

# ICON

# Transaction Fee and SCORE Operation Policy <sup>EN</sup>

---

ver 1.0.0.0



# 1. Introduction

The ICON Network initially operated with a fixed fee system. However, as more diverse functions on the ICON Network have become available, a more detailed and reasonable fee system has been required, and revisions to the policy are expected in the future.

This document is intended to introduce the SCORE (Smart Contract On Reliable Environment, the ICON smart contract implementation environment) transaction fee policy on the ICON mainnet and consists of 3 components: Transaction Fee Policy, Virtual Step, and Smart Contract Termination Policy.

First, as mentioned in the earlier white paper, we adopted a 'differential fee system that reflects the degree of complexity of each transaction'. Fees incurred when executing a smart contract on the ICON Network depend on the amount of network resources used, and the unit 'Step' is applied for measurement.

It also introduces a concept known as 'Virtual Step', which provides a system to mitigate the burden of transaction fees. SCORE operator can receive and utilize Virtual Step by agreeing to deposit a certain amount of ICX for a given period of time. When SCORE operator deposits ICX into the contract, Virtual Step is immediately created in proportion to the amount of ICX and the duration of the deposit. This Virtual Step will be used to pay transaction fees associated with interacting with the smart contract.

Finally, this document outlines the penalty policy applied when withdrawing deposited ICX before the end of the stipulated period.

## 2. Transaction Fee Policy

### 2.1. Step

Step, where 100,000,000 Step is equivalent to 1 ICX, is the unit of measurement for transaction fees on the ICON Network. The amount of Step required is measured by the computational resources required to execute the transaction. The exchange rate between ICX and Step can be changed through consensus of the Representatives.

### 2.2. Items Requiring Transaction Fees

Transaction fees are charged for the following three items:

- A. Smart Contract Function Usage
- B. Blockchain Database Usage
- C. Amount of Transaction Data

Details surrounding transaction fee parameters and weights are outlined in Sections 2.3 and 2.4. The details disclosed in Sections 2.3 and 2.4 can be adjusted through consensus of the Representatives.

### 2.3. Step Calculation Formula

Step is calculated as follows:

$$Step = \max \left( \sum_i \beta_i S_i + C, C \right)$$

The amount of Step required is the weighted sum of the variables listed in Section 2.3.1. Here,  $S$  refers to the amount of usage of the respective variable,  $\beta$  denotes the weight, and  $C$  denotes a constant minimum fee. Constant value  $C$  prevents a negative result, as some variables have a negative weight (e.g.  $S_{contractDestruct}$  and  $S_{delete}$ ), and transactions with value lower than  $C$  will not be processed.

#### 2.3.1. Transaction Fee Variables

Transaction fee variables are defined as follows:

Name	Description
$S_{contractCall}$	Number of times to call the smart contract function
$S_{contractCreate}$	Number of times to call the smart contract code generation function
$S_{contractUpdate}$	Number of times to call the smart contract code update function
$S_{contractDestruct}$	Number of times to call the smart contract code delete function
$S_{contractSet}$	Size of generated/updated smart contract code (Bytes)
$S_{set}$	Size of data newly set in the state database (Bytes)
$S_{replace}$	Size of data to be updated in the state database (Bytes)
$S_{delete}$	Size of data to be deleted in the state database (Bytes)
$S_{input}$	Size of input data included in transaction (Bytes)
$S_{eventLog}$	Size of event log as a result of transaction (Bytes)
$C$	Default value that is charged each time transaction is executed

[Table 1] Transaction Fee Variables

### 2.3.2. Transaction Fee Weight

Transaction fee weight ( $\beta$ ) for each item is as follows:

Name	Value
$\beta_{contractCall}$	25,000
$\beta_{contractCreate}$	1,000,000,000
$\beta_{contractUpdate}$	1,600,000,000
$\beta_{contractDestruct}$	-70,000
$\beta_{contractSet}$	30,000
$\beta_{set}$	320
$\beta_{replace}$	80
$\beta_{delete}$	-240
$\beta_{input}$	200
$\beta_{eventLog}$	100
<b>C</b>	100,000

[ Table 2 ] Transaction Fee Weight

### 2.4. Step Usage Limit

To ensure stable operation of the ICON Network, the maximum available amount of Step that can be used for a single transaction is limited to approximately 2.5 billion Step. If the transaction does not close at the time when the maximum Step limit is reached, the transaction is suspended and the fees are exhausted.

The maximum Step limit is as follows, and it can be changed according to a SCORE execution environment update.

Type	Max Step Limit
<b>Transaction</b>	2,500,000,000

[ Table 3 ] Maximum Step Limit

## 2.5. Transaction Fee Payment Policy

### 2.5.1. Entity Responsible for Fees

In principle, the transaction fee will be charged to the SCORE user. However, it may be partly shared by the SCORE operator.

### 2.5.2. Sharing Ratio

The sharing ratio allows SCORE operators to attract more users by sharing some or all of the users' transaction fees. The operator can set the ratio between the user and the operator at the time of smart contract registration. The sharing ratio can be set from 0% to 100%.

If the operator's sharing ratio exceeds 0%, the operator must deposit a certain amount of ICX in the corresponding SCORE, and when a transaction occurs, the fee will be deducted from the 'Virtual Step' within the SCORE or with ICX. The policy regarding the ICX deposit is detailed in the next chapter.

Case	Operator	User	Sum
1	100%	0%	100%
2	50%	50%	100%
3	0%	100%	100%

[ Table 4 ] Transaction Fee Sharing Ratio Example

## 3. Virtual Step

If a service operator using a SCORE sets the sharing ratio above zero, the more the SCORE is used, the more fees must be paid by the service operator. This increases the burden on the operator and thus hinders the stability of the contract.

Because the ICON Network wants active service operators, we have included the Virtual Step system, which is a means of reasonably offsetting the fee burden on the service operators. Virtual Step is generated in proportion to the quantity of ICX deposited and the duration of the deposit. The operator can pay fees with the generated Virtual Step. Although the generated Virtual Step is used to pay fees and thus has economic value, it will not be available for trade on the secondary market.

### 3.1. Virtual Step Features

#### A. Function

- I . Transaction fees for running SCORE can be paid with Virtual Step.
- II . Virtual Step and Step are converted with a 1:1 ratio.
- III. As soon as the ICX deposit agreement is executed, Virtual Step is generated as detailed in [Table 5].

#### B. Calculation

- I . When depositing ICX in a SCORE, set the deposit amount and the deposit duration.
- II . When depositing  $a$  amount of ICX in a smart contract for  $d$  block period,  $f(a, d)$  amount of Virtual Step is generated. ( $f(a, d)$  is defined as the ratio of ICX deposited as shown in [Table 5])
- III. The deposit period can be set from a minimum of 1 month to a maximum of 24 months.
- IV. The deposit amount can be set from a minimum of 5,000 ICX to a maximum of 100,000 ICX.
- V . The minimum and maximum deposit duration, deposit amount, and Virtual Step production can be adjusted through consensus among the Representatives.

#### C. Policy

- I . Generated Virtual Step can not be transferred or traded.
- II . Virtual Step that have not been consumed within the deposit period are extinguished.
- III. If Virtual Step is exhausted, the required fee is deducted from the deposited ICX.

#### D. Amendment to the Agreement

- I . Multiple deposits in one SCORE can be made, but the agreed upon deposit amount and period can not be changed.
- II . Making a new deposit agreement is available even if the existing agreement still contains residual Virtual Step, and the amount of Virtual Step produced by each deposit is calculated independently.

### 3.2. Virtual Step Calculation

The SCORE operator can pay the transaction fees using the Virtual Step generated by depositing a certain amount of ICX for a certain period of time.

The amount of Virtual Step generated is designed to have a positive correlation with the ICX deposit period and deposit amount (refer to [Table 5]). For example, if you deposit 10,000 ICX for 1 month, you can use 13,120,000,000 Virtual Step, which is equivalent to 1.312% of the deposit, or 131.2 ICX. If you deposit 100,000 ICX for 24 months, you can use 24,022,100,000,000 Virtual Step, which is equivalent to using 240,221 ICX. The deposit amount can range from 5,000 ICX to 100,000 ICX, and the deposit period can range from 1,296,000 blocks (approximately 1 month) to 31,104,000 blocks (approximately 24 months) with each interval being 1,296,000 blocks.

(Unit : %, 1M=1,296,000 blocks)

Period (M, d)	Deposit Amount(ICX, a)										
	5,000 ~9,999	10,000 ~19,999	20,000 ~29,999	30,000 ~39,999	40,000 ~49,999	50,000 ~59,999	60,000 ~69,999	70,000 ~79,999	80,000 ~89,999	90,000 ~99,999	100,000
1	1.253	1.312	1.432	1.551	1.670	1.790	1.909	2.028	2.147	2.267	2.386
2	2.925	3.065	3.343	3.622	3.901	4.179	4.458	4.736	5.015	5.294	5.572
3	5.009	5.247	5.724	6.201	6.678	7.155	7.632	8.109	8.586	9.063	9.540
4	7.492	7.849	8.562	9.276	9.989	10.703	11.416	12.130	12.843	13.557	14.270
5	10.366	10.860	11.847	12.834	13.821	14.809	15.796	16.783	17.770	18.758	19.745
6	13.621	14.269	15.567	16.864	18.161	19.458	20.756	22.053	23.350	24.647	25.944
7	17.247	18.068	19.710	21.353	22.996	24.638	26.281	27.923	29.566	31.208	32.851
8	21.234	22.245	24.267	26.289	28.311	30.334	32.356	34.378	36.400	38.423	40.445
9	25.572	26.789	29.225	31.660	34.096	36.531	38.966	41.402	43.837	46.273	48.708
10	30.251	31.692	34.573	37.454	40.335	43.216	46.097	48.978	51.859	54.741	57.622
11	35.263	36.942	40.300	43.658	47.017	50.375	53.734	57.092	60.450	63.809	67.167

<sup>1</sup>This document assumes that ICON Network generates 1 block in around 2 seconds(1,296,000 blocks in 30 days). Therefore, 1 month is represented as 1,296,000 blocks in this document.

<b>12</b>	40.596	42.529	46.395	50.261	54.128	57.994	61.860	65.726	69.593	73.459	77.325
<b>13</b>	46.241	48.443	52.847	57.250	61.654	66.058	70.462	74.866	79.270	83.674	88.078
<b>14</b>	52.188	54.673	59.643	64.614	69.584	74.554	79.524	84.495	89.465	94.435	99.406
<b>15</b>	58.427	61.210	66.774	72.339	77.903	83.468	89.032	94.597	100.161	105.726	111.290
<b>16</b>	64.949	68.042	74.228	80.414	86.599	92.785	98.971	105.156	111.342	117.528	123.713
<b>17</b>	71.744	75.161	81.993	88.826	95.659	102.492	109.324	116.157	122.990	129.823	136.656
<b>18</b>	78.802	82.554	90.059	97.564	105.069	112.574	120.079	127.584	135.089	142.593	150.098
<b>19</b>	86.112	90.213	98.414	106.615	114.816	123.017	131.219	139.420	147.621	155.822	164.023
<b>20</b>	93.666	98.126	107.047	115.967	124.888	133.808	142.729	151.650	160.570	169.491	178.411
<b>21</b>	101.453	106.284	115.946	125.608	135.271	144.933	154.595	164.257	173.919	183.581	193.244
<b>22</b>	109.464	114.676	125.101	135.526	145.951	156.376	166.802	177.227	187.652	198.077	208.502
<b>23</b>	117.688	123.292	134.500	145.709	156.917	168.125	179.334	190.542	201.750	212.959	224.167
<b>24</b>	126.116	132.121	144.132	156.144	168.155	180.166	192.177	204.188	216.199	228.210	240.221

[ Table 5 ] Virtual Step Calculation according to ICX Deposit Amount and Deposit Period

### 3.3. Virtual Step Calculation Example

The concept of Virtual Step reflects the opportunity cost of depositing a certain amount of ICX for a certain period of time. SCORE operators will be able to choose the optimal combination of deposit size and time based on their operational budgets and SCORE usage forecasts. Below is an example scenario for calculating the Virtual Step according to a given lock-up period and ICX deposit amount.

#### 3.3.1. Scenario 1 (50,000 ICX deposited for 1 month)

[Table 6] breaks down several scenarios in which a SCORE operator deposits 50,000 ICX in a 1 month period of time. The sum of the Virtual Step generated varies depending on whether the service operator deposits 50,000 ICX in a lump sum versus multiple installments. Service operators can choose the way that is more efficient and operate their services.



Case	10,000 ICX	20,000 ICX	30,000 ICX	40,000 ICX	50,000 ICX	The total sum of Virtual Step
1	5 times					65,600,000,000
2	3 times	1 time				68,000,000,000
3	1 time	2 times				70,400,000,000
4	2 times		1 time			72,770,000,000
5		1 time	1 time			75,170,000,000
6	1 time			1 time		79,920,000,000
7					1 time	89,500,000,000

[ Table 6 ] Example of Depositing 50,000 ICX

- Case 1 depicts a situation in which 50,000 ICX deposit is broken into five installments of 10,000 ICX each. In this case, according to [Table 5], when 10,000 ICX are deposited for 1 month, the Virtual Step generated is 13,120,000,000. Therefore, if they are deposited five times subsequently, the total Virtual Step is 65,600,000,000.
- Case 5 depicts a situation in which 50,000 ICX deposit is broken into two installments of 30,000 ICX and 20,000 ICX each. In this case, according to [Table 5], when 30,000 ICX are deposited for 1 month, the Virtual Step generated is 46,530,000,000, and when the 20,000 ICX are deposited for 1 month, the Virtual Step generated is 28,640,000,000, and the total Virtual Step generated is 75,170,000,000.
- Case 7 depicts a situation in which 50,000 ICX deposit is made at once. In this case, according to [Table 5], when 50,000 ICX are deposited for 1 month, the Virtual Step generated is 89,500,000,000. Compared to the scenarios in Case 1 ~ 6, this case can deposit the same amount of ICX and generate the most Virtual Steps.

### 3.3.2. Scenario 2 (30,000 ICX deposited for 5 months)

[Table 7] breaks down several scenarios in which a SCORE operator deposits 30,000 ICX over 5 months period of time. This flexibility allows SCORE operators to choose the optimal strategy based on their respective business and liquidity needs. The longer the ICX is deposited, the more Virtual Step generated.

(Unit : 1,000,000 Virtual Step)

Case	1 Month	2 Month	3 Month	4 Month	5 Month	The total sum of Virtual Step
1	385,020					385,020
2	186,030			108,660		294,690
3	108,660		108,660		46,530	263,850
4	46,530	46,530	46,530	46,530	46,530	232,650

[ Table 7 ] Example of Operating 30,000 ICX for 5 Months

- Case 1 depicts the amount of Virtual Step generated for depositing 30,000 ICX for 5 months straight. According to [Table 5], given a specified amount of ICX, more Virtual Step are created as the deposit period increases. This method generates the most Virtual Step.
- Case 4 depicts the amount of Virtual Step generated for depositing 30,000 ICX on a monthly basis for 5 months. Rather than sacrificing liquidity for 5 months straight, this case allows for optionality at the end of each month, and this optionality comes at a cost. In this case, the cost is 152,370 Virtual Step (the difference between Case 1 and Case 4). The SCORE operator may still choose Case 4, as it offers greater liquidity and more flexibility to react to variance in the usage of the SCORE.

## 4. SCORE Termination Policy

### 4.1. Termination of Deposit for Early Withdrawal

SCORE operators will incur a penalty if they need to withdraw the deposited ICX prior to the end of the predetermined period. This fee can exceed the Virtual Step generated and result in losing some of the deposit. The penalty is based on the sum of the below two factors:

- Deduction of excess profits from early withdrawal ( $Penalty_{over}$ )
- Penalties for breach of agreement ( $Penalty_{foul}$ )

#### 4.1.1. Penalty Calculation

##### 4.1.1.1. $Penalty_{over}$

Given the aforementioned benefits of depositing ICX for longer period of time, an early withdrawal will trigger the appropriate amount of Virtual Step to be recalculated, resulting in a clawback of a portion of the Virtual Step (i.e. penalty) that was generated prior to withdrawing the deposit.

- Virtual Step Calculation at Withdrawal Time

[Table 5] can not be directly be applied because it only depicts monthly periods, while an early withdrawal can happen at any given block height. Therefore, the total deposited period at the time of early withdrawal should be expressed in the number of months and the remaining number of blocks that is applicable for Virtual Step. The number of blocks can be thought of as "days" in the calendar. For example, a period of 15,855,200 blocks can be represented as 12 months(15,555,200 blocks) and 300,000 blocks. The Virtual Step generation amount for the "month" at the time of withdrawal is directly determined according to [Table 5], and the Virtual Step generation amount corresponding to the remaining "days" is calculated on a block height basis. The following formula calculates the amount of Virtual Step generated at the point of withdrawal,  $d$  block height:

- $d$ : Representation of given duration in terms of blocks
- $d_{lower}$ : Number of months between deposit and withdrawal period in blocks
- $d_{upper}$ : Number of months between deposit and withdrawal period + 1 month period in blocks
- $a$ : Number of deposited ICX at the time of the deposit

$$d_{lower} = \lfloor d / 1,296,000 \rfloor * 1,296,000$$

$$d_{upper} = d_{lower} + 1,296,000$$

$$f(a,d) = f(a,d_{lower}) + \{f(a,d_{upper}) - f(a,d_{lower})\} * \frac{d - d_{lower}}{1,296,000}$$

If  $d_{lower}$  is obtained by converting the number of months to the number of blocks at the time of  $d$ , the amount of Virtual Step generation at point  $d$  is larger than the amount of Virtual Step generation in the  $d_{lower}$ .

The amount of Virtual Step generated for the remaining blocks at point  $d$  is determined by the amount of Virtual Step generated in this month ( $d_{lower}$ ) and the next month ( $d_{upper}$ ).

The above formula  $\{f(a, d_{upper}) - f(a, d_{lower})\}$  takes the difference between this month's and next month's Virtual Step generation. This is then multiplied by the ratio where the remaining blocks of  $d$  is represented as a certain fraction of a month where 1 month is assumed to be 1,296,000 blocks.

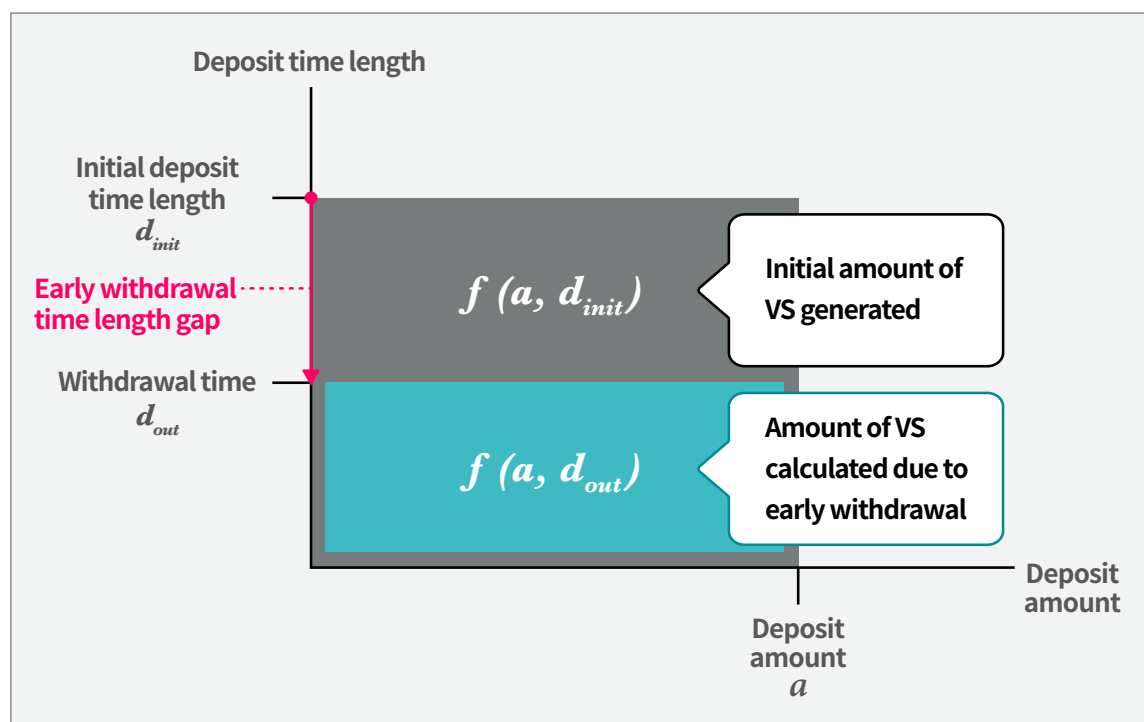
- Determination of  $Penalty_{over}$

-  $d_{init}$ : Initial committed duration of deposit in blocks

-  $d_{out}$ : Duration between deposit and withdrawal period in blocks

$Penalty_{over}$  is determined by the below formula, where  $a$  is the number of ICX deposited,  $d_{out}$  is the time of withdrawal, and  $d_{init}$  is the initial committed duration of deposit.

$$Penalty_{over} = f(a, d_{init}) - f(a, d_{out})$$



[ Figure 1 ] Concept of Early Full Withdrawal

#### **4.1.1.2. $Penalty_{foul}$**

A SCORE containing an ICX deposit implies that it is currently operating and will likely continue doing so. Therefore, it is necessary to prevent the confusion of SCORE users that can be caused by an early withdrawal. When the initial deposit amount is  $a$  ICX, the  $Penalty_{foul}$  due to the breach of agreement is defined as follows:

$$Penalty_{foul} = a * \frac{1}{100}$$

#### **4.1.2. Penalty Charging Policy**

Penalty calculated in 4.1.1 will be deducted from the operator's Virtual Step and deposited ICX, and the remaining deposited ICX balance will be returned to the operator. Meanwhile, if the user's transaction fee exceeds the Virtual Step held by SCORE operator, the penalty at the time of the early withdrawal can be greater than the remaining deposit. In this case, the withdrawal execution will fail.

## **4.2. Guarantee System to Incentivize the Termination of Smart Contracts**

The SCORE operator may cease operating a SCORE for a variety of reasons. So long as a smart contract is not in the process of being penalized, it may be stopped by the SCORE operator at any time. If a SCORE is no longer being used, it would be desirable to terminate the SCORE as it consumes network resources.

A guarantee system is introduced to allow for voluntary SCORE termination. A minimum deposit is required when first deploying a SCORE, and this deposit is automatically returned upon termination of smart contract.