclient.transfer({value: 0, bounce:true, flag: 128});
71    } else {
72      dexclient.transfer({value: 0, bounce:true, flag: 128});
73    }
74  }
```

5.7.4 Function expectedWalletAddressCallback

- Minor Issue: this method should check `require(!statusConnected,..)`
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
77  function expectedWalletAddressCallback(address wallet, uint256
        wallet_public_key, address owner_address) public override {
78    require(msg.sender == drivenRoot && wallet_public_key == 0 &&
          owner_address == address(this), 102);
79    tvm.rawReserve(address(this).balance - msg.value, 2);
80    statusConnected = true;
81    driven = wallet;
82    TvmCell body = tvm.encodeBody(IDEXConnect(dexclient).
          connectCallback, wallet);
83    dexclient.transfer({value: 0, bounce:true, flag: 128, body:body
          });
84  }
```

5.7.5 Function getBalance

- Minor issue: is there a good reason to use `checkOwnerAndAccept` to allow the user to spend gas to get the balance when this action can be performed without spending gas (through the GraphQL interface or through get-methods executed locally).

```
124   function getBalance() public pure checkOwnerAndAccept returns (
          uint128 balance){
125     balance = address(this).balance;
126   }
```

5.7.6 Function setBouncedCallback

- Minor Issue: there is no real need for `setBouncedCallback` and `setTransferCallback` to be in two different methods instead of having a single method performing both actions, as they are always called together.
- Minor Issue: this method should check `require(statusConnected,..)`
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
95    function setBouncedCallback() public override {
96      require(msg.sender == dexclient, 101);
97      tvm.rawReserve(address(this).balance - msg.value, 2);
98      TvmCell body = tvm.encodeBody(ITONTokenWallet(driven).
            setBouncedCallback, dexclient);
99      driven.transfer({value: 0, bounce:true, flag: 128, body:body});
100   }
```

5.7.7 Function setTransferCallback

- Minor Issue: this method should check `require(statusConnected,..)`
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
87    function setTransferCallback() public override {
88      require(msg.sender == dexclient, 101);
89      tvm.rawReserve(address(this).balance - msg.value, 2);
90      TvmCell body = tvm.encodeBody(ITONTokenWallet(driven).
            setReceiveCallback, dexclient, true);
91      driven.transfer({value: 0, bounce:true, flag: 128, body:body});
92    }
```

5.7.8 Function transfer

- Minor Issue: this method should check `require(statusConnected,..)`
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
108   function transfer(address to, uint128 tokens, TvmCell payload)
          public override {
109     require(msg.sender == dexclient, 101);
110     tvm.rawReserve(address(this).balance - msg.value, 2);
111     TvmCell body = tvm.encodeBody(ITONTokenWallet(driven).transfer,
            to, tokens, 0, dexclient, true, payload);
112     driven.transfer({value: 0, bounce:true, flag: 128, body:body});
113   }
```

5.8 Internal Method Definitions

5.8.1 Function getQuotient

- Minor Issue: This function is unused.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
48   function getQuotient(uint128 arg0, uint128 arg1, uint128 arg2)
         private inline pure returns (uint128) {
49     (uint128 quotient, ) = math.muldivmod(arg0, arg1, arg2);
50     return quotient;
51   }
```

5.8.2 Function getRemainder

- Minor Issue: This function is unused.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
54   function getRemainder(uint128 arg0, uint128 arg1, uint128 arg2)
         private inline pure returns (uint128) {
55     (, uint128 remainder) = math.muldivmod(arg0, arg1, arg2);
56     return remainder;
57   }
```

Chapter 6

Contract DEXPair

In file `DEXPair.sol`

6.1 Contract Inheritance

IDEXPair	
IDEXConnect	
ITokensReceivedCallback	
IBurnTokensCallback	

6.2 Type Definitions

6.2.1 Struct Connector

- TODO

```
37  struct Connector {
38    address root_address;
39    uint256 souint;
40    bool status;
41  }
```

6.2.2 Struct Callback

- TODO

```
48  struct Callback {
49    address token_wallet;
50    address token_root;
51    uint128 amount;
52    uint256 sender_public_key;
53    address sender_address;
```

```
54      address sender_wallet;
55      address original_gas_to;
56      uint128 updated_balance;
57      uint8 payload_arg0;
58      address payload_arg1;
59      address payload_arg2;
60    }
```

6.3 Constant Definitions

- TODO

```
65  uint128 constant GRAMS_SET_CALLBACK_ADDR = 500000000;
66  uint128 constant GRAMS_SEND_UNUSED_RETURN = 100000000;
67  uint128 constant GRAMS_MINT = 50000000;
68  uint128 constant GRAMS_RETURN = 200000000;
```

6.4 Static Variable Definitions

- TODO

```
19  address static public rootDEX;
20  uint256 static public soUINT;
21  address static public creator;
22  TvmCell static public codeDEXConnector;
23  address static public rootA;
24  address static public rootB;
25  address static public rootAB;
```

6.5 Variable Definitions

- TODO

```
27  mapping(address => address) public walletReserve;
28  mapping(address => bool) public syncStatus;
```

```
29  mapping(address => uint128) public balanceReserve;

31  uint128 public totalSupply;

33  mapping(address => mapping(address => bool)) public
        processingStatus;

34  mapping(address => mapping(address => uint128)) public
        processingData;

35  mapping(address => mapping(address => address)) public
        processingDest;

43  mapping (address => address) public rootConnector;

44  mapping (address => Connector) public connectors;

46  uint public counterCallback;

62  mapping (uint => Callback) callbacks;
```

6.6 Modifier Definitions

6.6.1 Modifier alwaysAccept

- **Critical issue: Accept-All Modifier in `DEXPair`**
  See Accept Methods withtout Checks (3.2.1). This modifier should be removed.

```
71  modifier alwaysAccept {
72    tvm.accept();
73    _;
74  }
```

6.6.2 Modifier checkOwnerAndAccept

- TODO
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

```
76  modifier checkOwnerAndAccept {
77    require(msg.sender == rootDEX, 102);
78    tvm.accept();
79    _;
80  }
```

6.6.3 Modifier checkPubKeyAndAccept

- TODO
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

```
82  modifier checkPubKeyAndAccept {
83    require(msg.pubkey() == tvm.pubkey(), 103);
84    tvm.accept();
85    _;
86  }
```

6.7 Constructor Definitions

6.7.1 Constructor

- TODO

```
88  constructor(uint256 souintA, uint256 souintB, uint128
        gramsDeployConnector, uint128 gramsDeployWallet) public
        checkOwnerAndAccept {
89    counterCallback = 0;
90    connectRoot(rootA, souintA, gramsDeployConnector,
          gramsDeployWallet);
91    connectRoot(rootB, souintB, gramsDeployConnector,
          gramsDeployWallet);
92  }
```

6.8 Public Method Definitions

6.8.1 Receive function

- TODO

```
609 receive() external {
610 }
```

6.8.2 Function burnCallback

- TODO
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
function burnCallback(
  uint128 tokens,
  TvmCell payload,
  uint256 sender_public_key,
  address sender_address,
  address wallet_address,
  address send_gas_to
) public override alwaysAccept {
  if (msg.sender == rootAB) {
    tvm.rawReserve(address(this).balance - msg.value, 2);
    TvmSlice slice = payload.toSlice();
    (uint8 arg0, address arg1, address arg2) = slice.decode(uint8,
        address, address);
    counterCallback++;
    Callback cc = callbacks[counterCallback];
    cc.token_wallet = wallet_address;
    cc.token_root = msg.sender;
    cc.amount = tokens;
    cc.sender_public_key = sender_public_key;
    cc.sender_address = sender_address;
    cc.sender_wallet = wallet_address;
    cc.original_gas_to = address(0);
    cc.updated_balance = 0;
    cc.payload_arg0 = arg0;
    cc.payload_arg1 = arg1;
    cc.payload_arg2 = arg2;
    callbacks[counterCallback] = cc;
    if (arg0 == 3 && arg1 != address(0) && arg2 != address(0)) {
      uint128 returnA = math.muldiv(balanceReserve[rootA],tokens,
          totalSupply);
      uint128 returnB = math.muldiv(balanceReserve[rootB],tokens,
          totalSupply);
      if (!(returnA > balanceReserve[rootA]) && !(returnB >
          balanceReserve[rootB])) {
        totalSupply -= tokens;
        balanceReserve[rootA] -= returnA;
        balanceReserve[rootB] -= returnB;
        TvmBuilder builder;
        builder.store(uint8(6), address(0), address(0));
        TvmCell new_payload = builder.toCell();
        TvmCell bodyA = tvm.encodeBody(IDEXConnector(rootConnector[
            rootA]).transfer, arg1, returnA, new_payload);
        TvmCell bodyB = tvm.encodeBody(IDEXConnector(rootConnector[
            rootB]).transfer, arg2, returnB, new_payload);
        rootConnector[rootA].transfer({value: GRAMS_RETURN, bounce:
            true, body:bodyA});
        rootConnector[rootB].transfer({value: GRAMS_RETURN, bounce:
            true, body:bodyB});
        if (counterCallback > 10){delete callbacks[getFirstCallback
            ()];}
        send_gas_to.transfer({value: 0, bounce:true, flag: 128});
      }
      if (counterCallback > 10){delete callbacks[getFirstCallback()
          ];}
    }
    if (counterCallback > 10){delete callbacks[getFirstCallback()
        ];}
```

```
568   }
569 }
```

6.8.3 Function connect

- TODO
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
149   function connect() public override {
150     address dexclient = msg.sender;
151     tvm.rawReserve(address(this).balance - msg.value, 2);
152     TvmCell body = tvm.encodeBody(IDEXClient(dexclient).setPair,
            rootA, walletReserve[rootA], rootB, walletReserve[rootB],
            rootAB);
153     dexclient.transfer({ value: 0, flag: 128, body:body});
154   }
```

6.8.4 Function connectCallback

- TODO
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
132   function connectCallback(address wallet) public override
          alwaysAccept {
133     address connector = msg.sender;
134     if (connectors.exists(connector)) {
135       Connector cr = connectors[connector];
136       walletReserve[cr.root_address] = wallet;
137       syncStatus[cr.root_address] = true;
138       rootConnector[cr.root_address] = connector;
139       TvmCell bodySTC = tvm.encodeBody(IDEXConnector(connector).
              setTransferCallback);
140       connector.transfer({value: GRAMS_SET_CALLBACK_ADDR, bounce:
              true, flag: 0, body:bodySTC});
141       TvmCell bodySBC = tvm.encodeBody(IDEXConnector(connector).
              setBouncedCallback);
142       connector.transfer({value: GRAMS_SET_CALLBACK_ADDR, bounce:
              true, flag: 0, body:bodySBC});
143       cr.status = true;
144       connectors[connector] = cr;
145     }
146   }
```

6.8.5 Function getBalance

- TODO

```
604 function getBalance() public pure responsible returns (uint128) {
605   return { value: 0, bounce: false, flag: 64 } thisBalance();
606 }
```

6.8.6 Function getCallback

- TODO

```
571 function getCallback(uint id) public view checkPubKeyAndAccept
        returns (
572   address token_wallet,
573   address token_root,
574   uint128 amount,
575   uint256 sender_public_key,
576   address sender_address,
577   address sender_wallet,
578   address original_gas_to,
579   uint128 updated_balance,
580   uint8 payload_arg0,
581   address payload_arg1,
582   address payload_arg2
583 ){
584   Callback cc = callbacks[id];
585   token_wallet = cc.token_wallet;
586   token_root = cc.token_root;
587   amount = cc.amount;
588   sender_public_key = cc.sender_public_key;
589   sender_address = cc.sender_address;
590   sender_wallet = cc.sender_wallet;
591   original_gas_to = cc.original_gas_to;
592   updated_balance = cc.updated_balance;
593   payload_arg0 = cc.payload_arg0;
594   payload_arg1 = cc.payload_arg1;
595   payload_arg2 = cc.payload_arg2;
596 }
```

6.8.7 Function getConnectorAddress

- TODO

```
108   function getConnectorAddress(uint256 connectorSoArg) public view
          responsible returns (address) {
109     return { value: 0, bounce: false, flag: 64 }
            computeConnectorAddress( connectorSoArg);
110   }
```

6.8.8 Function tokensReceivedCallback

- TODO
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)

```
248   function tokensReceivedCallback(
249     address token_wallet,
250     address token_root,
251     uint128 amount,
252     uint256 sender_public_key,
```

```
253     address sender_address,
254     address sender_wallet,
255     address original_gas_to,
256     uint128 updated_balance,
257     TvmCell payload
258   ) public override alwaysAccept {
259     if (msg.sender == walletReserve[rootA] || msg.sender ==
            walletReserve[rootB]) {
260       if (counterCallback > 10) {
261         Callback cc = callbacks[counterCallback];
262         cc.token_wallet = token_wallet;
263         cc.token_root = token_root;
264         cc.amount = amount;
265         cc.sender_public_key = sender_public_key;
266         cc.sender_address = sender_address;
267         cc.sender_wallet = sender_wallet;
268         cc.original_gas_to = original_gas_to;
269         cc.updated_balance = updated_balance;
270         TvmSlice slice = payload.toSlice();
271         (uint8 arg0, address arg1, address arg2) = slice.decode(
                uint8, address, address);
272         cc.payload_arg0 = arg0;
273         cc.payload_arg1 = arg1;
274         cc.payload_arg2 = arg2;
275         callbacks[counterCallback] = cc;
276         counterCallback++;
277         delete callbacks[getFirstCallback()];
278         if (arg0 == 1) {
279           tvm.rawReserve(address(this).balance - msg.value, 2);
280           uint128 amountOut = getAmountOut(amount, token_root, arg1
                );
281           if (!(amountOut > balanceReserve[arg1])){
282             balanceReserve[token_root] += amount;
283             balanceReserve[arg1] -= amountOut;
284             syncStatus[token_root] = balanceReserve[token_root] ==
                    updated_balance ? true : false;
285             TvmBuilder builder;
286             builder.store(uint8(0), address(0), address(0));
287             TvmCell new_payload = builder.toCell();
288             TvmCell body = tvm.encodeBody(IDEXConnector(
                    rootConnector[arg1]).transfer, arg2, amountOut,
                    new_payload);
289             rootConnector[arg1].transfer({value: 0, bounce:true,
                    flag: 128, body:body});
290           } else {
291             TvmBuilder builder;
292             builder.store(uint8(8), address(0), address(0));
293             TvmCell new_payload = builder.toCell();
294             TvmCell body = tvm.encodeBody(IDEXConnector(
                    rootConnector[token_root]).transfer, token_wallet,
                    amount, new_payload);
295             rootConnector[token_root].transfer({value: 0, bounce:
                    true, flag: 128, body:body});
296           }
297         }
298         if (arg0 == 2) {
299           tvm.rawReserve(address(this).balance - msg.value, 2);
```

```
300             processingStatus[token_root][arg1] = true;
301             processingData[token_root][arg1] += amount;
302             processingDest[token_root][arg1] = sender_wallet;
303             if (processingStatus[rootA][arg1] == true &&
                    processingStatus[rootB][arg1] == true) {
304               uint128 amountA = processingData[rootA][arg1];
305               uint128 amountB = processingData[rootB][arg1];
306               if (totalSupply == 0 && balanceReserve[rootA] == 0 &&
                      balanceReserve[rootB] == 0) {
307                 uint128 liquidity = math.min(amountA,amountB);
308                 balanceReserve[rootA] += amountA;
309                 balanceReserve[rootB] += amountB;
310                 totalSupply += liquidity;
311                 TvmCell body = tvm.encodeBody(IRootTokenContract(
                        rootAB).mint, liquidity, arg2);
312                 rootAB.transfer({value: GRAMS_MINT, bounce:true, body
                        :body});
313                 cleanProcessing(arg1);
314                 arg1.transfer({ value: 0, flag: 128});
315               } else {
316                 (uint128 provideA, uint128 provideB) =
                        acceptForProvide(amountA, amountB);
317                 if (provideA > 0 && provideB > 0) {
318                   uint128 liquidity = math.min(liquidityA(provideA),
                          liquidityB(provideB));
319                   uint128 unusedReturnA = amountA - provideA;
320                   uint128 unusedReturnB = amountB - provideB;
321                   balanceReserve[rootA] += provideA;
322                   balanceReserve[rootB] += provideB;
323                   totalSupply += liquidity;
324                   TvmCell body = tvm.encodeBody(IRootTokenContract(
                          rootAB).mint, liquidity, arg2);
325                   rootAB.transfer({value: GRAMS_MINT, bounce:true,
                          body:body});
326                   if (unusedReturnA > 0 && unusedReturnB > 0) {
327                     TvmBuilder builder;
328                     builder.store(uint8(7), address(0), address(0));
329                     TvmCell new_payload = builder.toCell();
330                     TvmCell bodyA = tvm.encodeBody(IDEXConnector(
                            rootConnector[rootA]).transfer,
                            processingDest[rootA][arg1], unusedReturnA,
                            new_payload);
331                     TvmCell bodyB = tvm.encodeBody(IDEXConnector(
                            rootConnector[rootB]).transfer,
                            processingDest[rootB][arg1], unusedReturnB,
                            new_payload);
332                     rootConnector[rootA].transfer({value:
                            GRAMS_SEND_UNUSED_RETURN, bounce:true, body:
                            bodyA});
333                     rootConnector[rootB].transfer({value:
                            GRAMS_SEND_UNUSED_RETURN, bounce:true, body:
                            bodyB});
334                     cleanProcessing(arg1);
335                     arg1.transfer({ value: 0, flag: 128});
336                   } else if (unusedReturnA > 0) {
337                     TvmBuilder builder;
338                     builder.store(uint8(7), address(0), address(0));
```

```
339                   TvmCell new_payload = builder.toCell();
340                   TvmCell bodyA = tvm.encodeBody(IDEXConnector(
                          rootConnector[rootA]).transfer,
                          processingDest[rootA][arg1], unusedReturnA,
                          new_payload);
341                   rootConnector[rootA].transfer({value:
                          GRAMS_SEND_UNUSED_RETURN, bounce:true, body:
                          bodyA});
342                   cleanProcessing(arg1);
343                   arg1.transfer({ value: 0, flag: 128});
344                 } else if (unusedReturnB > 0) {
345                   TvmBuilder builder;
346                   builder.store(uint8(7), address(0), address(0));
347                   TvmCell new_payload = builder.toCell();
348                   TvmCell bodyB = tvm.encodeBody(IDEXConnector(
                          rootConnector[rootB]).transfer,
                          processingDest[rootB][arg1], unusedReturnB,
                          new_payload);
349                   rootConnector[rootB].transfer({value:
                          GRAMS_SEND_UNUSED_RETURN, bounce:true, body:
                          bodyB});
350                   cleanProcessing(arg1);
351                   arg1.transfer({ value: 0, flag: 128});
352                 } else {
353                   cleanProcessing(arg1);
354                   arg1.transfer({ value: 0, flag: 128});
355                 }
356               } else {
357                 TvmBuilder builder;
358                 builder.store(uint8(9), address(0), address(0));
359                 TvmCell new_payload = builder.toCell();
360                 TvmCell bodyA = tvm.encodeBody(IDEXConnector(
                        rootConnector[rootA]).transfer, processingDest[
                        rootA][arg1], amountA, new_payload);
361                 TvmCell bodyB = tvm.encodeBody(IDEXConnector(
                        rootConnector[rootB]).transfer, processingDest[
                        rootB][arg1], amountB, new_payload);
362                 rootConnector[rootA].transfer({value:
                        GRAMS_SEND_UNUSED_RETURN, bounce:true, body:
                        bodyA});
363                 rootConnector[rootB].transfer({value:
                        GRAMS_SEND_UNUSED_RETURN, bounce:true, body:
                        bodyB});
364                 cleanProcessing(arg1);
365                 arg1.transfer({ value: 0, flag: 128});
366               }
367             }
368           } else {
369             arg1.transfer({ value: 0, flag: 128});
370           }
371         }
372       } else {
373         [same as lines 260...276]
374         [same as lines 278...371]
375       }
376     }
377   }
```

6.9 Internal Method Definitions

6.9.1 Function acceptForProvide

- TODO
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
214  function acceptForProvide(uint128 arg0, uint128 arg1) private
         inline view returns (uint128, uint128) {
215    require(balanceReserve[rootA] > 0 && balanceReserve[rootB] > 0,
           106);
216    uint128 qtyB = qtyBforA(arg0);
217    uint128 qtyA = qtyAforB(arg1);
218    uint128 minAmountA = math.min(arg0, qtyA);
219    uint128 minAmountB = math.min(arg1, qtyB);
220    uint128 crmin = math.min(balanceReserve[rootA], balanceReserve[
           rootB]);
221    uint128 crmax = math.max(balanceReserve[rootA], balanceReserve[
           rootB]);
222    uint128 crquotient = getQuotient(crmin, crmax);
223    uint128 crremainder = getRemainder(crmin, crmax);
224    uint128 amountMin = math.min(minAmountA,minAmountB);
225    uint128 amountOther = amountMin * crquotient + math.muldiv(
           amountMin,crremainder,crmin);
226    uint128 acceptForProvideA = minAmountA < minAmountB ? amountMin
           : amountOther;
227    uint128 acceptForProvideB = minAmountB < minAmountA ? amountMin
           : amountOther;
228    return (acceptForProvideA,acceptForProvideB);
229  }
```

6.9.2 Function cleanProcessing

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
232  function cleanProcessing(address dexclient) private inline {
233    delete processingStatus[rootA][dexclient];
234    delete processingStatus[rootB][dexclient];
235    delete processingData[rootA][dexclient];
236    delete processingData[rootB][dexclient];
237    delete processingDest[rootA][dexclient];
238    delete processingDest[rootB][dexclient];
239  }
```

6.9.3 Function computeConnectorAddress

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
95  function computeConnectorAddress(uint256 souint) private inline
        view returns (address) {
96    TvmCell stateInit = tvm.buildStateInit({
97      contr: DEXConnector,
98      varInit: { soUINT: souint, dexclient: address(this) },
99      code: codeDEXConnector,
100     pubkey: tvm.pubkey()
101   });
102   return address(tvm.hash(stateInit));
103 }
```

6.9.4 Function connectRoot

- TODO
- Minor Issue: see Method Calls instead of `tvm.encodeBody` (3.1.6)
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
113 function connectRoot(address root, uint256 souint, uint128
        gramsToConnector, uint128 gramsToRoot) private inline {
114   TvmCell stateInit = tvm.buildStateInit({
115     contr: DEXConnector,
116     varInit: { soUINT: souint, dexclient: address(this) },
117     code: codeDEXConnector,
118     pubkey: tvm.pubkey()
119   });
120   TvmCell init = tvm.encodeBody(DEXConnector);
121   address connector = tvm.deploy(stateInit, init,
          gramsToConnector, address(this).wid);
122   Connector cr = connectors[connector];
123   cr.root_address = root;
124   cr.souint = souint;
125   cr.status = false;
126   connectors[connector] = cr;
127   TvmCell body = tvm.encodeBody(IDEXConnector(connector).
          deployEmptyWallet, root);
128   connector.transfer({value:gramsToRoot, bounce:true, body:body})
          ;
129 }
```

6.9.5 Function getAmountOut

- TODO

- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
157   function getAmountOut(uint128 amountIn, address rootIn, address
          rootOut) private inline view returns (uint128){
158     uint128 amountInWithFee = math.muldiv(amountIn,997,1);
159     uint128 numerator = math.muldiv(amountInWithFee,balanceReserve[
            rootOut],1);
160     uint128 denominator = amountInWithFee + math.muldiv(
            balanceReserve[rootIn],1000,1);
161     return math.muldiv(1,numerator,denominator);
162   }
```

6.9.6 Function getFirstCallback

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
242   function getFirstCallback() private view returns (uint) {
243     optional(uint, Callback) rc = callbacks.min();
244     if (rc.hasValue()) {(uint number, ) = rc.get();return number;}
            else {return 0;}
245   }
```

6.9.7 Function getQuotient

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
165   function getQuotient(uint128 min, uint128 max) private inline
          pure returns (uint128) {
166     (uint128 quotient, ) = math.muldivmod(1, max, min);
167     return quotient;
168   }
```

6.9.8 Function getRemainder

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
171   function getRemainder(uint128 min, uint128 max) private inline
          pure returns (uint128) {
172     (, uint128 remainder) = math.muldivmod(1, max, min);
173     return remainder;
174   }
```

6.9.9 Function liquidityA

- TODO
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
191   function liquidityA(uint128 arg0) private inline view returns (
          uint128) {
192     require(arg0 > 0, 105);
193     require(totalSupply > 0, 110);
194     require(balanceReserve[rootA] > 0, 108);
195     return math.muldiv(arg0, totalSupply, balanceReserve[rootA]);
196   }
```

6.9.10 Function liquidityB

- TODO
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
199   function liquidityB(uint128 arg1) private inline view returns (
          uint128) {
200     require(arg1 > 0, 105);
201     require(totalSupply > 0, 110);
202     require(balanceReserve[rootB] > 0, 109);
203     return math.muldiv(arg1, totalSupply, balanceReserve[rootB]);
204   }
```

6.9.11 Function qtyAforB

- TODO
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
184   function qtyAforB(uint128 arg1) private inline view returns (
          uint128) {
185     require(arg1 > 0, 107);
186     require(balanceReserve[rootA] > 0 && balanceReserve[rootB] > 0,
            106);
187     return math.muldiv(arg1, balanceReserve[rootA], balanceReserve[
            rootB]);
188   }
```

6.9.12 Function qtyBforA

- TODO
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
177   function qtyBforA(uint128 arg0) private inline view returns (
          uint128) {
178     require(arg0 > 0, 105);
179     require(balanceReserve[rootA] > 0 && balanceReserve[rootB] > 0,
            106);
180     return math.muldiv(arg0, balanceReserve[rootB], balanceReserve[
            rootA]);
181   }
```

6.9.13 Function thisBalance

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
599 function thisBalance() private inline  pure returns (uint128) {
600   return address(this).balance;
601 }
```

Chapter 7

Contract DEXroot

In file `DEXRoot.sol`

7.1 Contract Inheritance

IDEXRoot	

7.2 Type Definitions

7.2.1 Struct Pair

- Minor Issue: keep naming should be consistent, `root0` and `root1`, or `rootA` and `rootB`, but not both. Idem for `rootLP` vs `rootAB`.

```
24  struct Pair {
25    address root0;
26    address root1;
27    address rootLP;
28  }
```

7.3 Constant Definitions

```
42  uint128 constant public GRAMS_CREATE_DEX_CLIENT = 1 ton;
```

7.4 Static Variable Definitions

- Minor Issue: `soUINT` is never used, as in other contracts. It would be worth using the same number for all contracts derived from this root.
- Minor Issue: see Typography of Static Variables (3.1.1)

```
13  uint256 static public soUINT;
```

7.5 Variable Definitions

- Minor Issue: see Typography of Global Variables (3.1.2)
- Minor Issue: naming should be more explicit. For example, `roots` could be renamed `pair_by_roots`, `pubkeys` amd `clients` could be renamed `dexclient_by_pubkey` and `pubkey_by_dexclient`.

```
15  TvmCell public codeDEXclient;
16  TvmCell public codeDEXpair;
17  TvmCell public codeDEXconnector;
18  TvmCell public codeRootToken;
19  TvmCell public codeTONTokenWallet;
21  mapping(address => mapping(address => address)) roots;
30  mapping(address => Pair) public pairs;
31  address[] public pairKeys;
33  mapping(uint256 => address) public pubkeys;
34  mapping(address => uint256) public clients;
35  address[] public clientKeys;
37  mapping(address => uint128) public balanceOf;
38  mapping(uint256 => address) public creators;
```

7.6 Modifier Definitions

7.6.1 Modifier alwaysAccept

- **Critical issue: Accept-All Modifier in `DEXroot`**
  See Accept Methods withtout Checks (3.2.1). This modifier should be removed.

```
45  modifier alwaysAccept {
46    tvm.accept();
47    _;
48  }
```

7.6.2 Modifier checkOwnerAndAccept

- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

```
51  modifier checkOwnerAndAccept {
52    require(msg.pubkey() == tvm.pubkey(), 101);
53    tvm.accept();
54    _;
55  }
```

7.6.3 Modifier checkCreatorAndAccept

- **Critical issue: Accept-All Modifier in `DEXroot`**
  See Accept Methods withtout Checks (3.2.1). The check on pubkey performed by this modifier is too weak to limit `tvm.accept`.
- Minor Issue: see Naming of Constants (3.1.4). A number is directly used in `require()`.

```
58  modifier checkCreatorAndAccept {
59    require(msg.pubkey() != 0, 103);
60    tvm.accept();
61    _;
62  }
```

7.7 Constructor Definitions

7.7.1 Constructor

- Minor Issue: see Naming of Constants (3.1.4). A number should be named through a constant.

```
65  constructor() public {
66    require(tvm.pubkey() == msg.pubkey(), 102);
67    tvm.accept();
68  }
```

7.8 Public Method Definitions

7.8.1 Receive function

- OK

```
76  receive() external {
77    balanceOf[msg.sender] += msg.value;
78  }
```

7.8.2 Function checkPubKey

- **Critical issue: Accept-All Method in `DEXroot.checkPubKey`**
  See No Accept-All Methods (3.2.1) The balance of the contract could be drained by sending many `checkPubKey` messages. This method could be a get-method without `tvm.accept`, to be executed locally.

```
328  function checkPubKey(uint256 pubkey) public view alwaysAccept
         returns (bool status, address dexclient) {
329    status = pubkeys.exists(pubkey);
330    dexclient = pubkeys[pubkey];
331  }
```

7.8.3 Function createDEXclient

- TODO

```
122  function createDEXclient(uint256 pubkey, uint256 souint) public
         alwaysAccept returns (address deployedAddress, bool
         statusCreate){
123    statusCreate = false;
124    deployedAddress = address(0);
125    uint128 prepay = balanceOf[creators[pubkey]];
126    require (!pubkeys.exists(pubkey) && !(prepay <
           GRAMS_CREATE_DEX_CLIENT), 106);
127    delete balanceOf[creators[pubkey]];
128    TvmCell stateInit = tvm.buildStateInit({
129      contr: DEXClient,
130      varInit: {rootDEX:address(this),soUINT:souint,
             codeDEXConnector:codeDEXconnector},
131      code: codeDEXclient,
132      pubkey: pubkey
133    });
134    deployedAddress = new DEXClient{
135      stateInit: stateInit,
136      flag: 0,
137      bounce : false,
138      value : (prepay - 3100000)
139    }();
140    pubkeys[pubkey] = deployedAddress;
141    clients[deployedAddress] = pubkey;
142    clientKeys.push(deployedAddress);
143    statusCreate = true;
144  }
```

7.8.4 Function createDEXpair

- TODO

```
237  function createDEXpair(
238    address root0,
239    address root1,
```

```
240     uint256 pairSoArg,
241     uint256 connectorSoArg0,
242     uint256 connectorSoArg1,
243     uint256 rootSoArg,
244     bytes rootName,
245     bytes rootSymbol,
246     uint8 rootDecimals,
247     uint128 grammsForPair,
248     uint128 grammsForRoot,
249     uint128 grammsForConnector,
250     uint128 grammsForWallet
251   ) public override {
252     require(root0 != address(0) && root1 != address(0) ,104);
253     require(!(grammsForPair < 500000000) && !(grammsForRoot <
            500000000) && !(grammsForConnector < 500000000) && !(
            grammsForWallet < 500000000),105);
254     tvm.rawReserve(address(this).balance - msg.value, 2);
255     uint128 grammsNeeded = grammsForPair + (2 * grammsForConnector)
             + (2 * grammsForWallet) + grammsForRoot;
256     if (clients.exists(msg.sender) && !(msg.value < grammsNeeded)
            && !(root0 == root1) && !roots[root0].exists(root1) && !
            roots[root1].exists(root0)) {
257       TvmCell stateInitR = tvm.buildStateInit({
258         contr: RootTokenContract,
259         varInit: {
260           _randomNonce:rootSoArg,
261           name:rootName,
262           symbol:rootSymbol,
263           decimals:rootDecimals,
264           wallet_code:codeTONTokenWallet
265         },
266         code: codeRootToken,
267         pubkey : clients[msg.sender]
268       });
269       address root01 = address(tvm.hash(stateInitR));
270       TvmCell stateInitP = tvm.buildStateInit({
271         contr: DEXPair,
272         varInit: {
273           rootDEX:address(this),
274           soUINT:pairSoArg,
275           creator:msg.sender,
276           codeDEXConnector:codeDEXconnector,
277           rootA:root0,
278           rootB:root1,
279           rootAB:root01
280         },
281         code: codeDEXpair,
282         pubkey : clients[msg.sender]
283       });
284       address pairAddress = new DEXPair{
285         stateInit: stateInitP,
286         flag: 0,
287         bounce : false,
288         value : grammsForPair + (2 * grammsForConnector) + (2 *
                grammsForWallet)
289       }(connectorSoArg0, connectorSoArg1, grammsForConnector,
              grammsForWallet);
```

```
290         address rootAddress = new RootTokenContract{
291           stateInit: stateInitR,
292           flag: 0,
293           bounce : false,
294           value : grammsForRoot
295         }(0, pairAddress);
296         roots[root0][root1] = pairAddress;
297         roots[root1][root0] = pairAddress;
298         Pair cp = pairs[pairAddress];
299         cp.root0 = root0;
300         cp.root1 = root1;
301         cp.rootLP = rootAddress;
302         pairs[pairAddress] = cp;
303         pairKeys.push(pairAddress);
304         msg.sender.transfer({ value: 0, flag: 128});
305       } else {
306         msg.sender.transfer({ value: 0, flag: 128});
307       }
308     }
```

7.8.5 Function getBalanceTONgrams

- TODO

```
334   function getBalanceTONgrams() public pure alwaysAccept returns (
          uint128 balanceTONgrams){
335     return address(this).balance;
336   }
```

7.8.6 Function getClientAddress

- TODO

```
118   function getClientAddress(uint256 clientPubKey, uint256
          clientSoArg) public view responsible returns (address) {
119     return { value: 0, bounce: false, flag: 64 }
            computeClientAddress(clientPubKey,clientSoArg);
120   }
```

7.8.7 Function getConnectorAddress

- TODO

```
233   function getConnectorAddress(uint256 connectorPubKey, uint256
          connectorSoArg, address connectorCommander) public view
          responsible returns (address) {
234     return { value: 0, bounce: false, flag: 64 }
            computeConnectorAddress(connectorPubKey, connectorSoArg,
            connectorCommander);
235   }
```

7.8.8 Function getPairAddress

- TODO

```
171   function getPairAddress(
172     uint256 pairPubKey,
173     uint256 pairSoArg,
174     address pairCreator,
175     address pairRootA,
176     address pairRootB,
177     address pairRootAB
178   ) public view responsible returns (address) {
179     return { value: 0, bounce: false, flag: 64 } computePairAddress
          (pairPubKey,pairSoArg,pairCreator,pairRootA,pairRootB,
          pairRootAB);
180   }
```

7.8.9 Function getPairByRoots01

- TODO

```
314   function getPairByRoots01(address root0, address root1) public
          view alwaysAccept returns (address pairAddr) {
315     pairAddr = roots[root0][root1];
316   }
```

7.8.10 Function getPairByRoots10

- TODO

```
318   function getPairByRoots10(address root1, address root0) public
          view alwaysAccept returns (address pairAddr) {
319     pairAddr = roots[root1][root0];
320   }
```

7.8.11 Function getRootTokenAddress

- TODO

```
213   function getRootTokenAddress(
214     uint256 rootPubKey,
215     uint256 rootSoArg,
216     bytes rootName,
217     bytes rootSymbol,
218     uint8 rootDecimals
219   ) public view responsible returns (address) {
220     return { value: 0, bounce: false, flag: 64 }
          computeRootTokenAddress(rootPubKey,rootSoArg,rootName,
          rootSymbol,rootDecimals);
221   }
```

7.8.12 Function getRootsByPair

- TODO

```
322  function getRootsByPair(address pairAddr) public view
         alwaysAccept returns (address root0, address root1) {
323    Pair cp = pairs[pairAddr];
324    root0 = cp.root0;
325    root1 = cp.root1;
326  }
```

7.8.13 Function sendTransfer

- TODO

```
71   function sendTransfer(address dest, uint128 value, bool bounce)
         public pure checkOwnerAndAccept {
72     dest.transfer(value, bounce, 0);
73   }
```

7.8.14 Function setCreator

- TODO

```
100  function setCreator(address giverAddr) public
         checkCreatorAndAccept {
101    uint256 pubkey = msg.pubkey();
102    creators[pubkey] = giverAddr;
103  }
```

7.8.15 Function setDEXclientCode

- Minor Issue: the code should be checked against a code hash, hardcoded in the code, or set either in the constructor or in the static variables.
- Minor Issue: a bitmap should be used to verify that the contract has been properly initialized, i.e. all the codes of the sub-contracts have been correctly set.

```
80   function setDEXclientCode(TvmCell code) public
         checkOwnerAndAccept {
81     codeDEXclient = code;
82   }
```

7.8.16 Function setDEXconnectorCode

- Minor Issue: the code should be checked against a code hash, hardcoded in the code, or set either in the constructor or in the static variables.
- Minor Issue: a bitmap should be used to verify that the contract has been properly initialized, i.e. all the codes of the sub-contracts have been correctly set.

```
88  function setDEXconnectorCode(TvmCell code) public
        checkOwnerAndAccept {
89    codeDEXconnector = code;
90  }
```

7.8.17 Function setDEXpairCode

- Minor Issue: the code should be checked against a code hash, hardcoded in the code, or set either in the constructor or in the static variables.
- Minor Issue: a bitmap should be used to verify that the contract has been properly initialized, i.e. all the codes of the sub-contracts have been correctly set.

```
84  function setDEXpairCode(TvmCell code) public checkOwnerAndAccept
        {
85    codeDEXpair = code;
86  }
```

7.8.18 Function setRootTokenCode

- Minor Issue: the code should be checked against a code hash, hardcoded in the code, or set either in the constructor or in the static variables.
- Minor Issue: a bitmap should be used to verify that the contract has been properly initialized, i.e. all the codes of the sub-contracts have been correctly set.

```
92  function setRootTokenCode(TvmCell code) public
        checkOwnerAndAccept {
93    codeRootToken = code;
94  }
```

7.8.19 Function setTONTokenWalletCode

- Minor Issue: the code should be checked against a code hash, hardcoded in the code, or set either in the constructor or in the static variables.

- Minor Issue: a bitmap should be used to verify that the contract has been properly initialized, i.e. all the codes of the sub-contracts have been correctly set.

```
96  function setTONTokenWalletCode(TvmCell code) public
        checkOwnerAndAccept {
97    codeTONTokenWallet = code;
98  }
```

7.9 Internal Method Definitions

7.9.1 Function computeClientAddress

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
108 function computeClientAddress(uint256 pubkey, uint256 souint)
        private inline view returns (address) {
109   TvmCell stateInit = tvm.buildStateInit({
110     contr: DEXClient,
111     varInit: {rootDEX:address(this),soUINT:souint,
          codeDEXConnector:codeDEXconnector},
112     code: codeDEXclient,
113     pubkey: pubkey
114   });
115   return address(tvm.hash(stateInit));
116 }
```

7.9.2 Function computeConnectorAddress

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
223 function computeConnectorAddress(uint256 pubkey, uint256 souint,
        address commander) private inline view returns (address) {
224   TvmCell stateInit = tvm.buildStateInit({
225     contr: DEXConnector,
226     varInit: { soUINT: souint, dexclient: commander },
227     code: codeDEXconnector,
228     pubkey: pubkey
229   });
230   return address(tvm.hash(stateInit));
231 }
```

7.9.3 Function computePairAddress

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
146   function computePairAddress(
147     uint256 pubkey,
148     uint256 souint,
149     address creator,
150     address rootA,
151     address rootB,
152     address rootAB
153   ) private inline view returns (address){
154     TvmCell stateInit = tvm.buildStateInit({
155       contr: DEXPair,
156       varInit: {
157         rootDEX:address(this),
158         soUINT:souint,
159         creator:creator,
160         codeDEXConnector:codeDEXconnector,
161         rootA:rootA,
162         rootB:rootB,
163         rootAB:rootAB
164       },
165       code: codeDEXpair,
166       pubkey : pubkey
167     });
168     return address(tvm.hash(stateInit));
169   }
```

7.9.4 Function computeRootTokenAddress

- TODO
- Minor Issue: see Typography of Internal Functions (3.1.3). The function name should start with _.

```
182   function computeRootTokenAddress(
183     uint256 pubkey,
184     uint256 souint,
185     bytes name,
186     bytes symbol,
187     uint8 decimals
188   ) private inline view returns (address){
189     TvmCell stateInit = tvm.buildStateInit({
190       contr: RootTokenContract,
191       varInit: {
192         _randomNonce:souint,
193         name:name,
194         symbol:symbol,
195         decimals:decimals,
196         wallet_code:codeTONTokenWallet
```

```
197       },
198       code: codeRootToken,
199       pubkey : pubkey
200     });
201     return address(tvm.hash(stateInit));
202   }
```

Chapter 8

Contract RootTokenContract

In file `RootTokenContract.sol`

8.1 Contract Inheritance

IRootTokenContract	
IBurnableTokenRootContract	
IBurnableByRootTokenRootContract	
IPausable	
ITransferOwner	
ISendSurplusGas	
IVersioned	

8.2 Static Variable Definitions

```
28     uint256 static _randomNonce;

30     bytes public static name;

31     bytes public static symbol;

32     uint8 public static decimals;

34     TvmCell static wallet_code;
```

8.3 Variable Definitions

```
36     uint128 total_supply;
```

```
38      uint256 root_public_key;

39      address root_owner_address;

40      uint128 public start_gas_balance;

42      bool public paused;
```

8.4 Modifier Definitions

8.4.1 Modifier onlyOwner

```
458     modifier onlyOwner() {
459         require(isOwner(), RootTokenContractErrors.
                error_message_sender_is_not_my_owner);
460         _;
461     }
```

8.4.2 Modifier onlyInternalOwner

```
463     modifier onlyInternalOwner() {
464         require(isInternalOwner(), RootTokenContractErrors.
                error_message_sender_is_not_my_owner);
465         _;
466     }
```

8.5 Constructor Definitions

8.5.1 Constructor

```
48      constructor(uint256 root_public_key_, address
            root_owner_address_) public {
49          require((root_public_key_ != 0 && root_owner_address_.value
                 == 0) ||
50                  (root_public_key_ == 0 && root_owner_address_.value
                         != 0),
51                  RootTokenContractErrors.
                        error_define_public_key_or_owner_address);
52          tvm.accept();
53
54          root_public_key = root_public_key_;
55          root_owner_address = root_owner_address_;
56
57          total_supply = 0;
58          paused = false;
59
60          start_gas_balance = address(this).balance;
61      }
```

8.6 Public Method Definitions

8.6.1 Fallback function

```
523     fallback() external {
524     }
```

8.6.2 OnBounce function

```
514     onBounce(TvmSlice slice) external {
515         tvm.accept();
516         uint32 functionId = slice.decode(uint32);
517         if (functionId == tvm.functionId(ITONTokenWallet.accept)) {
518             uint128 latest_bounced_tokens = slice.decode(uint128);
519             total_supply -= latest_bounced_tokens;
520         }
521     }
```

8.6.3 Function deployEmptyWallet

```
237     function deployEmptyWallet(
238         uint128 deploy_grams,
239         uint256 wallet_public_key_,
240         address owner_address_,
241         address gas_back_address
242     )
243         override
244         external
245     returns (
246         address
247     ) {
248         require((owner_address_.value != 0 && wallet_public_key_ ==
                0) ||
249                 (owner_address_.value == 0 && wallet_public_key_ !=
                     0),
250                 RootTokenContractErrors.
                    error_define_public_key_or_owner_address);
```

```
251
252         tvm.rawReserve(address(this).balance - msg.value, 2);
253
254         address wallet = new TONTokenWallet{
255             value: deploy_grams,
256             flag: 1,
257             code: wallet_code,
258             pubkey: wallet_public_key_,
259             varInit: {
260                 root_address: address(this),
261                 code: wallet_code,
262                 wallet_public_key: wallet_public_key_,
263                 owner_address: owner_address_
264             }
265         }();
266
267         if (gas_back_address.value != 0) {
268             gas_back_address.transfer({ value: 0, flag: 128 });
269         } else {
270             msg.sender.transfer({ value: 0, flag: 128 });
271         }
272
273         return wallet;
274     }
```

8.6.4 Function deployWallet

```
164     function deployWallet(
165         uint128 tokens,
166         uint128 deploy_grams,
167         uint256 wallet_public_key_,
168         address owner_address_,
169         address gas_back_address
170     )
171         override
172         external
173         onlyOwner
174     returns(
175         address
176     ) {
177         require(tokens >= 0);
178         require((owner_address_.value != 0 && wallet_public_key_ ==
                0) ||
179                 (owner_address_.value == 0 && wallet_public_key_ !=
                     0),
180                 RootTokenContractErrors.
                    error_define_public_key_or_owner_address);
181
182         if(root_owner_address.value == 0) {
183             tvm.accept();
184         } else {
```

```
185             tvm.rawReserve(math.max(start_gas_balance, address(this
                    ).balance - msg.value), 2);
186         }
187
188         TvmCell stateInit = tvm.buildStateInit({
189             contr: TONTokenWallet,
190             varInit: {
191                 root_address: address(this),
192                 code: wallet_code,
193                 wallet_public_key: wallet_public_key_,
194                 owner_address: owner_address_
195             },
196             pubkey: wallet_public_key_,
197             code: wallet_code
198         });
199
200         address wallet;
201
202         if(deploy_grams > 0) {
203             wallet = new TONTokenWallet{
204                 stateInit: stateInit,
205                 value: deploy_grams,
206                 wid: address(this).wid,
207                 flag: 1
208             }();
209         } else {
210             wallet = address(tvm.hash(stateInit));
211         }
212
213         ITONTokenWallet(wallet).accept(tokens);
214
215         total_supply += tokens;
216
217         if (root_owner_address.value != 0) {
218             if (gas_back_address.value != 0) {
219                 gas_back_address.transfer({ value: 0, flag: 128 });
220             } else {
221                 msg.sender.transfer({ value: 0, flag: 128 });
222             }
223         }
224
225         return wallet;
226     }
```

8.6.5 Function getDetails

```
77     function getDetails() override external view responsible
           returns (IRootTokenContractDetails) {
78         return { value: 0, bounce: false, flag: 64 }
               IRootTokenContractDetails(
79             name,
```

```
            symbol,
            decimals,
            root_public_key,
            root_owner_address,
            total_supply
        );
    }
```

8.6.6 Function getTotalSupply

```
    function getTotalSupply() override external view responsible
        returns (uint128) {
        return { value: 0, bounce: false, flag: 64 } total_supply;
    }
```

8.6.7 Function getVersion

```
    function getVersion() override external pure responsible
        returns (uint32) {
        return 4;
    }
```

8.6.8 Function getWalletAddress

```
    function getWalletAddress(
        uint256 wallet_public_key_,
        address owner_address_
    )
        override
        external
        view
        responsible
    returns (
        address
    ) {
        require((owner_address_.value != 0 && wallet_public_key_ ==
            0) ||
```

```
123                 (owner_address_.value == 0 && wallet_public_key_ !=
                        0),
124                 RootTokenContractErrors.
                        error_define_public_key_or_owner_address);
125         return { value: 0, bounce: false, flag: 64 }
                getExpectedWalletAddress(wallet_public_key_,
                owner_address_);
126     }
```

8.6.9 Function getWalletCode

```
100     function getWalletCode() override external view responsible
            returns (TvmCell) {
101         return { value: 0, bounce: false, flag: 64 } wallet_code;
102     }
```

8.6.10 Function mint

```
282     function mint(
283         uint128 tokens,
284         address to
285     )
286         override
287         external
288         onlyOwner
289     {
290         tvm.accept();
291
292         ITONTokenWallet(to).accept(tokens);
293
294         total_supply += tokens;
295     }
```

8.6.11 Function proxyBurn

```
307     function proxyBurn(
308         uint128 tokens,
309         address sender_address,
```

```
310         address send_gas_to,
311         address callback_address,
312         TvmCell callback_payload
313     )
314         override
315         external
316         onlyInternalOwner
317     {
318         tvm.rawReserve(address(this).balance - msg.value, 2);
319 
320         address send_gas_to_ = send_gas_to;
321         address expectedWalletAddress = getExpectedWalletAddress(0,
                sender_address);
322 
323         if (send_gas_to.value == 0) {
324             send_gas_to_ = sender_address;
325         }
326 
327         IBurnableByRootTokenWallet(expectedWalletAddress).
                burnByRoot{value: 0, flag: 128}(
328             tokens,
329             send_gas_to_,
330             callback_address,
331             callback_payload
332         );
333     }
```

8.6.12 Function sendExpectedWalletAddress

```
134     function sendExpectedWalletAddress(
135         uint256 wallet_public_key_,
136         address owner_address_,
137         address to
138     )
139         override
140         external
141     {
142         tvm.rawReserve(address(this).balance - msg.value, 2);
143 
144         address wallet = getExpectedWalletAddress(
                wallet_public_key_, owner_address_);
145         IExpectedWalletAddressCallback(to).
                expectedWalletAddressCallback{value: 0, flag: 128}(
146             wallet,
147             wallet_public_key_,
148             owner_address_
149         );
150     }
```

8.6.13 Function sendPausedCallbackTo

```
423     function sendPausedCallbackTo(
424         uint64 callback_id,
425         address callback_addr
426     )
427         override
428         external
429     {
430         tvm.rawReserve(address(this).balance - msg.value, 2);
431         IPausedCallback(callback_addr).pausedCallback{ value: 0,
                flag: 128 }(callback_id, paused);
432     }
```

8.6.14 Function sendSurplusGas

```
386     function sendSurplusGas(
387         address to
388     )
389         override
390         external
391         onlyInternalOwner
392     {
393         tvm.rawReserve(start_gas_balance, 2);
394         IReceiveSurplusGas(to).receiveSurplusGas{ value: 0, flag:
                128 }();
395     }
```

8.6.15 Function setPaused

```
407     function setPaused(
408         bool value
409     )
410         override
411         external
412         onlyOwner
413     {
414         tvm.accept();
```

```
415         paused = value;
416     }
```

8.6.16 Function tokensBurned

```
347     function tokensBurned(
348         uint128 tokens,
349         uint256 sender_public_key,
350         address sender_address,
351         address send_gas_to,
352         address callback_address,
353         TvmCell callback_payload
354     ) override external {
355 
356         require(!paused, RootTokenContractErrors.error_paused);
357 
358         address expectedWalletAddress = getExpectedWalletAddress(
                sender_public_key, sender_address);
359 
360         require(msg.sender == expectedWalletAddress,
                RootTokenContractErrors.
                error_message_sender_is_not_good_wallet);
361 
362         tvm.rawReserve(address(this).balance - msg.value, 2);
363 
364         total_supply -= tokens;
365 
366         if (callback_address.value == 0) {
367             send_gas_to.transfer({ value: 0, flag: 128 });
368         } else {
369             IBurnTokensCallback(callback_address).burnCallback{
                    value: 0, flag: 128}(
370                 tokens,
371                 callback_payload,
372                 sender_public_key,
373                 sender_address,
374                 expectedWalletAddress,
375                 send_gas_to
376             );
377         }
378 
379     }
```

8.6.17 Function transferOwner

```
440     function transferOwner(
441         uint256 root_public_key_,
442         address root_owner_address_
443     )
444         override
445         external
446         onlyOwner
447     {
448         require((root_public_key_ != 0 && root_owner_address_.value
                == 0) ||
449                 (root_public_key_ == 0 && root_owner_address_.value
                        != 0),
450                 RootTokenContractErrors.
                        error_define_public_key_or_owner_address);
451         tvm.accept();
452         root_public_key = root_public_key_;
453         root_owner_address = root_owner_address_;
454     }
```

8.7 Internal Method Definitions

8.7.1 Function getExpectedWalletAddress

```
485     function getExpectedWalletAddress(
486         uint256 wallet_public_key_,
487         address owner_address_
488     )
489         private
490         inline
491         view
492     returns (
493         address
494     ) {
495         TvmCell stateInit = tvm.buildStateInit({
496             contr: TONTokenWallet,
497             varInit: {
498                 root_address: address(this),
499                 code: wallet_code,
500                 wallet_public_key: wallet_public_key_,
501                 owner_address: owner_address_
502             },
503             pubkey: wallet_public_key_,
504             code: wallet_code
505         });
506
507         return address(tvm.hash(stateInit));
508     }
```

8.7.2 Function isExternalOwner

```
476     function isExternalOwner() private inline view returns (bool) {
477         return root_public_key != 0 && root_public_key == msg.
                pubkey();
478     }
```

8.7.3 Function isInternalOwner

```
472     function isInternalOwner() private inline view returns (bool) {
473         return root_owner_address.value != 0 && root_owner_address
                == msg.sender;
474     }
```

8.7.4 Function isOwner

```
468     function isOwner() private inline view returns (bool) {
469         return isInternalOwner() || isExternalOwner();
470     }
```

Chapter 9

Contract TONTokenWallet

In file `TONTokenWallet.sol`

9.1 Contract Inheritance

ITONTokenWallet	
IDestroyable	
IBurnableByOwnerTokenWallet	
IBurnableByRootTokenWallet	
IVersioned	

9.2 Static Variable Definitions

```
24      address static root_address;
25      TvmCell static code;
27      uint256 static wallet_public_key;
29      address static owner_address;
```

9.3 Variable Definitions

```
31      uint128 balance_;
32      optional(AllowanceInfo) allowance_;
34      address receive_callback;
35      address bounced_callback;
```

```
36      bool allow_non_notifiable;
```

9.4 Modifier Definitions

9.4.1 Modifier onlyRoot

```
598     modifier onlyRoot() {
599         require(root_address == msg.sender, TONTokenWalletErrors.
                error_message_sender_is_not_my_root);
600         _;
601     }
```

9.4.2 Modifier onlyOwner

```
603     modifier onlyOwner() {
604         require((owner_address.value != 0 && owner_address == msg.
                sender) ||
605                 (wallet_public_key != 0 && wallet_public_key == msg
                        .pubkey()),
606                 TONTokenWalletErrors.
                        error_message_sender_is_not_my_owner);
607         _;
608     }
```

9.4.3 Modifier onlyInternalOwner

```
610     modifier onlyInternalOwner() {
611         require(owner_address.value != 0 && owner_address == msg.
                sender);
612         _;
613     }
```

9.5 Constructor Definitions

9.5.1 Constructor

```
43      constructor() public {
44          require(wallet_public_key == tvm.pubkey() && (owner_address
                .value == 0 || wallet_public_key == 0));
45          tvm.accept();
46
47          allow_non_notifiable = true;
48
49          if (owner_address.value != 0) {
50              ITokenWalletDeployedCallback(owner_address).
                    notifyWalletDeployed{value: 0.00001 ton, flag: 1}(
                    root_address);
```

```
51          }
52      }
```

9.6 Public Method Definitions

9.6.1 Fallback function

```
683     fallback() external {
684     }
```

9.6.2 OnBounce function

```
653     onBounce(TvmSlice body) external {
654         tvm.accept();
655
656         uint32 functionId = body.decode(uint32);
657         if (functionId == tvm.functionId(ITONTokenWallet.
                internalTransfer)) {
658             uint128 tokens = body.decode(uint128);
659             balance_ += tokens;
660
661             if (bounced_callback.value != 0) {
662                 tvm.rawReserve(address(this).balance - msg.value,
                        2);
663                 ITokensBouncedCallback(bounced_callback).
                        tokensBouncedCallback{ value: 0, flag: 128 }(
664                     address(this),
665                     root_address,
666                     tokens,
667                     msg.sender,
668                     balance_
669                 );
670             } else if (owner_address.value != 0) {
671                 tvm.rawReserve(math.max(TONTokenWalletConstants.
                        target_gas_balance, address(this).balance - msg
                        .value), 2);
672                 owner_address.transfer({ value: 0, flag: 128 });
673             }
674         } else if (functionId == tvm.functionId(
                IBurnableTokenRootContract.tokensBurned)) {
675             balance_ += body.decode(uint128);
676             if (owner_address.value != 0) {
```

```
677                 tvm.rawReserve(math.max(TONTokenWalletConstants.
                        target_gas_balance, address(this).balance - msg
                        .value), 2);
678                 owner_address.transfer({ value: 0, flag: 128 });
679             }
680         }
681     }
```

9.6.3 Function accept

```
96      function accept(
97          uint128 tokens
98      )
99          override
100         external
101         onlyRoot
102     {
103         tvm.accept();
104         balance_ += tokens;
105     }
```

9.6.4 Function allowance

```
107     function allowance() override external view responsible returns
            (AllowanceInfo) {
108         return { value: 0, bounce: false, flag: 64 } (allowance_.
                hasValue() ? allowance_.get() : AllowanceInfo(0,
                address.makeAddrStd(0, 0)));
109     }
```

9.6.5 Function approve

```
119     function approve(
120         address spender,
121         uint128 remaining_tokens,
122         uint128 tokens
123     )
124         override
```

```
125         external
126         onlyOwner
127     {
128         require(remaining_tokens == 0 || !allowance_.hasValue(),
                TONTokenWalletErrors.error_non_zero_remaining);
129         if (owner_address.value != 0 ) {
130             tvm.rawReserve(math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value), 2);
131         } else {
132             tvm.accept();
133         }
134 
135         if (allowance_.hasValue()) {
136             if (allowance_.get().remaining_tokens ==
                    remaining_tokens) {
137                 allowance_.set(AllowanceInfo(tokens, spender));
138             }
139         } else {
140             allowance_.set(AllowanceInfo(tokens, spender));
141         }
142 
143         if (owner_address.value != 0 ) {
144             msg.sender.transfer({ value: 0, flag: 128 });
145         }
146     }
```

9.6.6 Function balance

```
58      function balance() override external view responsible returns (
            uint128) {
59          return { value: 0, bounce: false, flag: 64 } balance_;
60      }
```

9.6.7 Function burnByOwner

```
473     function burnByOwner(
474         uint128 tokens,
475         uint128 grams,
476         address send_gas_to,
477         address callback_address,
478         TvmCell callback_payload
479     ) override external onlyOwner {
480         require(tokens > 0);
```

```
481         require(tokens <= balance_, TONTokenWalletErrors.
                error_not_enough_balance);
482         require((owner_address.value != 0 && msg.value > 0) ||
483                 (owner_address.value == 0 && grams <= address(this)
                        .balance && grams > 0), TONTokenWalletErrors.
                        error_low_message_value);
484
485         if (owner_address.value != 0 ) {
486             tvm.rawReserve(math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value), 2);
487             balance_ -= tokens;
488             IBurnableTokenRootContract(root_address)
489                 .tokensBurned{ value: 0, flag: 128, bounce: true }(
490                     tokens,
491                     wallet_public_key,
492                     owner_address,
493                     send_gas_to.value != 0 ? send_gas_to :
                            owner_address,
494                     callback_address,
495                     callback_payload
496                 );
497         } else {
498             tvm.accept();
499             balance_ -= tokens;
500             IBurnableTokenRootContract(root_address)
501                 .tokensBurned{ value: grams, bounce: true }(
502                     tokens,
503                     wallet_public_key,
504                     owner_address,
505                     send_gas_to.value != 0 ? send_gas_to : address(
                            this),
506                     callback_address,
507                     callback_payload
508                 );
509         }
510     }
```

9.6.8 Function burnByRoot

```
520     function burnByRoot(
521         uint128 tokens,
522         address send_gas_to,
523         address callback_address,
524         TvmCell callback_payload
525     ) override external onlyRoot {
526         require(tokens > 0);
527         require(tokens <= balance_, TONTokenWalletErrors.
                error_not_enough_balance);
528
529         tvm.rawReserve(address(this).balance - msg.value, 2);
```

```
530
531         balance_ -= tokens;
532
533         IBurnableTokenRootContract(root_address)
534             .tokensBurned{ value: 0, flag: 128, bounce: true }(
535                 tokens,
536                 wallet_public_key,
537                 owner_address,
538                 send_gas_to,
539                 callback_address,
540                 callback_payload
541             );
542     }
```

9.6.9 Function destroy

```
584     function destroy(
585         address gas_dest
586     )
587         override
588         public
589         onlyOwner
590     {
591         require(balance_ == 0);
592         tvm.accept();
593         selfdestruct(gas_dest);
594     }
```

9.6.10 Function disapprove

```
148     function disapprove() override external onlyOwner {
149         if (owner_address.value != 0 ) {
150             tvm.rawReserve(math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value), 2);
151         } else {
152             tvm.accept();
153         }
154
155         allowance_.reset();
156
157         if (owner_address.value != 0 ) {
158             msg.sender.transfer({ value: 0, flag: 128 });
159         }
160     }
```

9.6.11 Function getDetails

```
72      function getDetails() override external view responsible
            returns (ITONTokenWalletDetails) {
73          return { value: 0, bounce: false, flag: 64 }
                ITONTokenWalletDetails(
74              root_address,
75              wallet_public_key,
76              owner_address,
77              balance_,
78              receive_callback,
79              bounced_callback,
80              allow_non_notifiable
81          );
82      }
```

9.6.12 Function getVersion

```
54      function getVersion() override external pure responsible
            returns (uint32) {
55          return 4;
56      }
```

9.6.13 Function getWalletCode

```
87      function getWalletCode() override external view responsible
            returns (TvmCell) {
88          return { value: 0, bounce: false, flag: 64 } code;
89      }
```

9.6.14 Function internalTransfer

```
370     function internalTransfer(
371         uint128 tokens,
372         uint256 sender_public_key,
373         address sender_address,
374         address send_gas_to,
375         bool notify_receiver,
376         TvmCell payload
377     )
378         override
379         external
380     {
381         require(notify_receiver || allow_non_notifiable ||
                receive_callback.value == 0,
382                 TONTokenWalletErrors.
                        error_recipient_has_disallow_non_notifiable);
383         address expectedSenderAddress = getExpectedAddress(
                sender_public_key, sender_address);
384         require(msg.sender == expectedSenderAddress,
                TONTokenWalletErrors.
                error_message_sender_is_not_good_wallet);
385         require(sender_address != owner_address ||
                sender_public_key != wallet_public_key,
                TONTokenWalletErrors.error_wrong_recipient);
386
387         if (owner_address.value != 0 ) {
388             uint128 reserve = math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value);
389             require(address(this).balance > reserve,
                    TONTokenWalletErrors.error_low_message_value);
390             tvm.rawReserve(reserve, 2);
391         } else {
392             tvm.rawReserve(address(this).balance - msg.value, 2);
393         }
394
395         balance_ += tokens;
396
397         if (notify_receiver && receive_callback.value != 0) {
398             ITokensReceivedCallback(receive_callback).
                    tokensReceivedCallback{ value: 0, flag: 128 }(
399                 address(this),
400                 root_address,
401                 tokens,
402                 sender_public_key,
403                 sender_address,
404                 msg.sender,
405                 send_gas_to,
406                 balance_,
407                 payload
408             );
409         } else {
410             send_gas_to.transfer({ value: 0, flag: 128 });
411         }
412     }
```

9.6.15 Function internalTransferFrom

```
423     function internalTransferFrom(
424         address to,
425         uint128 tokens,
426         address send_gas_to,
427         bool notify_receiver,
428         TvmCell payload
429     )
430         override
431         external
432     {
433         require(allowance_.hasValue(), TONTokenWalletErrors.
                error_no_allowance_set);
434         require(msg.sender == allowance_.get().spender,
                TONTokenWalletErrors.error_wrong_spender);
435         require(tokens <= allowance_.get().remaining_tokens,
                TONTokenWalletErrors.error_not_enough_allowance);
436         require(tokens <= balance_, TONTokenWalletErrors.
                error_not_enough_balance);
437         require(tokens > 0);
438         require(to != address(this), TONTokenWalletErrors.
                error_wrong_recipient);
439
440         if (owner_address.value != 0 ) {
441             uint128 reserve = math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value);
442             require(address(this).balance > reserve +
                    TONTokenWalletConstants.target_gas_balance,
                    TONTokenWalletErrors.error_low_message_value);
443             tvm.rawReserve(reserve, 2);
444             tvm.rawReserve(math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value), 2);
445         } else {
446             require(msg.value > TONTokenWalletConstants.
                    target_gas_balance, TONTokenWalletErrors.
                    error_low_message_value);
447             tvm.rawReserve(address(this).balance - msg.value, 2);
448         }
449
450         balance_ -= tokens;
451
452         allowance_.set(AllowanceInfo(allowance_.get().
                remaining_tokens - tokens, allowance_.get().spender));
453
454         ITONTokenWallet(to).internalTransfer{ value: 0, bounce:
                true, flag: 129 }(
455             tokens,
456             wallet_public_key,
```

```
            owner_address,
            send_gas_to,
            notify_receiver,
            payload
        );
    }
```

9.6.16 Function setBouncedCallback

```
    function setBouncedCallback(
        address bounced_callback_
    )
        override
        external
        onlyOwner
    {
        tvm.accept();
        bounced_callback = bounced_callback_;
    }
```

9.6.17 Function setReceiveCallback

```
    function setReceiveCallback(
        address receive_callback_,
        bool allow_non_notifiable_
    )
        override
        external
        onlyOwner
    {
        tvm.accept();
        receive_callback = receive_callback_;
        allow_non_notifiable = allow_non_notifiable_;
    }
```

9.6.18 Function transfer

```
    function transfer(
```

```
263         address to,
264         uint128 tokens,
265         uint128 grams,
266         address send_gas_to,
267         bool notify_receiver,
268         TvmCell payload
269     ) override external onlyOwner {
270         require(tokens > 0);
271         require(tokens <= balance_, TONTokenWalletErrors.
                error_not_enough_balance);
272         require(to.value != 0, TONTokenWalletErrors.
                error_wrong_recipient);
273         require(to != address(this), TONTokenWalletErrors.
                error_wrong_recipient);
274
275         if (owner_address.value != 0 ) {
276             uint128 reserve = math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value);
277             require(address(this).balance > reserve +
                    TONTokenWalletConstants.target_gas_balance,
                    TONTokenWalletErrors.error_low_message_value);
278             tvm.rawReserve(reserve, 2);
279             balance_ -= tokens;
280
281             ITONTokenWallet(to).internalTransfer{ value: 0, flag:
                    129, bounce: true }(
282                 tokens,
283                 wallet_public_key,
284                 owner_address,
285                 send_gas_to.value != 0 ? send_gas_to :
                        owner_address,
286                 notify_receiver,
287                 payload
288             );
289         } else {
290             require(address(this).balance > grams,
                    TONTokenWalletErrors.error_low_message_value);
291             require(grams > TONTokenWalletConstants.
                    target_gas_balance, TONTokenWalletErrors.
                    error_low_message_value);
292             tvm.accept();
293             balance_ -= tokens;
294
295             ITONTokenWallet(to).internalTransfer{ value: grams,
                    bounce: true, flag: 1 }(
296                 tokens,
297                 wallet_public_key,
298                 owner_address,
299                 send_gas_to.value != 0 ? send_gas_to : address(this
                        ),
300                 notify_receiver,
301                 payload
302             );
303         }
304     }
```

9.6.19 Function transferFrom

```
317     function transferFrom(
318         address from,
319         address to,
320         uint128 tokens,
321         uint128 grams,
322         address send_gas_to,
323         bool notify_receiver,
324         TvmCell payload
325     )
326         override
327         external
328         onlyOwner
329     {
330         require(to.value != 0, TONTokenWalletErrors.
                error_wrong_recipient);
331         require(tokens > 0);
332         require(from != to, TONTokenWalletErrors.
                error_wrong_recipient);
333
334         if (owner_address.value != 0 ) {
335             uint128 reserve = math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value);
336             require(address(this).balance > reserve + (
                    TONTokenWalletConstants.target_gas_balance * 2),
                    TONTokenWalletErrors.error_low_message_value);
337             tvm.rawReserve(reserve, 2);
338
339             ITONTokenWallet(from).internalTransferFrom{ value: 0,
                    flag: 129 }(
340                 to,
341                 tokens,
342                 send_gas_to.value != 0 ? send_gas_to :
                        owner_address,
343                 notify_receiver,
344                 payload
345             );
346         } else {
347             require(address(this).balance > grams,
                    TONTokenWalletErrors.error_low_message_value);
348             require(grams > TONTokenWalletConstants.
                    target_gas_balance * 2, TONTokenWalletErrors.
                    error_low_message_value);
349             tvm.accept();
350             ITONTokenWallet(from).internalTransferFrom{ value:
                    grams, flag: 1 }(
351                 to,
352                 tokens,
353                 send_gas_to.value != 0 ? send_gas_to : address(this
```

```
                    ),
354                 notify_receiver,
355                 payload
356             );
357         }
358     }
```

9.6.20 Function transferToRecipient

```
177     function transferToRecipient(
178         uint256 recipient_public_key,
179         address recipient_address,
180         uint128 tokens,
181         uint128 deploy_grams,
182         uint128 transfer_grams,
183         address send_gas_to,
184         bool notify_receiver,
185         TvmCell payload
186     ) override external onlyOwner {
187         require(tokens > 0);
188         require(tokens <= balance_, TONTokenWalletErrors.
                error_not_enough_balance);
189         require(recipient_address.value == 0 ||
                recipient_public_key == 0, TONTokenWalletErrors.
                error_wrong_recipient);
190
191         if (owner_address.value != 0 ) {
192             uint128 reserve = math.max(TONTokenWalletConstants.
                    target_gas_balance, address(this).balance - msg.
                    value);
193             require(address(this).balance > reserve +
                    TONTokenWalletConstants.target_gas_balance +
                    deploy_grams, TONTokenWalletErrors.
                    error_low_message_value);
194             require(recipient_address != owner_address,
                    TONTokenWalletErrors.error_wrong_recipient);
195             tvm.rawReserve(reserve, 2);
196         } else {
197             require(address(this).balance > deploy_grams +
                    transfer_grams, TONTokenWalletErrors.
                    error_low_message_value);
198             require(transfer_grams > TONTokenWalletConstants.
                    target_gas_balance, TONTokenWalletErrors.
                    error_low_message_value);
199             require(recipient_public_key != wallet_public_key);
200             tvm.accept();
201         }
202
203         TvmCell stateInit = tvm.buildStateInit({
204             contr: TONTokenWallet,
205             varInit: {
```

```
                root_address: root_address,
                code: code,
                wallet_public_key: recipient_public_key,
                owner_address: recipient_address
            },
            pubkey: recipient_public_key,
            code: code
        });

        address to;

        if(deploy_grams > 0) {
            to = new TONTokenWallet{
                stateInit: stateInit,
                value: deploy_grams,
                wid: address(this).wid,
                flag: 1
            }();
        } else {
            to = address(tvm.hash(stateInit));
        }

        if (owner_address.value != 0 ) {
            balance_ -= tokens;
            ITONTokenWallet(to).internalTransfer{ value: 0, flag:
                129, bounce: true }(
                tokens,
                wallet_public_key,
                owner_address,
                send_gas_to.value != 0 ? send_gas_to :
                    owner_address,
                notify_receiver,
                payload
            );
        } else {
            balance_ -= tokens;
            ITONTokenWallet(to).internalTransfer{ value:
                transfer_grams, flag: 1, bounce: true }(
                tokens,
                wallet_public_key,
                owner_address,
                send_gas_to.value != 0 ? send_gas_to : address(this
                    ),
                notify_receiver,
                payload
            );
        }
    }
```

9.7 Internal Method Definitions

9.7.1 Function getExpectedAddress

```
620     function getExpectedAddress(
621         uint256 wallet_public_key_,
622         address owner_address_
623     )
624         private
625         inline
626         view
627     returns (
628         address
629     ) {
630         TvmCell stateInit = tvm.buildStateInit({
631             contr: TONTokenWallet,
632             varInit: {
633                 root_address: root_address,
634                 code: code,
635                 wallet_public_key: wallet_public_key_,
636                 owner_address: owner_address_
637             },
638             pubkey: wallet_public_key_,
639             code: code
640         });
641 
642         return address(tvm.hash(stateInit));
643     }
```