(ENG) Reward Distribution Model Ver. 1.0

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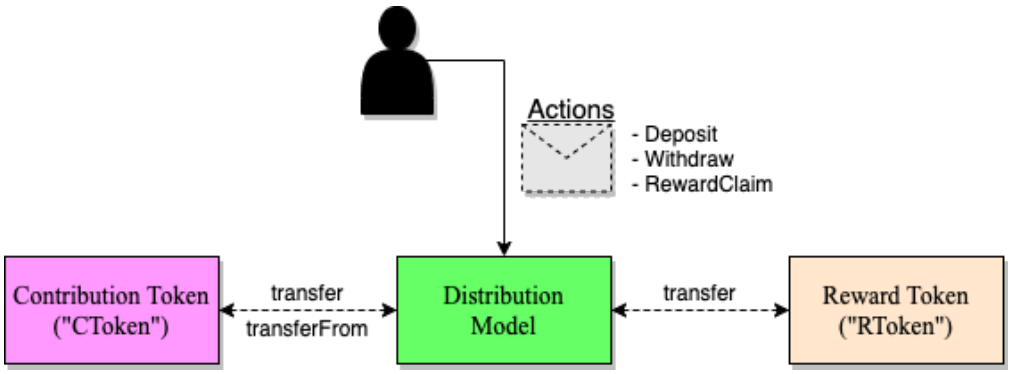
1. Introduction



Distribution Model Contract ("DMC") distributes reward to the users who have contributed to a token ecosystem. The contributions are measured by how much a user deposited the Contribution Tokens ("CTokens") to DMC. DMC calculates and distributes the Reward Tokens ("RTokens") depending on the contributions. The reward of a user is accumulated as proportionally to the deposited period and the relative portion of the deposited amount compared to the total amount at the moment.

2. Assumptions and Terminology

Assumptions

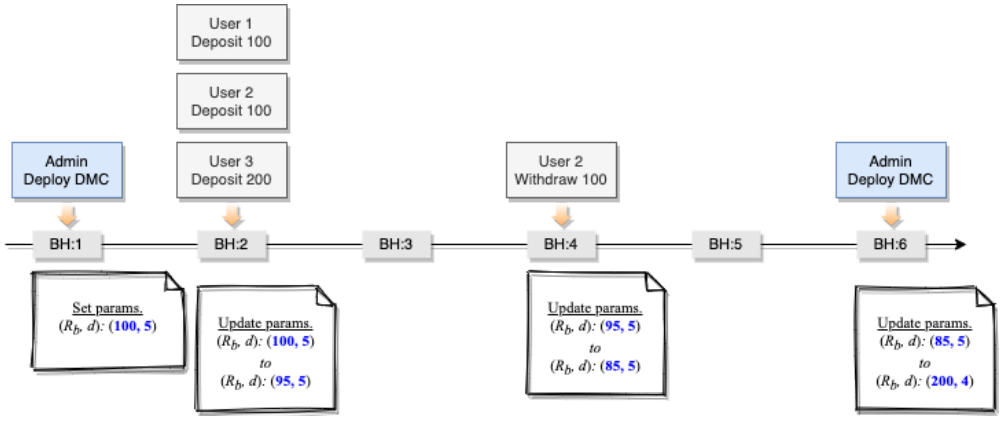
- DMC has enough balance of RTokens for all users.
- RTokens are calculated in every block.
- At every moment (block), the portion of distributing RTokens of a user is the same as the portion of CTokens of the user.
- The amount of RTokens that are distributed in a single block constantly decreases every block.

Terminology

- R_b : The total amount of RTokens for all users in a single block. It decrements constantly every block.
- D_t: The total amount of deposited CTokens in DMC.
- R_u : The rate of RTokens that a single CToken can earn in a single block, i.e., $R_u = \frac{R_b}{D_t}$.
- R_{user}: The amount of RTokens to be rewarded to a user in the block.
- d : The decrement amount of R_b per block.
- D_{user}: The amount of CTokens deposited by a user.
- $H_{current}$: The current block height
- H_{latest}: The block height when the latest action happens (before the current block)

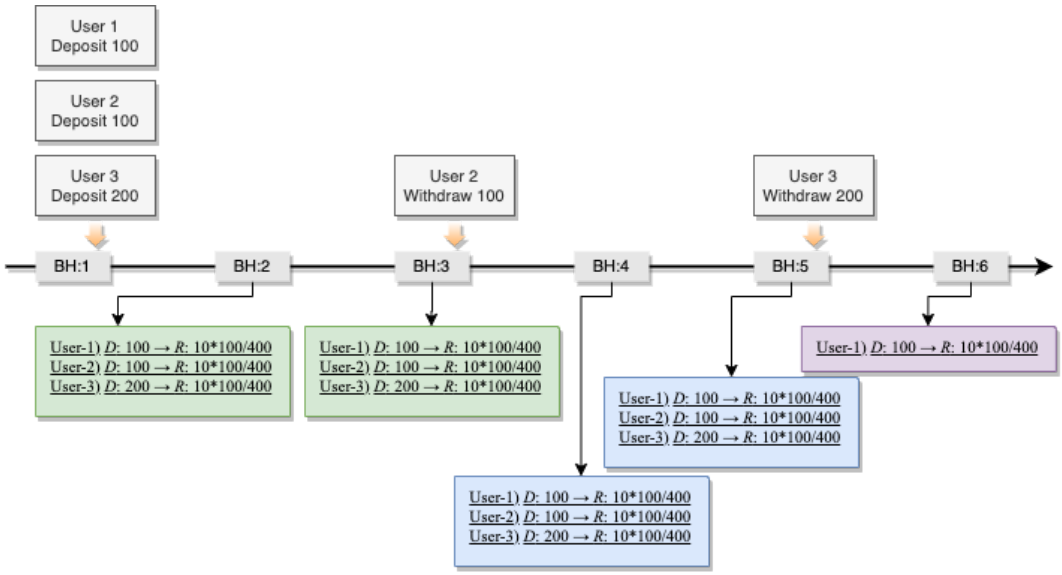
3. Design

3-1. Constant Decrement of Rewards



- For every block, R_b constantly decrements by d.
- Whenever an action occurs, DMC calculates R_b again.

3-2. The Basic Concept of Distribution



Assuming rewards per block is constant in this figure.

- User`s rewards in a block, $R_{user} = R_b * \frac{D_{User}}{D_t}$ = $D_{User} * \frac{R_b}{D_t}$.
- For instance, at `BH:2` (Block Height No 2) of the figure above:
  - The ratio of the deposited CTokens among users: `1 : 2 : 3`
  - R_b at `BH:2`: `10`
  - R_{user} for each user: `1.66 : 3.33 : 5`
- Requirement: for smart contracts, calculating the rewards for all users every block is inefficient. Hence, we let the rewards be updated only when the balance of CTokens changes.

3-3. Strategy

RewardUnit, R_u

- R_u depends on R_b and D_t of the current block, (i.e., $R_u = \frac{R_b}{D_t}$).
- To calculate the RToken for each user (R_{user}) in that block, DMC simply multiplies the R_u by the user's deposit amount (D_{user}) as follows:

$$R_{user} = D_{user} * R_u = D_{user} * \frac{R_b}{D_t} = R_b * \frac{D_{user}}{D_t}$$

RewardLane

- Definition: The accumulated sum of all *RewardUnit* for all blocks.
- At the beginning of every user action, *RewardUnit* is added to *RewardLane*.
- When the *RewardLane* is calculated, we accumulate *RewardUnits* from the block of latest action to the current block because we may not have any action every block.

- For example, assume that an action updates *RewardLane* from `BH:1` to `BH:4`.
  - Note that $R_{b,i}$ denotes the R_b at the i-th block.

$$\sum_{i=1}^{4} RewardUnit_i = \frac{R_{b,1}}{D_t} + \frac{R_{b,2}}{D_t} + \frac{R_{b,3}}{D_t} + \frac{R_{b,4}}{D_t}$$

  - Since there is no action between the last action and the current action, the value of D_t is the same.

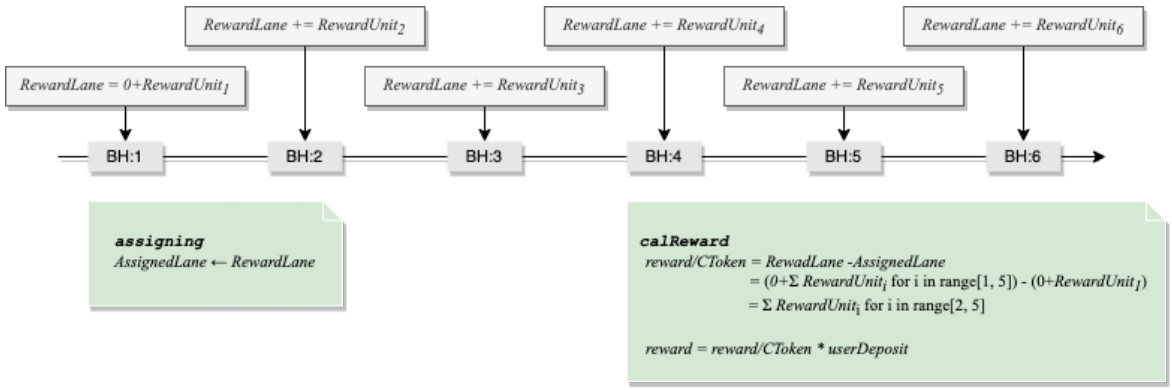
$$\frac{R_{b,1} + R_{b,2} + R_{b,3} + R_{b,4}}{D_t}$$

  - Since R_b is a regularly decreasing sequence, the equation can be simplified as following:

$$\frac{2nR_{b,1} + n(n-1)d}{2D_t}, \text{where } n = 4$$

- DMC can directly access the values of $R_{b,1}$, d, and D_t. It can derive n by subtracting the block height recorded by the previous action, H_{latest}, from the current block height, $H_{current}$.

Storing the previous RewardLane



- DMC stores the current *RewardLane* value, referred to as *AssignedLane*, for the user (tx sender) at the end of action execution for future actions.
- Regardless of what the action is or when the action was executed, DMC can calculate the R_{user} as follows:

$$R_{user} = D_{user} * (RewardLane - AssignedLane)$$

- The result of $RewardLane - AssignedLane$ implies the accumulated *RewardUnit* between the latest action and current action of the user. Therefore, the user can receive the accrued rewards at once.

4. Test Case

Test

Aa User	blockNum	rewardPerBlock	decrement	totalDeposit	Global Lane	User Lane	Action	RewardAmount
admin	0	**140**	4	0	0	-	-	-
1	10	140 → 100	4	0	0	-	100 Deposit	-
2	15	100 → 80	4	100	0 → 4.6	-	100 Deposit	-
3	20	80 → 60	4	200	4.6 → 6.4	-	200 Deposit	-
admin	25	60 → 40	4	400	6.4 → 7.05	-	setRewardVelocity	-
1	30	**100** → 75	5	400	7.05 → 8.175	0	WithdrawAll	[817.5, 0, 0]
2	35	75 → 50	5	300	8.175 → 9.25833	4.6	WithdrawAll	[817.5, 465.833, 0]
3	40	50 → 25	5	200	9.25833 → 10.25833	6.4	WithdrawAll	[817.5, 465.833, 771.66]

Simple Result Validation

- According to the table above, the sum of each user's rewards in total period is equal to the follow:

$$817.5 + 465.833 + 771.66 = 2054.993$$

- Expected Result
  - In the first period, `BH:11` ~ `BH:25`:
    - Number of blocks: 15
    - Starting rewards per block: 100
    - Decrement: 4
    - Total reward in this period: $\frac{15*2*100+15(15-1)(-4)}{2} = 1080$
  - In the second period, `BH:26` ~ `BH:40`:
    - Number of blocks: 15
    - Starting reward per block: 100
    - Decrement: 5
    - Total reward in this period: $\frac{15*2*100+15(15-1)(-5)}{2} = 975$
  - Total reward amount in the whole period: $1080 + 975 = 2055$