ICON Developers Meetup

ICON foundation

Prerequisite for hands-on lab

Docker : Download link - https://docs.docker.com

T-Bears Docker :

```
$ docker run -it -p 9000:9000 --name tbears-container iconloop/tbears
```

- Guide : https://github.com/icon-project/t-bears/tree/develop/Docker

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Step 1. ICON Basics

Step 2. Interacting with ICON nodes

Step 3. Smart Contract Development

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- 2.1. Account & Transaction
- 2.2. Test Environment

Step 3. Smart Contract Development

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Blockchain - Beginning of new Era

- Blockchain
  - Centralized ⇒ Decentralized world

- Problem
  - Low TPS (Transaction Per Second)
  - Limited scalability
  - Isolated blockchains

ICON - New Generation Blockchain

1st Generation : Bitcoin and the simple alt-coins (eg. litecoin) [2009]

Programmable Smart Contract

2nd Generation : Ethereum. Turing complete Smart Contract [2015]

Performance Enhancement

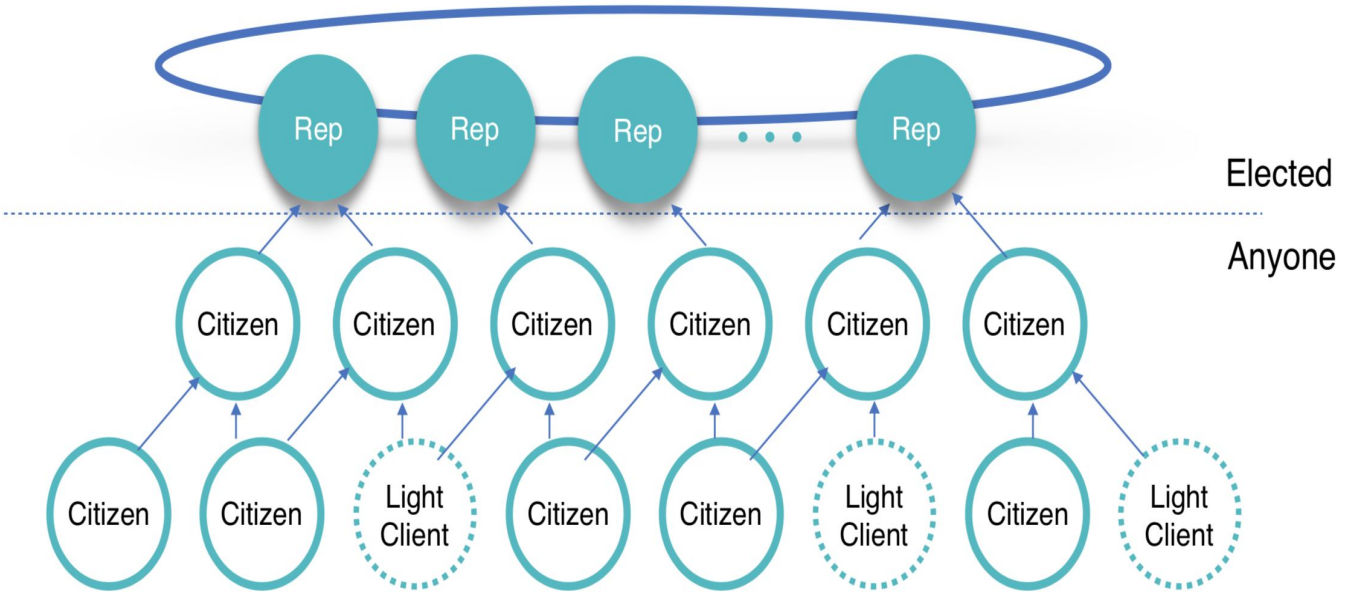
3rd Generation : EOS, AION, Zilliqa, ICON [2017] …

ICON Characteristic

- Delegated proof of contribution (DPoC)
  - One confirmation
  - 1000+ TPS
- Multi channel
  - 1000+ TPS per channel
- Low / flexible transaction fee
- Interchain
- Native python code Smart Contract + JVM

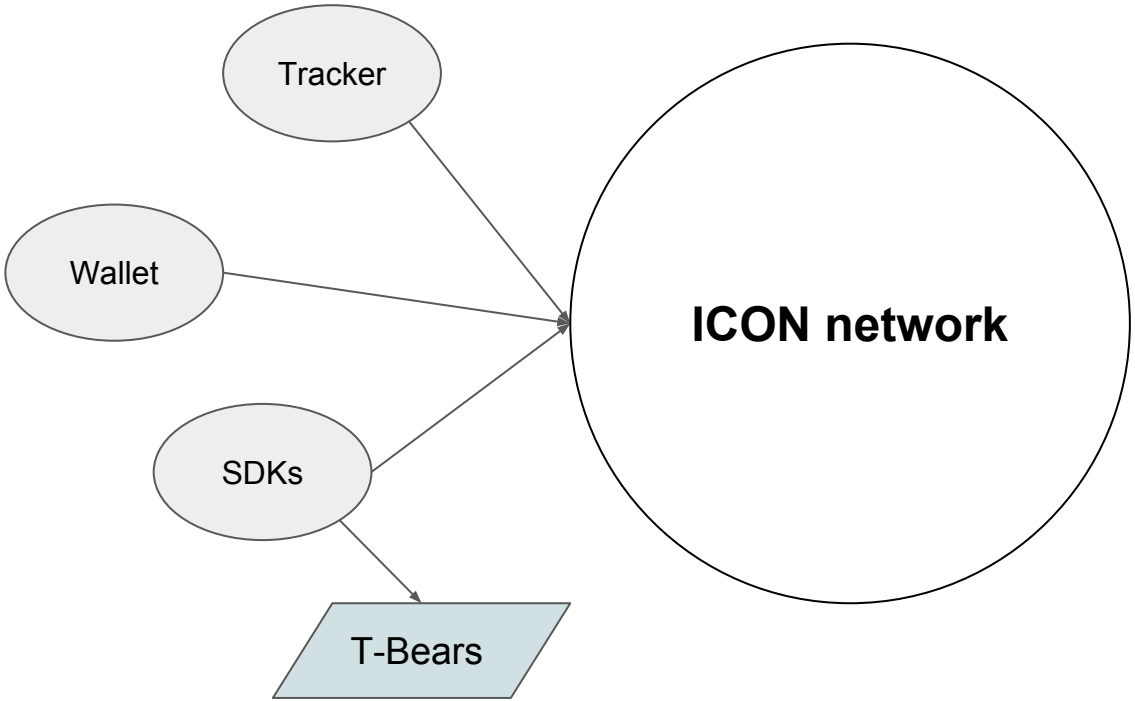
ICON Network

- Representatives
- Citizen
- Light Client



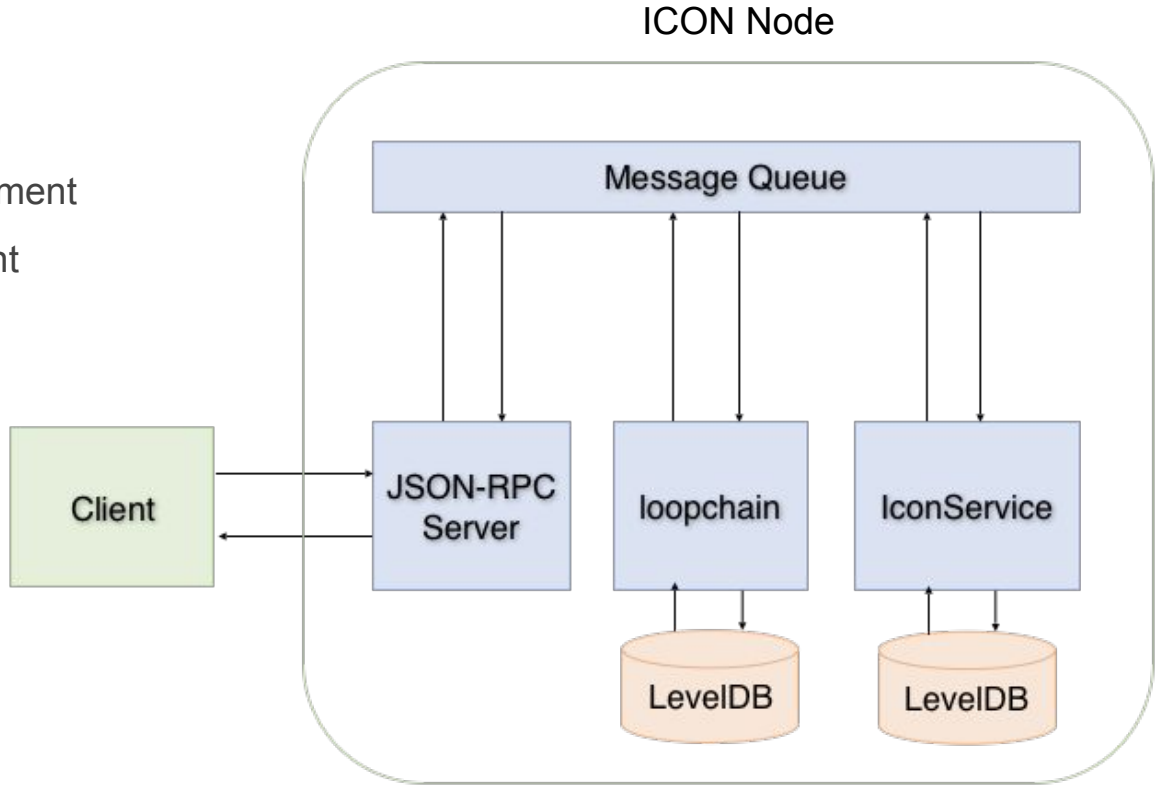
Applications and Tools

- T-Bears
- SDK
- Wallet
- Tracker



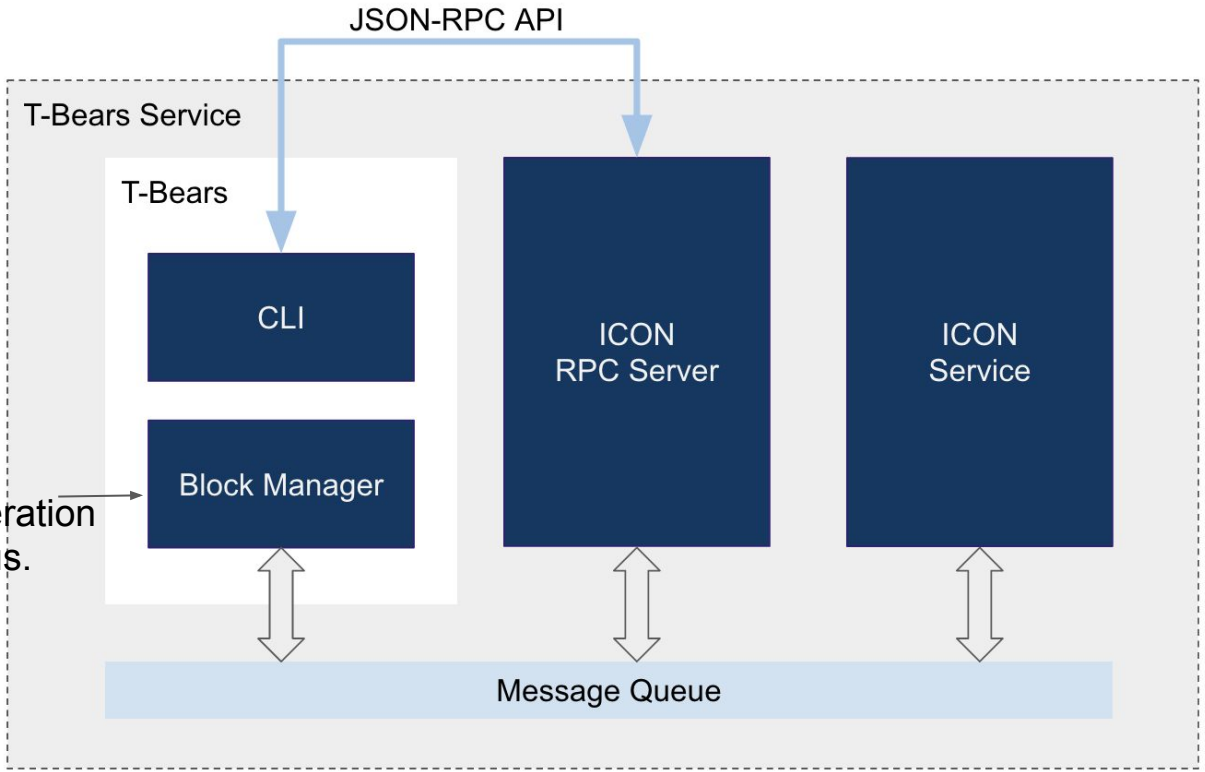
Node View

- IconService
  - SCORE execution environment
  - ICX base coin management
  - Transaction fee calculation
- Loopchain
  - Peer management
  - Block management
  - LFT consensus engine



T-Bears

Emulated node environment.
Mimic block generation without consensus.



Summary

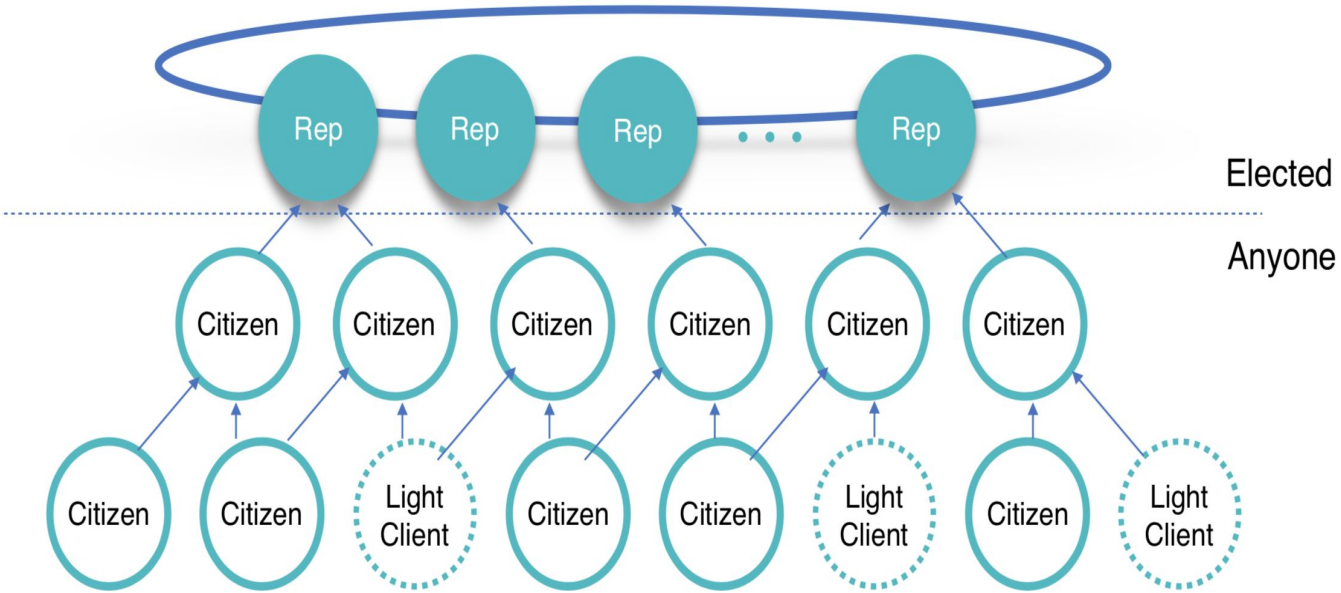
- 3rd Generation Blockchain
  - Programmable Smart Contract
  - Performance Enhancement

- ICON Characteristic
  - DPoC
  - Interchain
  - Native python code Smart Contract + JVM
  - Low / flexible transaction fee
  - Multi channel

Summary

- Representatives
- Citizen
- Light Client

- T-Bears
- SDK
- Wallet
- Tracker



2. Interacting with ICON nodes

ICON Developers Meetup

Step 1. ICON Basics

Step 2. Interacting with ICON nodes

- 2.1. Account & Transaction
- 2.2. Test Environment

실습 :
- T-Bears 로 test 계정 생성
- T-Bears 로 testnet 에 query 보내기

Step 3. Smart Contract Development

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2.1. Account & Transaction

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Account

- Account : Address, Balance ...

- Address
  - Unique Identifier of Account

  - PREFIX
    - hx : **EOA(External Owned Account)**
      - ex) hxe7af5fcfd8dfc67530a01a0e403882687528dfcb
    - cx : **CA(Contract Account)**
      - ex) cx0000000000000000000000000000000000000000

Transaction

- Transfer
  - Used when transferring ICX.
- Message
  - Used when transferring a message, and HEX string data.
- Call
  - Used when calling a function in SCORE, with data which has dictionary value.
- Deploy
  - Used when installing or updating a SCORE, with data which has dictionary value.

Summary

- Address
  - hx6e1dd0d4432620778b54b2bbc21ac3df961adf89 ⇒ EOA
  - cxb25fe7b33016638b80fed733a4b1112cc8dbd27b ⇒ CA

- Transaction types
  - call, deploy, transfer, message

2.2. Test Environment

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- 2.2. Test Environment

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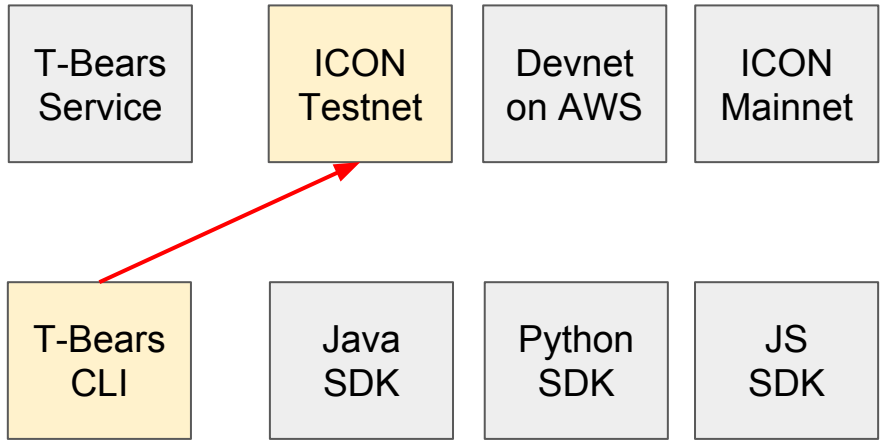
Test Environment

- T-Bears emulated environment
  - Transaction fee : off
  - SCORE audit : off
- ICON Testnet
  - Transaction fee : on
  - SCORE audit : off
- Private Devnet on AWS
  - Transaction fee : off
  - SCORE audit : off
- https://icon-project.github.io/docs/icon_network.html



Testnet : Create an Account

- `$ tbears keystore [file_path]`
- `Examine the keystore file`

```
{
    "address": "hxe7af5fcfd8dfc67530a01a0e403882687528dfcb",
    "crypto": {
        ....
    },
    "id": "e2ca66c6-b8de-4413-82cb-52c2a2200b8d",
    "version": 3,
    "coinType": "icx"
}
```

Testnet : Account & Balance

- To receive test ICX, send email to testicx@icon.foundation with following information
  - Testnet node url
  - Address to receive the testnet ICX
  - Faucet : http://52.88.70.222

Name	Yeouido (여의도)
Node	**https://bicon.net.solidwallet.io**
API endpoint	https://bicon.net.solidwallet.io/api/v3
Network ID (nid)	3
Tracker	https://bicon.tracker.solidwallet.io
Transaction fee	on
SCORE audit	off

Testnet : Send Queries

- `$ tbears balance [address] -u https://bicon.net.solidwallet.io/api/v3`
- `$ tbears totalsupply -u https://bicon.net.solidwallet.io/api/v3`
- `$ tbears lastblock -u https://bicon.net.solidwallet.io/api/v3`
- `$ tbears blockbyheight 0x1 -u https://bicon.net.solidwallet.io/api/v3`

ICON Dev Tools

- T-Bears
  - Guide [https://github.com/icon-project/t-bears]

- SDK
  - Java [https://github.com/icon-project/icon-sdk-java]
  - Python [https://github.com/icon-project/icon-sdk-python]
  - Javascript [https://github.com/icon-project/icon-sdk-js]

Summary

- Test Environment

    1. T-Bears emulated environment
    2. ICON Testnet
    3. Private Devnet on AWS

- Tools

    1. T-Bears
    2. SDK (Java, Python, Javascript)

3. Smart Contract Development

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Step 3. Smart Contract Development

- 3.1. Smart Contract Basics
- 3.2. Introduction to T-Bears
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실습 :
- greedyHello SCORE

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3.1. Smart Contract Basics

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Smart Contract Basics

- What is smart contract?

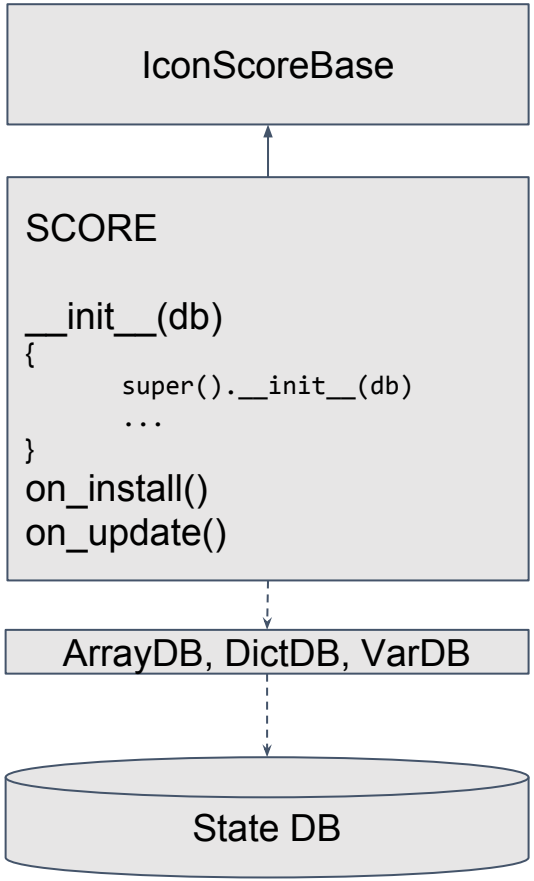
- SCORE(Smart Contract On Reliable Environment)
  - What is SCORE?
    - Written in Python (Easy to learn)
    - State DB abstractions (VarDB, DictDB, ArrayDB)
    - Sandbox policy

SCORE Implementation Guide

- SCORE
  - Sandbox policy
    - Should be deterministic
    - No random Operation
    - No outgoing network call
    - No system call (e.g. file system access, clock time)
    - No long-running operation inside the SCORE
  - Do not import python packages other than iconservice

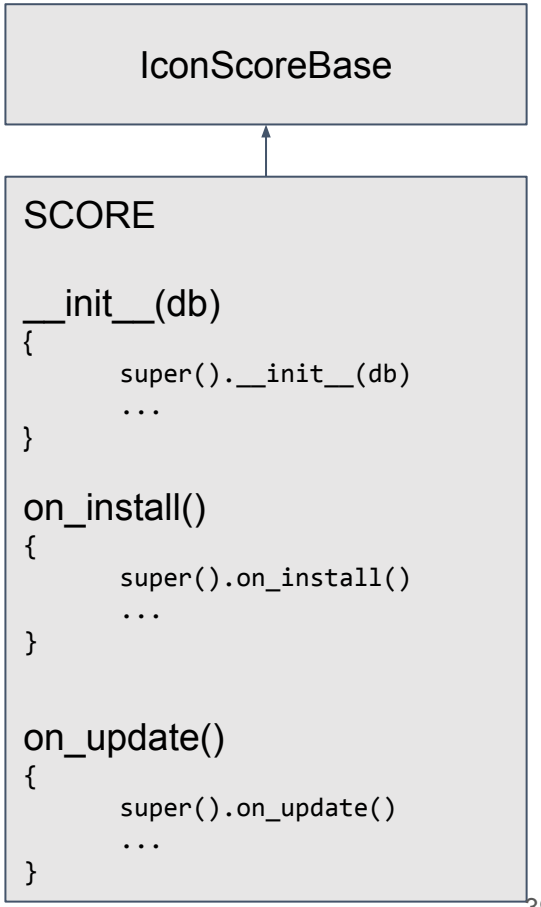
SCORE Model

- Finite state machine
- State transition by transaction
- Must inherit IconScoreBase



IconScoreBase - Methods

- __init__
  - Called when the contract is loaded at each nodes.
- on_install
  - Called when the SCORE is deployed
- on_update
  - Called when the SCORE is updated
- fallback
  - Reserved function executed whenever the SCORE receives plain ICX coins without data
  - Without @payable, icx coin transfers to the contract will fail



IconScoreBase - Properties

- msg : Holds information of the account who called the SCORE
  - msg.sender : Address of the account or contract who called this function
  - msg.value : Amount of icx that the sender attempts to transfer to the current SCORE

- tx : Transaction info
  - tx.origin : The account who created the transaction
  - tx.index : Transaction index
  - tx.hash : Transaction hash
  - tx.timestamp : Transaction creation time
  - tx.nonce : (Optional) random value

IconScoreBase - Properties

- icx : An object used to transfer icx coin
  - icx.transfer : Transfer designated amount of icx coin to addr_to. Return True or Exception can be occured
  - icx.send : Sends designated amount of icx coin to addr_to. Return True or False
- db : db instance used to access state DB
- address : SCORE address
- owner : Address of the account who deployed the contract
- block_height : Current block height

Decorators

- @external
  - Can be called from outside the SCORE

- @payable
  - Permitted to receive incoming ICX coins

- @eventlog
  - Include logs in its txresult as ‘eventLogs’

Utility Functions

- revert : Developer can force a revert exception. If the exception is thrown, all the changes in the state DB in current transaction will be rolled back.

- sha3_256 : Computes hash using the input data

- json_dumps : Converts a python object to a JSON string

- json_loads : Parses a JSON string and converts to a python object

State DB

- VarDB
  - Simple key-value state

- DictDB
  - Behaves more like python dict. DictDB does not maintain order.

- ArrayDB
  - Supports one dimensional array only. ArrayDB maintains order.

InterfaceScore

- InterfaceScore
  - InterfaceScore is an interface class used to invoke other SCORE's external function as if it is a local function call.
  - Get InterfaceScore by using IconScoreBase's built-in function create_interface_score

- IconScoreBase's create_interface_score
  - create_interface_score returns an object, through which you have an access to the designated SCORE's external functions

Logger

- Log Configuration Files
  - T-Bears : tbears_server_config.json

```
TAG = ‘MyScore’

Logger.debug(f‘on_install: total_supply={total_supply}’, TAG)
Logger.info(f‘on_install: total_supply={total_supply}’, TAG)
Logger.warning(f‘on_install: total_supply={total_supply}’, TAG)
Logger.error(f‘on_install: total_supply={total_supply}’, TAG)
```

Address

- Address
  - prefix : AddressPrefix.EOA(0) or AddressPrefix.CONTRACT(1)
  - body : 20-byte address body part
  - is_contract : Whether the address is SCORE
  - to_bytes : Returns data as bytes from the address object
  - from_string : Static method creates an address object from given 42-char string
  - from_data : Static method creates an address object using given bytes data

Audit Checklist

- Loop : Make sure that the code always reaches the exit condition
- import : Package import is prohibited generally except iconservice
- Randomness : Execution result of SCORE must be deterministic

…

Checklist : Github repository [Link - Click]

Summary

- IconScoreBase
  - Must inherit this class to create SCORE
- InterfaceScore
  - Interface class used to invoke other SCORE's external function as if it is a local function call
- Utility Functions
  - json_dumps, json_loads, sha3_256, revert
- State DB
  - VarDB, DictDB, ArrayDB

3.2. Introduction to T-Bears

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Week 2. Interacting with ICON nodes

Week 3. Smart Contract Development

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- 3.3. Smart Contract Development

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Introduction to T-Bears

- Docker container for T-Bears

```
$ docker run -it -p 9000:9000 --name tbears-container iconloop/tbears
$ docker start -i tbears-container
```

- Server configuration
  - Transaction fee, Log, Test accounts, Block generation ...
- Basic commands for SCORE development
  - init, deploy
  - scoreapi, call
  - sendtx, txresult

Basic commands for SCORE development

No	Command	Description
1	start	Start tbears service
2	stop	Stop tbears service
3	deploy	Deploy SCORE
4	clear	Clear all SCOREs deployed on tbears service
5	init	Initialize tbears project

Basic commands for SCORE development

No	Command	Description
6	test	Run the unittest in the SCORE
7	scoreapi	Get SCORE's API using given SCORE address.
8	call	Request icx_call with user input json file.
9	txresult	Get transaction's result by transaction hash
10	sendtx	Request icx_sendTransaction with user input json file.

T-Bears help

- `tbears <command> -h`

```
tbears <command> -h

This will show you <Help> message about <commands>

e.g) tbears init -h
      usage: tbears init [-h] project scoreClass

      Initialize SCORE development environment. Generate <project>.py, package.json and test code in
      <project> directory. The name of the score class is <scoreClass>.

      positional arguments:
       project     Project name
       scoreClass  SCORE class name

      optional arguments:
        -h, --help  show this help message and exit
```

Summary

- Basic commands for SCORE development
  - init : Initialize T-Bears project
  - scoreapi : Get score’s api using given score address
  - call : Request icx_call with user input json file
  - sendtx : Request icx_sendTransaction with user input json file and keystore file.
  - txresult : Get transaction result by transaction hash
  - deploy : Deploy the SCORE

3.3. Smart Contract Development

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SCORE Development

- Today's Goal : SCORE development & Test code implementation

- Learning object : Getting familiar with SCORE
  - 1 : Use database [VarDB, ArrayDB, DictDB]
  - 2 : Understand fallback & tokenFallback mechanism
  - 3 : Write and run integration test

Sample SCORE : Git Repository [Link - Click]

Create an empty SCORE Project

- `$ tbears init [projectName] [className]`

Sample SCORE : Git Repository [Link - Click]

GreedyHello.py

```
from iconservice import *
TAG = 'Scrooge'

class Scrooge(IconScoreBase):
    _CONTRIBUTOR_ICX = "contributor_icx"
    _CONTRIBUTOR_VALUE = "contributor_value"
    _CONTRIBUTOR_LIST = "contributor_list"
    _ICX_BALANCE = "icx_balance"
    _TOKEN_BALANCE = "token_balance"

    def __init__(self, db: IconScoreDatabase) -> None:
        super().__init__(db)
        self._ADB_contributor_list = ArrayDB(self._CONTRIBUTOR_LIST, db, value_type=Address)
        self._DDB_contributor_icx = DictDB(self._CONTRIBUTOR_ICX, db, value_type=int)
        self._DDB_contributor_token = DictDB(self._CONTRIBUTOR_VALUE, db, value_type=int)
        self._VDB_icx_balance = VarDB(self._ICX_BALANCE, db, value_type=int)
        self._VDB_token_balance = VarDB(self._TOKEN_BALANCE, db, value_type=int)

    def on_install(self) -> None:
        super().on_install()

    def on_update(self) -> None:
        super().on_update()

...
```

GreedyHello.py

```
...
    @external
    def tokenFallback(self, _from: Address, _value: int, _data: bytes):
        if self.msg.sender not in self._ADB_contributor_list:
            self._ADB_contributor_list.put(self.msg.sender)

        self._DDB_contributor_token[self.msg.sender] += _value
        self._VDB_token_balance.set(self._VDB_token_balance.get() + _value)

    @payable
    def fallback(self) -> None:
        if self.msg.sender not in self._ADB_contributor_list:
            self._ADB_contributor_list.put(self.msg.sender)

        self._DDB_contributor_icx[self.msg.sender] += self.msg.value
        self._VDB_icx_balance.set(self._VDB_icx_balance.get() + self.msg.value)
```

How to Run a SCORE Test

- $ tbears test <SCORE project's path>
- IconIntegrateTestBase
  - Support python unittest
  - Emulate ICON service for test
    - self._test1 : Account with 1,000,000 ICX
    - self._wallet_array[] : 10 empty accounts in list
  - Provides API for SCORE integration test
    - process_transaction()
    - process_call()

Source Reference : Git Repository [Link - Click]

test_GreedyHello.py

```
import os

from iconsdk.builder.call_builder import CallBuilder
from iconsdk.builder.transaction_builder import DeployTransactionBuilder, TransactionBuilder, CallTransactionBuilder
from iconsdk.libs.in_memory_zip import gen_deploy_data_content
from iconsdk.signed_transaction import SignedTransaction
from tbears.libs.icon_integrate_test import IconIntegrateTestBase, SCORE_INSTALL_ADDRESS

DIR_PATH = os.path.abspath(os.path.dirname(__file__))

class TestScrooge(IconIntegrateTestBase):
    SCORE_PROJECT = os.path.abspath(os.path.join(DIR_PATH, '..'))
    SAMPLE_TOKEN = os.path.abspath(os.path.join(DIR_PATH, '../{SampleTokenSCORE's path}'))

    def setUp(self):
        super().setUp()

        self.icon_service = None
        self._score_address = self._deploy_score(self.SCORE_PROJECT)['scoreAddress']
...
```

test_GreedyHello.py

```
...
    def _deploy_score(self, scorepath: str, to: str = SCORE_INSTALL_ADDRESS, _params: dict = None) -> dict:
        transaction = DeployTransactionBuilder() \
            .from_(self._test1.get_address()) \
            .to(to) \
            .step_limit(100_000_000_000) \
            .nid(3) \
            .content_type("application/zip") \
            .content(gen_deploy_data_content(scorepath)) \
            .params(_params) \
            .build()

        signed_transaction = SignedTransaction(transaction, self._test1)
        tx_result = self.process_transaction(signed_transaction, self.icon_service)

        self.assertTrue('status' in tx_result)
        self.assertEqual(1, tx_result['status'])
        self.assertTrue('scoreAddress' in tx_result)

        return tx_result
...
```

test_GreedyHello.py

```
...

    def test_score_update(self):
        tx_result = self._deploy_score(scorepath=self.SCORE_PROJECT, to=self._score_address)

        self.assertEqual(1, tx_result['status'])
        self.assertTrue('scoreAddress' in tx_result)
        self.assertEqual(self._score_address, tx_result['scoreAddress'])

    def test_fallback(self):
        transaction = TransactionBuilder() \
            .from_(self._test1.get_address()) \
            .to(self._score_address) \
            .value(1) \
            .step_limit(10000000000) \
            .nid(3) \
            .build()

        signed_transaction = SignedTransaction(transaction, self._test1)
        tx_result = self.process_transaction(signed_transaction, self.icon_service)

        self.assertTrue('status' in tx_result)
        self.assertEqual(1, tx_result['status'])

...
```

test_GreedyHello.py

```
...
    def test_token_fallback(self):
        input_params = {"_initialSupply": 1000, "_decimals": 1}
        token_deploy_result = self._deploy_score(scorepath=self.SAMPLE_TOKEN, _params=input_params)
        score_address = token_deploy_result['scoreAddress']

        transaction = CallTransactionBuilder().from_(self._test1.get_address()) \
            .to(score_address) \
            .step_limit(10000000000) \
            .nid(3) \
            .method("transfer") \
            .params({"_to": self._score_address, "_value": 10}) \
            .build()

        signed_transaction = SignedTransaction(transaction, self._test1)
        tx_result = self.process_transaction(signed_transaction, self.icon_service)

        self.assertEqual(1, tx_result['status'])

        call = CallBuilder().from_(self._test1.get_address()) \
            .to(score_address) \
            .method("balanceOf") \
            .params({"_owner": self._score_address})\
            .build()

        response = self.process_call(call, self.icon_service)
        self.assertEqual('0xa', response)
```

Run Test

```
$ tbears test <SCORE project's path>
```

```
...
----------------------------------------------------------------------
Ran 3 tests in 0.244s

OK
```

Summary

- $ tbears test <SCORE project's path>
- IconIntegrateTestBase
  - Support python unittest
  - Emulate ICON service for test
    - self._test1 : Account with 1,000,000 ICX
    - self._wallet_array[] : 10 empty accounts in list
  - Provides API for SCORE integration test
    - process_transaction()
    - process_call()

Appendix A. T-Bears Quickstart

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- A.1 Deploy, Call and SendTransaction

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How to Deploy & Update with T-Bears

```
$ vi deploy.json
```

```
{
   "uri": <API endpoint URI> e.g) "https://bicon.net.solidwallet.io/api/v3",
   "nid": "0x3",
   "to": "cx0000000000000000000000000000000000000000" for install or <SCORE address> for update,
   "deploy": {
      "stepLimit": <steplimit> e.g) "0x12a05f200",
      "mode": "install" or "update",
      "scoreParams": {
        <key> e.g) "initialSupply" : <value> e.g) "1000"
      }
   },
}
```

```
$ tbears deploy <project> -c deploy.json -k <keystore>
```

How to Call with T-Bears

```
$ vi call.json
```

```
{
   "jsonrpc": "2.0",
   "method": "icx_call",
   "params": {
      "to": <SCORE address>,
      "dataType": "call",
      "data": {
        "method": <readonly method to call> e.g) "hello"
      }
   },
   "id": 1
}
```

```
$ tbears call call.json -u <endpoint_URL>
```

How to SendTransaction with T-Bears

```
$ vi sendtx.json
```

```
{
  "jsonrpc": "2.0",
  "method": "icx_sendTransaction",
  "params": {
    "version": "0x3",
    "value": <ICX value> e.g) "0x0",
    "stepLimit": <stepLimit> e.g) "0x3000000",
    "timestamp": <timestamp> e.g) "0x573117f1d6568",
    "nid": "0x3",
    "to": <SCORE address>,
    "dataType": "call",

...
```

```
...

    "data": {
      "method": <method to call> e.g) "setValue",
      "params": {
        <key> e.g) "value": <value> e.g) "0x123"
      }
    }
  },
  "id": 1
}
```

```
$ tbears sendtx sendtx.json -k <keystore> -u <endpoint_URL>
```

Summary

- T-Bears Quickstart
  - Deploy & Update : `tbears deploy`
  - Call : `tbears call`
  - SendTransaction : `tbears sendtx`

T-Bears Documentaion : Git Repository [Link - Click]

Appendix B. AWS Development Network

ICON Developers Meetup

Step 1. ICON Basics

Step 2. Interacting with ICON nodes

Step 3. Smart Contract Development

Appendix A. T-Bears Quickstart

Appendix B. AWS Development Network

- B.1 AWS Marketplace : ICON Development Network
- B.2 AWS CloudFormation
- B.3 Interacting with Development Network

Appendix C. Development Resources

AWS Marketplace

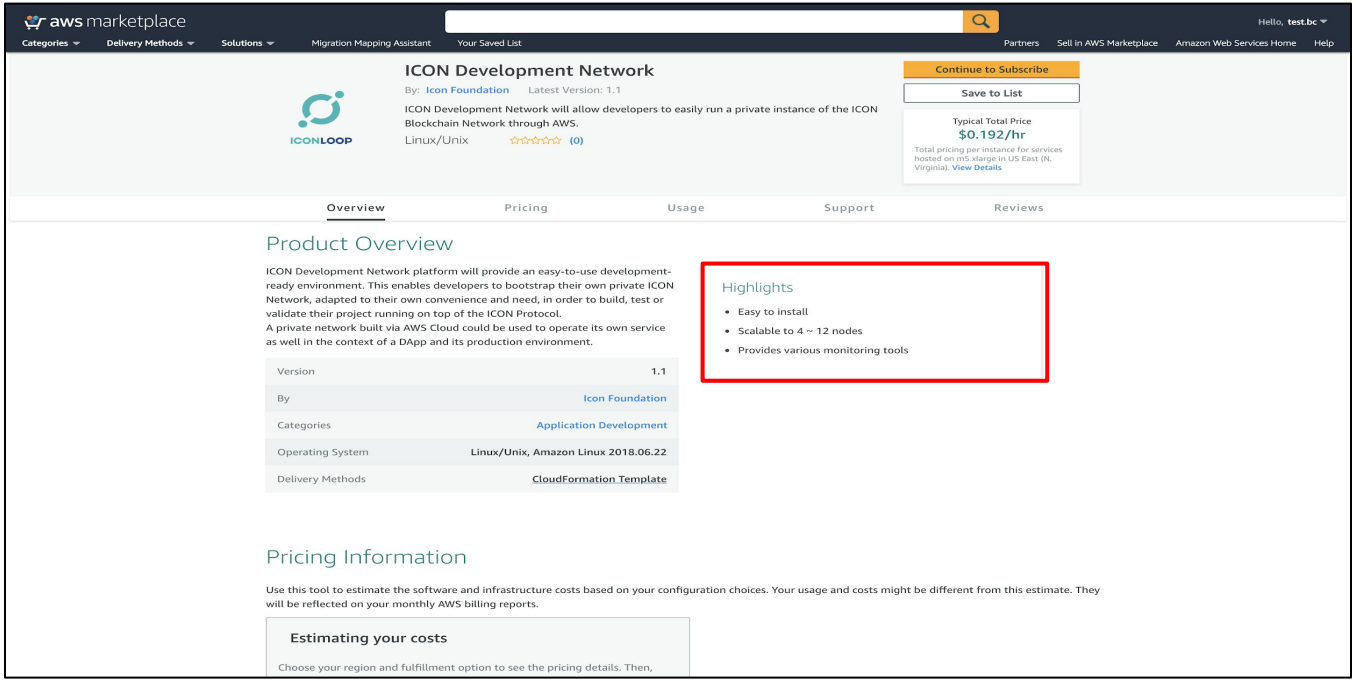
AWS Marketplace - ICON Development Network

Why?

- Easy to install
- Scalable to 4 ~ 12 nodes
- Provides various monitoring tools

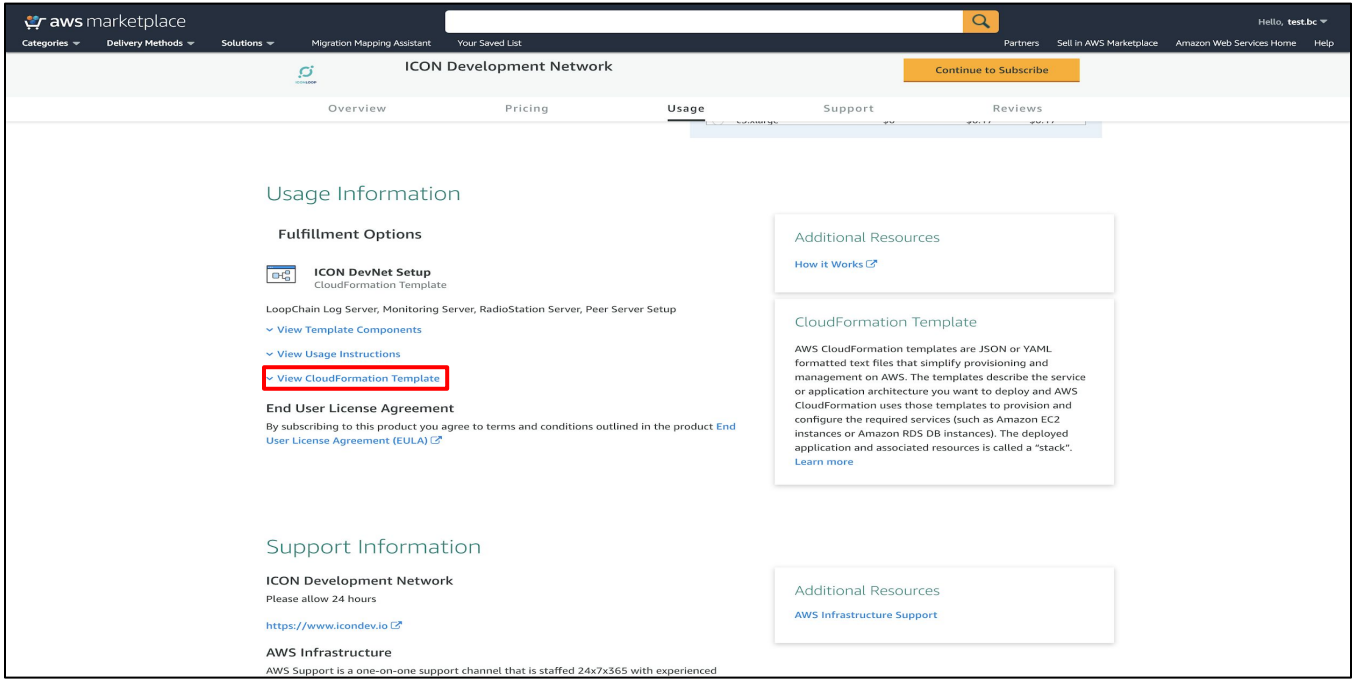
AWS Marketplace

1. Visit Marketplace [Link : Click]



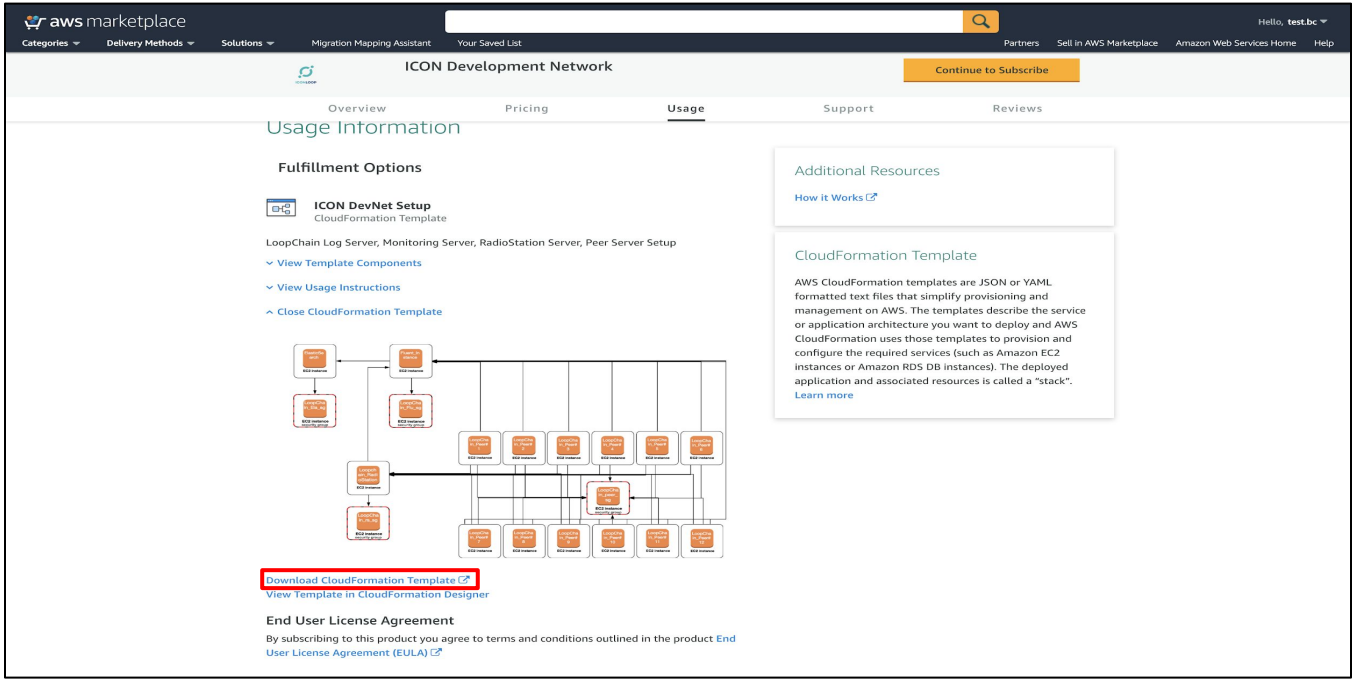
AWS Marketplace

2. Go to Usage Information



AWS Marketplace

3. Download CloudFormation Template



ICON Developers Meetup

Step 1. ICON Basics

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Appendix A. T-Bears Quickstart

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Appendix C. Development Resources

AWS CloudFormation

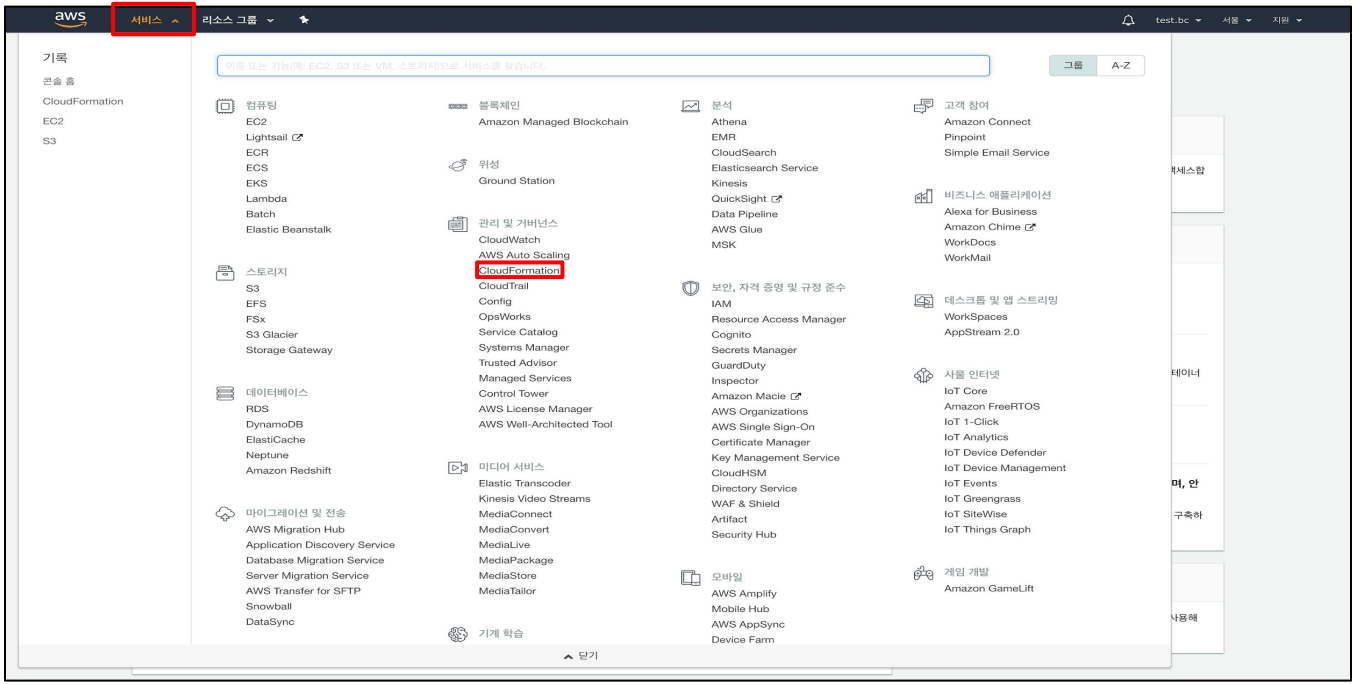
AWS CloudFormation - Create AWS Stack

Resource

- CloudFormation Template - ICON Development Network
- e.g) icon_dev_network.template

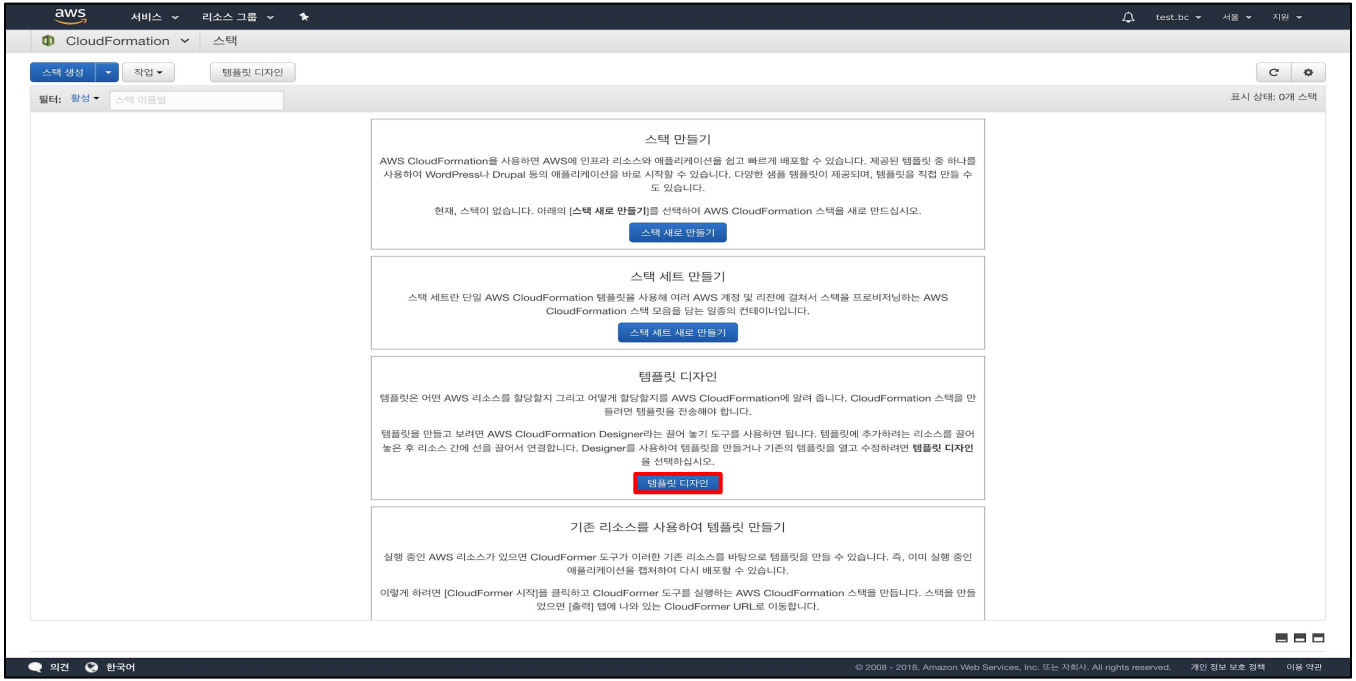
AWS CloudFormation

1. AWS Console ⇒ Service ⇒ CloudFormation



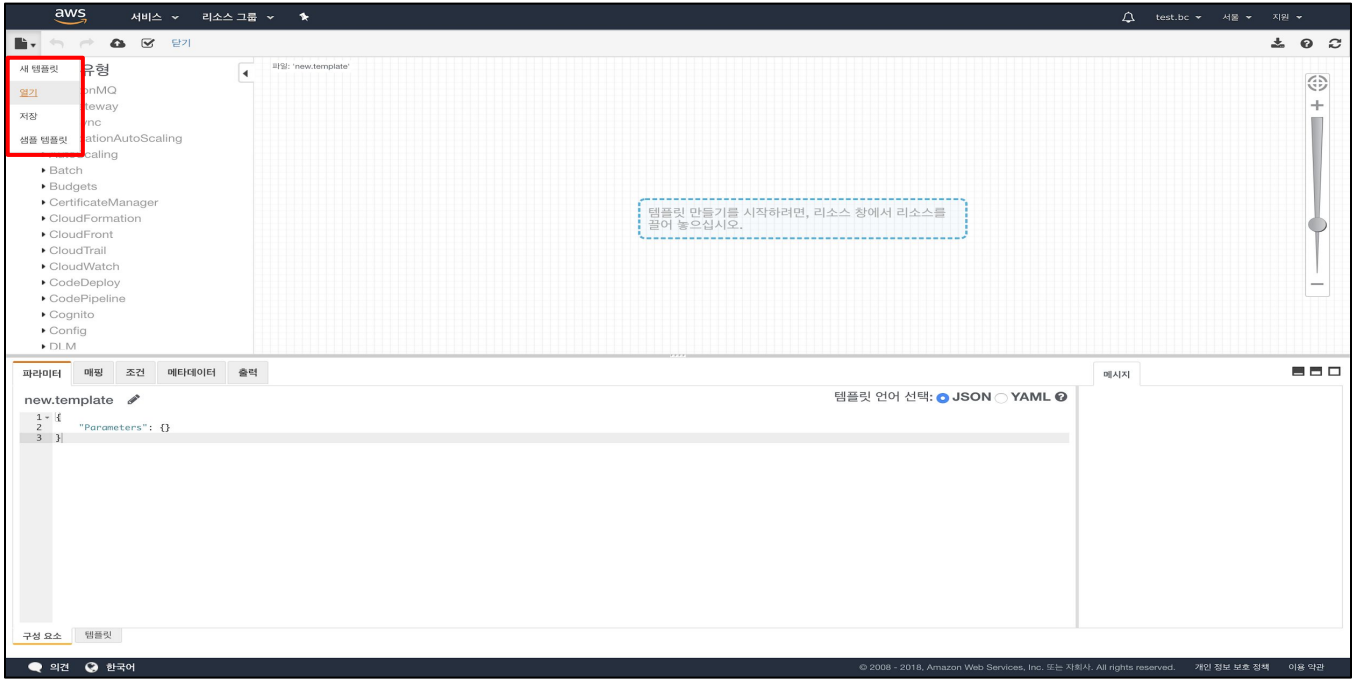
AWS CloudFormation

2. Click Template Design



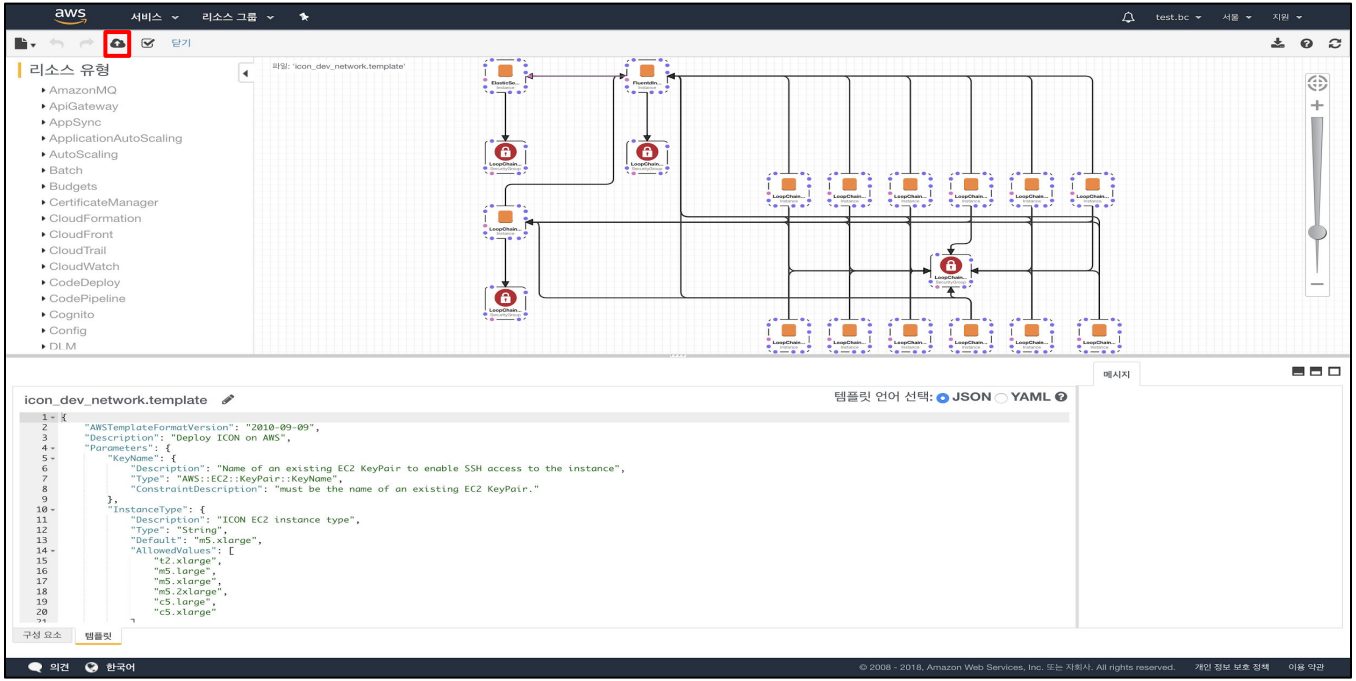
AWS CloudFormation

3. Open “icon_dev_network.template” on local storage



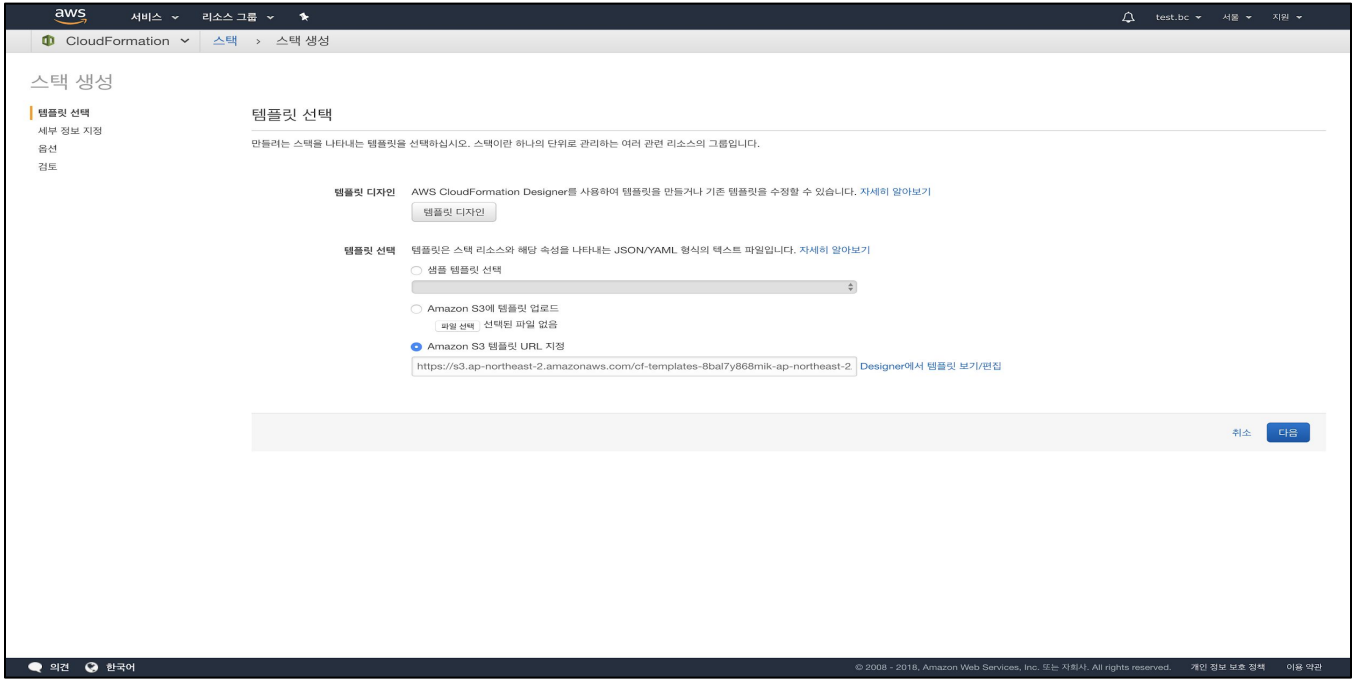
AWS CloudFormation

4. Create AWS Stack



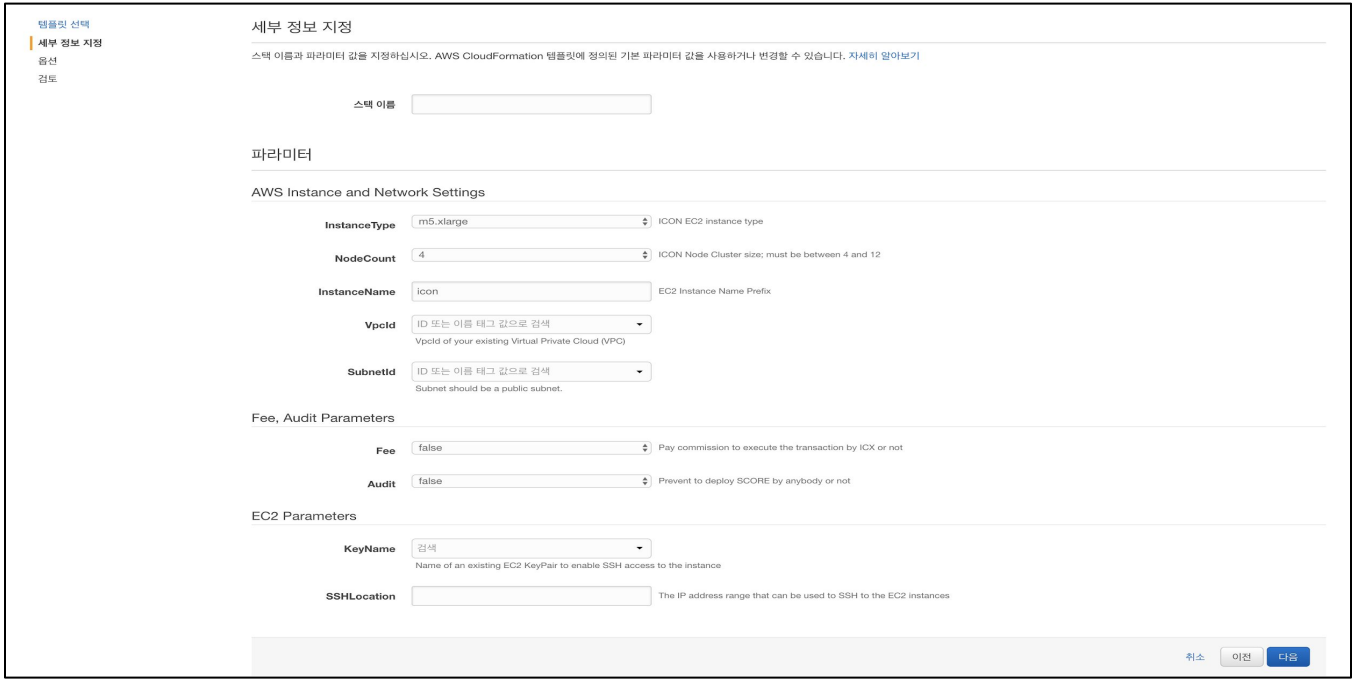
AWS CloudFormation

5. Select CloudFormation Template ⇒ Next



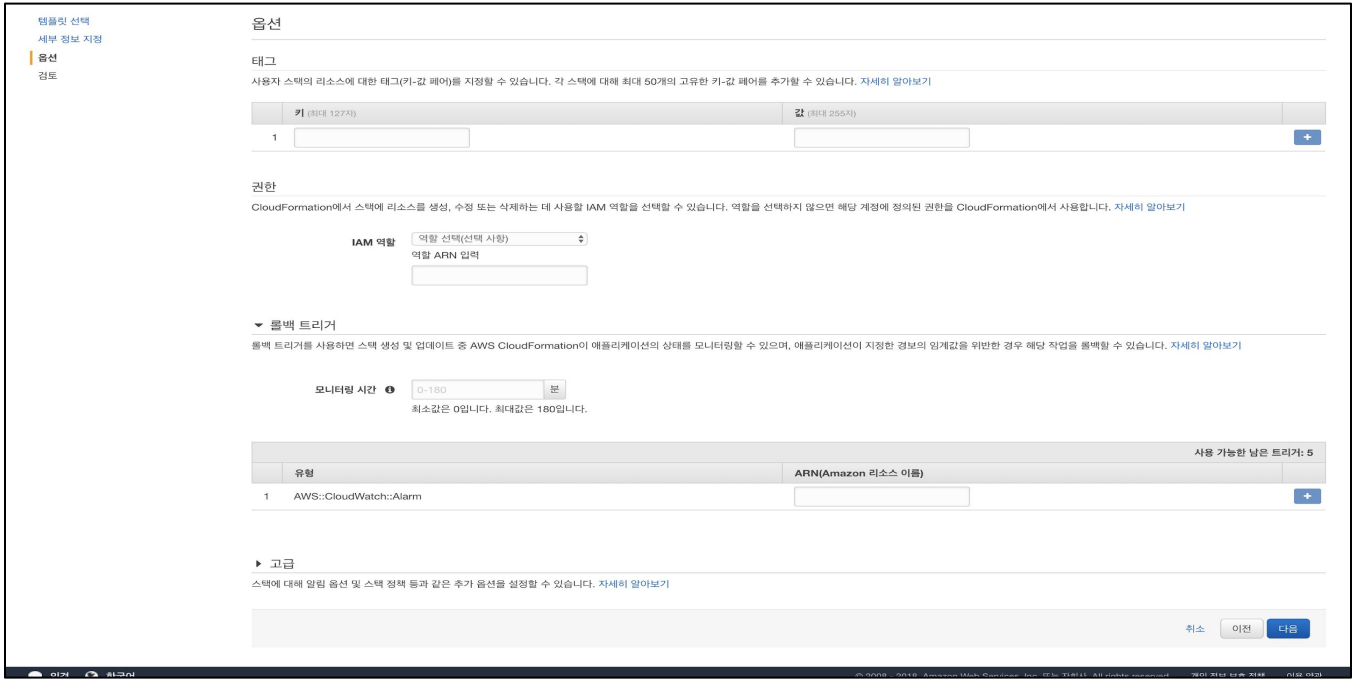
AWS CloudFormation

6. Edit Configuration



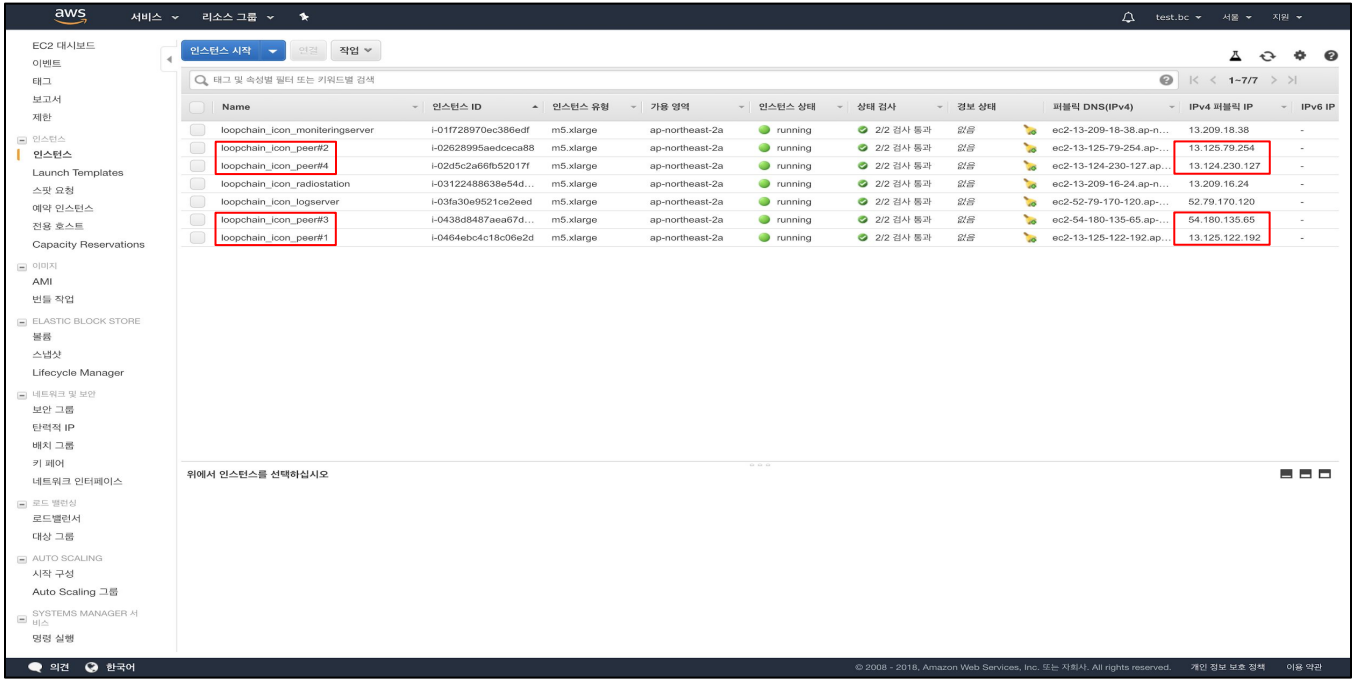
AWS CloudFormation

7. Finalize Options



AWS CloudFormation

8. Check Loaded Instances



ICON Developers Meetup

Step 1. ICON Basics

Step 2. Interacting with ICON nodes

Step 3. Smart Contract Development

Appendix A. T-Bears Quickstart

Appendix B. AWS Development Network

- B.1 AWS Marketplace : ICON Development Network
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- B.3 Interacting with Development Network

Appendix C. Development Resources

Interacting with Development Network

How to use ICON Development Network

- Usage Instructions :
  - Access the application via a browser at http://<radiostation_dns>:9002/api/v1/peer/list.
  - To connect to the operating system, use SSH and the username ec2-user.

- JSON-RPC API v3 Document :
  https://github.com/icon-project/icon-rpc-server/blob/master/docs/icon-json-rpc-v3.md

- DApp Developer Guide : https://www.icondev.io

Interacting with Development Network

Send Query to Each Nodes - vi sendQuery.sh

```
#!/usr/bin/env zsh

echo "-----peer#1-----"
echo "Total Supply"
tbears totalsupply -u http://{peer#1 URL}:9000/api/v3
echo "----------------"
echo "Last Block"
tbears lastblock -u http://{peer#1 URL}:9000/api/v3


echo "-----peer#2-----"
echo "Total Supply"
tbears totalsupply -u http://{peer#2 URL}:9000/api/v3
echo "----------------"
echo "Last Block"
tbears lastblock -u http://{peer#2 URL}:9000/api/v3

...
```

Interacting with Development Network

Send Query to Each Nodes - vi sendQuery.sh

```
...

echo "-----peer#3-----"
echo "Total Supply"
tbears totalsupply -u http://{peer#3 URL}:9000/api/v3
echo "----------------"
echo "Last Block"
tbears lastblock -u http://{peer#3 URL}:9000/api/v3


echo "-----peer#4-----"
echo "Total Supply"
tbears totalsupply -u http://{peer#4 URL}:9000/api/v3
echo "----------------"
echo "Last Block"
tbears lastblock -u http://{peer#4 URL}:9000/api/v3
```

Interacting with Development Network

Query Results - **peer#1**

```
-----peer#1-----
Total Supply
Total supply of ICX in hex: 0x52c3ff441ba8feb88e00000
Total supply of ICX in decimal: 1600919800000000000000000000
------
Last Block
block info : {
    "jsonrpc": "2.0",
    "result": {
        ...
        "merkle_tree_root_hash": "72722dad5bdb0adff8f5fbb061de07a2404b522d463b708d1a62071262616fb3",
        ...
        "block_hash": "b3c99e161f8013b7dabc2ff8be56bacb3209853d139bb54f0a37384388a36505",
        ...
    },
    "id": 1
}
```

Interacting with Development Network

Query Results - **peer#2**

```
-----peer#2-----
Total Supply
Total supply of ICX in hex: 0x52c3ff441ba8feb88e00000
Total supply of ICX in decimal: 1600919800000000000000000000
------
Last Block
block info : {
    "jsonrpc": "2.0",
    "result": {
        ...
        "merkle_tree_root_hash": "72722dad5bdb0adff8f5fbb061de07a2404b522d463b708d1a62071262616fb3",
        ...
        "block_hash": "b3c99e161f8013b7dabc2ff8be56bacb3209853d139bb54f0a37384388a36505",
        ...
    },
    "id": 1
}
```

Interacting with Development Network

Query Results - **peer#3**

```
-----peer#3-----
Total Supply
Total supply of ICX in hex: 0x52c3ff441ba8feb88e00000
Total supply of ICX in decimal: 1600919800000000000000000000
------
Last Block
block info : {
    "jsonrpc": "2.0",
    "result": {
        ...
        "merkle_tree_root_hash": "72722dad5bdb0adff8f5fbb061de07a2404b522d463b708d1a62071262616fb3",
        ...
        "block_hash": "b3c99e161f8013b7dabc2ff8be56bacb3209853d139bb54f0a37384388a36505",
        ...
    },
    "id": 1
}
```

Interacting with Development Network

Query Results - **peer#4**

```
-----peer#4-----
Total Supply
Total supply of ICX in hex: 0x52c3ff441ba8feb88e00000
Total supply of ICX in decimal: 1600919800000000000000000000
------
Last Block
block info : {
    "jsonrpc": "2.0",
    "result": {
        ...
        "merkle_tree_root_hash": "72722dad5bdb0adff8f5fbb061de07a2404b522d463b708d1a62071262616fb3",
        ...
        "block_hash": "b3c99e161f8013b7dabc2ff8be56bacb3209853d139bb54f0a37384388a36505",
        ...
    },
    "id": 1
}
```

Summary

- AWS Marketplace

  https://aws.amazon.com/marketplace/pp/B07KBTZHZD?qid=1544602499452&sr=0-1&ref_=srh_res_product_title

- AWS CloudFormation
  - Create AWS Stack & Load Instances
  - Resource : CloudFormation Template

Appendix C. Development Resources

ICON Developers Meetup

Step 1. ICON Basics

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Appendix C. Development Resources

Development Resources

- GitHub
- Developer Portal
- ICON official Documentation Project
- ICON Improvement Proposal

GitHub https://github.com/icon-project

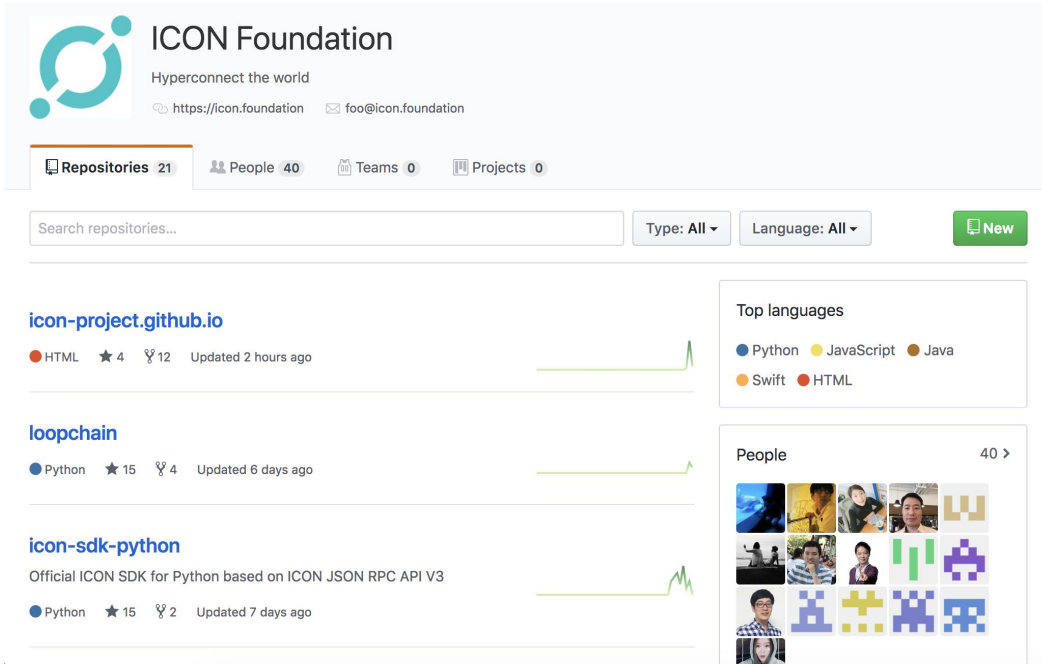
- loopchain
- icon-service
- icon-rpc-server

Node

- t-bears
- icon-sdk-python
- icon-sdk-java
- icon-sdk-js

Dev tools

- iconex_android
- iconex_ios
- iconex_chrome_extension



Developer Portal https://www.icondev.io

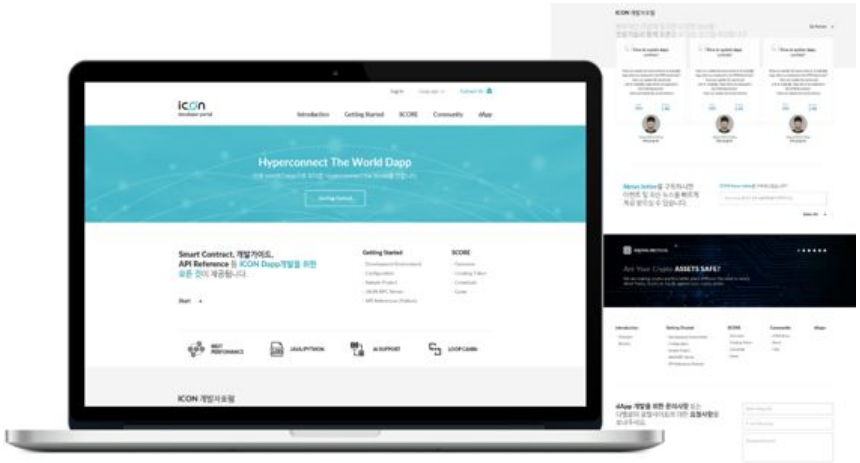
- Community portal for ICON DApp ecosystem

Getting Started
Tutorials for developers to get started

SCORE
Details on ICON's Smart Contract, SCORE

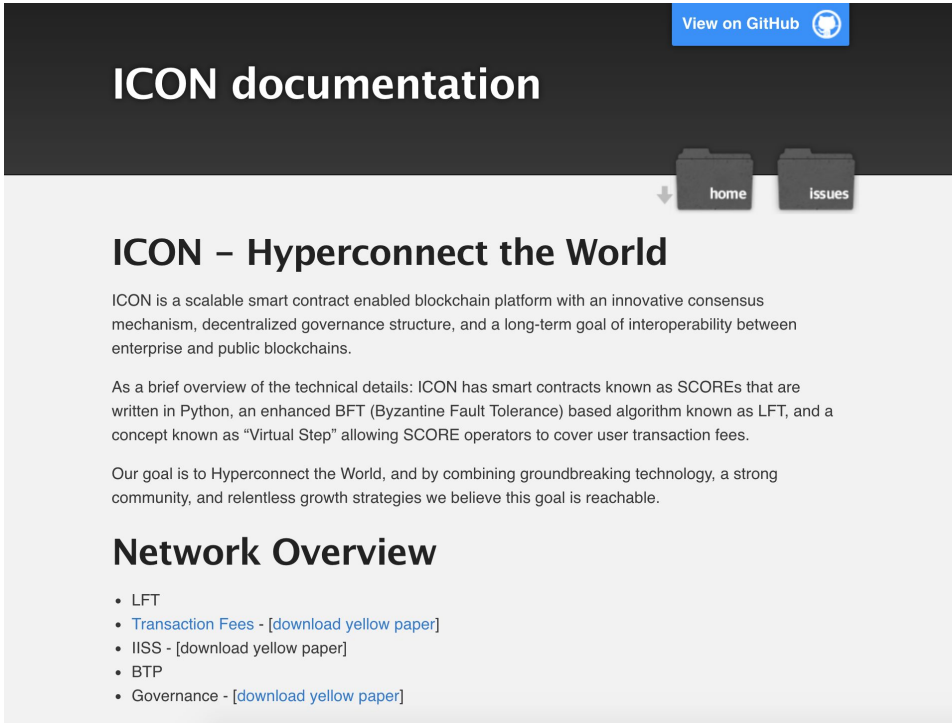
Community
Forum for Korean/English developers to discuss and communicate

DApp
Overview of ICON DApp Partners



Documentation Project https://icon-project.github.io

- GitHub Pages
  - ICON overview
  - Network info
  - Account management
  - Client SDKs
  - SCORE development
  - Mainnet SCORE audit guideline
  - Tutorials with sample codes
- We welcome contributors !
  - Read CONTRIBUTING.md
  - French / Chinese translation provided by volunteer contributors.



ICON Improvement Proposal https://github.com/icon-project/IIPs

- IIP describes a standard for ICON platform.
- Anyone can prompt suggestions and discussions on new functions or improvement.
- Selected items will be implemented on ICON network.

- **For all other IIPs**, open a PR changing the state of your IIP to 'Final'. An editor will review your draft and ask if anyone objects to its being finalised. If the editor decides there is no rough consensus - for instance, because contributors point out significant issues with the IIP - they may close the PR and request that you fix the issues in the draft before trying again.

IIP Status Terms

- **Draft** - an IIP that is open for consideration.
- **Last Call** - an IIP that is calling for last review before finalizaing. IIPs that has been more than 2 weeks in Last Call without any technical changes or objections enters either Accepted or Final state.
- **Accepted** - an IIP that is planned for immediate adoption, i.e. expected to be included in the next release (for Core/Consensus layer IIPs only).
- **Final** - an IIP that has been adopted. For Core/Consensus layer IIPs, the implementation has been adopted in the mainnet.
- **Deferred** - an IIP that is not being considered for immediate adoption. May be reconsidered in the future.

IIPs

Number	Title	Author	Type	Status
1	IIP Purpose and Guidelines	Sojin Kim	Meta	Active
2	ICON Token Standard	Jaechang Namgoong	IRC	Final
3	ICON Non-Fungible Token Standard	Jaechang Namgoong	IRC	Draft
6	ICON Name Service Standard	Phyrex Tsai, Portal Network Team	IRC	Draft

Summary

- GitHub
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