

연구 보고서

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1. 연구 계획

- 다양한 실험값 변경을 통해 성능측정을 결과값 도출

2. 논문 연구 진행

```
h2kim@h2kim-VBox:~/fabric-samples$ mkdir test-sandbox
h2kim@h2kim-VBox:~/fabric-samples$ ls
CHANGELOG.md          asset-transfer-private-data  e2-network
CODEOWNERS            asset-transfer-sbe          fabcar
CODE_OF_CONDUCT.md    asset-transfer-secured-agreement  high-throughput
CONTRIBUTING.md      bin                          interest_rate_swaps
LICENSE               chaincode                   off_chain_data
MAINTAINERS.md        ci                          prometheus-2.27.1.linux-amd64
README.md             commercial-paper            scripts
SECURITY.md           config                     test-application
asset-transfer-basic   e2-enter-basic             test-network
asset-transfer-integration  e2-list-basic             test-sandbox
asset-transfer-ledger-queries  e2-list-private-data
h2kim@h2kim-VBox:~/fabric-samples$ cd test-sandbox/
h2kim@h2kim-VBox:~/fabric-samples/test-sandbox$ ls
h2kim@h2kim-VBox:~/fabric-samples/test-sandbox$ cp -r ../test-network ./test-network-org2peer1
h2kim@h2kim-VBox:~/fabric-samples/test-sandbox$ cp -r ../test-network ./test-network-org2peer2
h2kim@h2kim-VBox:~/fabric-samples/test-sandbox$ ls
test-network-org2peer1  test-network-org2peer2
```

피어를 두개 늘려서 네트워크를 구성하여 테스트를 하기 위한 ~/fabric-samples의 하위 폴더로 test-sandbox라는 폴더를 생성하여 test-network-org2peer1과 test-network-org2peer2를 만들어서 test-network를 복사함.

```
1  # Copyright IBM Corp. All Rights Reserved.
2  #
3  # SPDX-License-Identifier: Apache-2.0
4  #
5
6  version: '2'
7
8  volumes:
9    orderer.example.com:
10    peer0.org1.example.com:
11    peer1.org1.example.com:
12    peer0.org2.example.com:
13    peer1.org2.example.com:
14
```

도커 컨테이너를 설정하는 파일에서 peer0 아래에 peer1를 새로 만들어서 설정함.

```
11 export CORE_PEER_TLS_ENABLED=true
12 export ORDERER_CA=${PWD}/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsca.example.com-cert.pem
13 export PEERO_ORG1_CA=${PWD}/organizations/peerOrganizations/org1.example.com/peers/peer0.org1.example.com/tls/ca.crt
14 export PEER1_ORG1_CA=${PWD}/organizations/peerOrganizations/org1.example.com/peers/peer1.org1.example.com/tls/ca.crt
15 export PEERO_ORG2_CA=${PWD}/organizations/peerOrganizations/org2.example.com/peers/peer0.org2.example.com/tls/ca.crt
16 export PEER1_ORG2_CA=${PWD}/organizations/peerOrganizations/org2.example.com/peers/peer1.org2.example.com/tls/ca.crt
17 export PEERO_ORG3_CA=${PWD}/organizations/peerOrganizations/org3.example.com/peers/peer0.org3.example.com/tls/ca.crt
```

환경변수를 설정하는 envVar.sh에 피어 추가를 위한 값을 삽입하여 피어가 추가되어도 작동을 할 수 있도록 함.

```
34 | info ln "Using organization ${USING_ORG}"
35 | if [ $USING_ORG -eq 1 ]; then
36 |     export CORE_PEER_LOCALMSPID="Org1MSP"
37 |     export CORE_PEER_TLS_ROOTCERT_FILE=$PEER0_ORG1_CA
38 |     export CORE_PEER_MSPCONFIGPATH=${PWD}/organizations/peerOrganizations/org1.example.com/users/Admin@org1.example.com/msp
39 |     export CORE_PEER_ADDRESS=localhost:7051
40 | elif [ $USING_ORG -eq 2 ]; then
41 |     export CORE_PEER_LOCALMSPID="Org1MSP"
42 |     export CORE_PEER_TLS_ROOTCERT_FILE=$PEER1_ORG1_CA
43 |     export CORE_PEER_MSPCONFIGPATH=${PWD}/organizations/peerOrganizations/org1.example.com/users/Admin@org1.example.com/msp
44 |     export CORE_PEER_ADDRESS=localhost:7151
45 | elif [ $USING_ORG -eq 3 ]; then
46 |     export CORE_PEER_LOCALMSPID="Org2MSP"
47 |     export CORE_PEER_TLS_ROOTCERT_FILE=$PEER0_ORG2_CA
48 |     export CORE_PEER_MSPCONFIGPATH=${PWD}/organizations/peerOrganizations/org2.example.com/users/Admin@org2.example.com/msp
49 |     export CORE_PEER_ADDRESS=localhost:9051
50 | elif [ $USING_ORG -eq 4 ]; then
51 |     export CORE_PEER_LOCALMSPID="Org2MSP"
52 |     export CORE_PEER_TLS_ROOTCERT_FILE=$PEER1_ORG2_CA
53 |     export CORE_PEER_MSPCONFIGPATH=${PWD}/organizations/peerOrganizations/org2.example.com/users/Admin@org2.example.com/msp
54 |     export CORE_PEER_ADDRESS=localhost:9151
55 | elif [ $USING_ORG -eq 5 ]; then
56 |     export CORE_PEER_LOCALMSPID="Org3MSP"
57 |     export CORE_PEER_TLS_ROOTCERT_FILE=$PEER0_ORG3_CA
58 |     export CORE_PEER_MSPCONFIGPATH=${PWD}/organizations/peerOrganizations/org3.example.com/users/Admin@org3.example.com/msp
59 |     export CORE_PEER_ADDRESS=localhost:11051
60 | else
61 |     error ln "ORG Unknown"
62 | fi
```

envVar.sh에서 추가된 피어의 MSPID와 TLS_ROOTCERT_FILE, MSPCONFIGPATH, PEER_ADDRESS 값을 추가하여 피어가 추가될 때 입력 값에 따라 실행하도록 함.

```
7 | function json_ccp {
8 |     local PP=$(one_line_pem $4)
9 |     local CP=$(one_line_pem $5)
10 |     sed -e "s/\${ORG}/${1}/" \
11 |         -e "s/\${POPORT}/${2}/" \
12 |         -e "s/\${CAPORT}/${3}/" \
13 |         -e "s#\${PEERPEM}#\${PP}#" \
14 |         -e "s#\${CAPEM}#\${CP}#" \
15 |         -e "s/\${P1PORT}/${6}/" \
16 |         organizations/ccp-template.json
17 | }
18 |
19 | function yaml_ccp {
20 |     local PP=$(one_line_pem $4)
21 |     local CP=$(one_line_pem $5)
22 |     sed -e "s/\${ORG}/${1}/" \
23 |         -e "s/\${POPORT}/${2}/" \
24 |         -e "s/\${CAPORT}/${3}/" \
25 |         -e "s#\${PEERPEM}#\${PP}#" \
26 |         -e "s#\${CAPEM}#\${CP}#" \
27 |         -e "s/\${P1PORT}/${6}/" \
28 |         organizations/ccp-template.yaml | sed -e 's/\\\\\\n/\\\\\\n/g'
29 | }
```

피어 연결을 하는 정보를 저장하는 json, yaml 파일을 생성하는 값에서 Peer0 포트를 저장하는 POPORT에 더해 Peer1의 정보를 담는 P1PORT를 저장하여 연결시

도 할 때 피어 연결이 가능하도록 설정파일을 작성함.

```
26     "peers": {
27         "peer0.org${ORG}.example.com": {
28             "url": "grpcs://localhost:${POPORT}",
29             "tlsCACerts": {
30                 "pem": "${PEERPEM}"
31             },
32             "grpcOptions": {
33                 "ssl-target-name-override": "peer0.org${ORG}.example.com",
34                 "hostnameOverride": "peer0.org${ORG}.example.com"
35             }
36         },
37         "peer1.org${ORG}.example.com": {
38             "url": "grpcs://localhost:${P1PORT}",
39             "tlsCACerts": {
40                 "pem": "${PEERPEM}"
41             },
42             "grpcOptions": {
43                 "ssl-target-name-override": "peer1.org${ORG}.example.com",
44                 "hostnameOverride": "peer1.org${ORG}.example.com"
45             }
46         }
47     },
```

피어 정보를 저장하는 "peers"에 "peer1.org\${ORG}.example.com": 항목을 위에서 연결설정을 저장한 \${P1PORT}정보를 가져와 저장함.

```
18 peers:
19   peer0.org${ORG}.example.com:
20     url: grpcs://localhost:${POPORT}
21     tlsCACerts:
22       pem: |
23         ${PEERPEM}
24     grpcOptions:
25       ssl-target-name-override: peer0.org${ORG}.example.com
26       hostnameOverride: peer0.org${ORG}.example.com
27   peer1.org${ORG}.example.com:
28     url: grpcs://localhost:${P1PORT}
29     tlsCACerts:
30       pem: |
31         ${PEERPEM}
32     grpcOptions:
33       ssl-target-name-override: peer1.org${ORG}.example.com
34       hostnameOverride: peer1.org${ORG}.example.com
35   certificateAuthorities:
```

yaml파일을 저장할 때에도 위와 같은 과정을 통해 피어1에 관한 정보를 저장할 수 있도록 설정함.

```

130  ## Join all the peers to the channel
131  infofn "Join Org1 peer0 to the channel..."
132  joinChannel 1
133  infofn "Join Org1 peer1 to the channel..."
134  joinChannel 2
135  infofn "Join Org2 peer0 to the channel..."
136  joinChannel 3
137  infofn "Join Org2 peer1 to the channel..."
138  joinChannel 4
139
140  ## Set the anchor peers for each org in the channel
141  infofn "Updating anchor peers for org1..."
142  updateAnchorPeers 1
143  infofn "Updating anchor peers for org2..."
144  updateAnchorPeers 2
145
146  successfn "Channel successfully joined"
147
148  exit 0
149

```

채널을 생성할 때 사용되는 createChannel.sh에 새롭게 생성한 피어를 참가시키는 쉘스크립트를 추가함.

```

h2kim@h2kim-VBox:~/fabric-samples/test-sandbox/test-network-org2peer2$ ./network.sh up createChannel
-ca -c mychannel -i 2.2 -s couchdb
Creating channel 'mychannel'.
If network is not up, starting nodes with CLI timeout of '5' tries and CLI delay of '3' seconds and u
sing database 'couchdb with crypto from 'Certificate Authorities'
Bringing up network
Peer binary and configuration files not found..

Follow the instructions in the Fabric docs to install the Fabric Binaries:
https://hyperledger-fabric.readthedocs.io/en/latest/install.html

```

네트워크를 실행하는 명령어를 실행했지만 제대로 작동하지 않는 것을 확인할 수 있음.

```

h2kim@h2kim-VBox:~/fabric-samples$ cp -r test-sandbox/test-network-org2peer2 ./
h2kim@h2kim-VBox:~/fabric-samples$ ls
CHANGELOG.md          asset-transfer-private-data  e2-network
CODEOWNERS            asset-transfer-sbe          fabcar
CODE_OF_CONDUCT.md   asset-transfer-secured-agreement  high-throughput
CONTRIBUTING.md      bin                          interest_rate_swaps
LICENSE               chaincode                   off_chain_data
MAINTAINERS.md        ci                          prometheus-2.27.1.linux-amd64
README.md             commercial-paper            scripts
SECURITY.md           config                      test-application
asset-transfer-basic  e2-enter-basic             test-network
asset-transfer-integration  e2-list-basic             test-network-org2peer2
asset-transfer-ledger-queries  e2-list-private-data     test-sandbox
h2kim@h2kim-VBox:~/fabric-samples$ cd test-network-org2peer2/

```

기존에 진행했던 ~/fabric-samples/test-network에서 진행했던 폴더 구조에서 발생하는 에러로 3단계 폴더에 있던 것을 상위 폴더로 올라와서 명령어를 작동시키기로 함.

```
h2kim@h2kim-VBox:~/fabric-samples/test-network-org2peer2$ ./network.sh up createChannel -ca -c mychan
nel -i 2.2 -s couchdb
Creating channel 'mychannel'.
If network is not up, starting nodes with CLI timeout of '5' tries and CLI delay of '3' seconds and u
sing database 'couchdb with crypto from 'Certificate Authorities'
Bringing up network
LOCAL_VERSION=2.2.0
DOCKER_IMAGE_VERSION=2.2.0
CA_LOCAL_VERSION=1.4.8
CA_DOCKER_IMAGE_VERSION=1.4.8
Generate certificates using Fabric CA's
Creating network "net_test" with the default driver
Creating ca_org1 ...
Creating ca_org2 ...
Creating ca_orderer ...
Creating ca_org1
Creating ca_org2
Creating ca_org1 ... done
```

명령어가 작동하는 것을 확인할 수 있음.

```
2021-05-31 14:54:57.741 KST [channelCmd] executeJoin -> INFO 002 Successfully submitted proposal to j
oin channel
Join Org1 peers to the channel...
Using organization 2
+ peer channel join -b ./channel-artifacts/mychannel.block
+ res=1
+ peer channel join -b ./channel-artifacts/mychannel.block
+ res=1
+ peer channel join -b ./channel-artifacts/mychannel.block
+ res=1
+ peer channel join -b ./channel-artifacts/mychannel.block
+ res=1
Error: error getting endorser client for channel: failed to load config for PeerClient: unable to loa
d peer.tls.rootcert.file: open /home/h2kim/fabric-samples/test-network-org2peer2/organizations/peerOr
ganizations/org1.example.com/peers/peer1.org1.example.com/tls/ca.crt: no such file or directory
After 5 attempts, peer0.org2 has failed to join channel 'mychannel'
Create channel failed
```

피어가 채널에 참가하는 중에 응답을 받지 않아서 네트워크에 참가하는 것을 허
가하지 않는 것을 확인할 수 있음.

```
organizations > fabric-ca > registerEnroll.sh
37
38 infoIn "Register peer1"
39 set -x
40 fabric-ca-client register --caname ca-org1 --id.name peer1 --id.secret peer1pw --id.type peer --tls.certfiles ${PWD}/organizations/fabric-ca/org1/tls-cert.pem
41 { set +x; } 2>/dev/null
42
43 infoIn "Register user"
44 set -x
45 fabric-ca-client register --caname ca-org1 --id.name user1 --id.secret user1pw --id.type client --tls.certfiles ${PWD}/organizations/fabric-ca/org1/tls-cert.pem
46 { set +x; } 2>/dev/null
47
48 infoIn "Register the org admin"
49 set -x
50 fabric-ca-client register --caname ca-org1 --id.name orgladmin --id.secret orgladminpw --id.type admin --tls.certfiles ${PWD}/organizations/fabric-ca/org1/tls-cer
51 { set +x; } 2>/dev/null
52
53 mkdir -p organizations/peerOrganizations/org1.example.com/peers
54 mkdir -p organizations/peerOrganizations/org1.example.com/peers/peer0.org1.example.com
55 mkdir -p organizations/peerOrganizations/org1.example.com/peers/peer1.org1.example.com
56
57 infoIn "Generate the peer0 msp"
58 set -x
59 fabric-ca-client enroll -u https://peer0:peer0pw@localhost:7054 --caname ca-org1 -M ${PWD}/organizations/peerOrganizations/org1.example.com/peers/peer0.org1.examp
60 { set +x; } 2>/dev/null
61
62 cp ${PWD}/organizations/peerOrganizations/org1.example.com/msp/config.yaml ${PWD}/organizations/peerOrganizations/org1.example.com/peers/peer0.org1.example.com/ms
63
64 infoIn "Generate the peer1 msp"
65 set -x
66 fabric-ca-client enroll -u https://peer1:peer0pw@localhost:7154 --caname ca-org1 -M ${PWD}/organizations/peerOrganizations/org1.example.com/peers/peer1.org1.examp
67 { set +x; } 2>/dev/null
68
69 cp ${PWD}/organizations/peerOrganizations/org1.example.com/msp/config.yaml ${PWD}/organizations/peerOrganizations/org1.example.com/peers/peer1.org1.example.com/ms
70
71 infoIn "Generate the peer0-tls certificates"
```

~/fabric-samples/organizatins/fabric-ca/registerEnroll.sh 파일에 새롭게 추가된
피어의 정보가 입력되지 않아서 작동하지 않았음. 추가된 피어의 정보를 입력하

여 작동이 가능하도록 조치함.

```
docker > docker-compose-couch.yaml
85      # The CORE_LEDGER_STATE_COUCHDBCONFIG_USERNAME and CORE_LEDGER_STATE_COUCHDBCONFIG_PASSWORD
86      # provide the credentials for ledger to connect to CouchDB. The username and password must
87      # match the username and password set for the associated CouchDB.
88      - CORE_LEDGER_STATE_COUCHDBCONFIG_USERNAME=admin
89      - CORE_LEDGER_STATE_COUCHDBCONFIG_PASSWORD=adminpw
90      depends_on:
91      - couchdb2
92
93      couchdb3:
94      container_name: couchdb3
95      image: couchdb:3.1
96      # Populate the COUCHDB_USER and COUCHDB_PASSWORD to set an admin user and password
97      # for CouchDB. This will prevent CouchDB from operating in an "Admin Party" mode.
98      environment:
99      - COUCHDB_USER=admin
100     - COUCHDB_PASSWORD=adminpw
101     # Comment/Uncomment the port mapping if you want to hide/expose the CouchDB service,
102     # for example map it to utilize Fauxton User Interface in dev environments.
103     ports:
104     - "9984:5984"
105     networks:
106     - test
107
108     peer1.org2.example.com:
109     environment:
110     - CORE_LEDGER_STATE_STATEDATABASE=CouchDB
111     - CORE_LEDGER_STATE_COUCHDBCONFIG_COUCHDBADDRESS=couchdb3:5984
112     # The CORE_LEDGER_STATE_COUCHDBCONFIG_USERNAME and CORE_LEDGER_STATE_COUCHDBCONFIG_PASSWORD
113     # provide the credentials for ledger to connect to CouchDB. The username and password must
114     # match the username and password set for the associated CouchDB.
115     - CORE_LEDGER_STATE_COUCHDBCONFIG_USERNAME=admin
116     - CORE_LEDGER_STATE_COUCHDBCONFIG_PASSWORD=adminpw
117     depends_on:
118     - couchdb3
```

~/fabric-samples/test-network/docker/docker-compose-couch.yaml에 추가된 피어에 새로운 정보를 담은 db설정을 추가함.

```
Generate the peer1 msp
+ fabric-ca-client enroll -u https://peer1:peer0pw@localhost:7154 --caname ca-org1 -M /home/h2kim/fabric-samples/test-network-org2peer2/organizations/peerOrganizations/org1.example.com/peers/peer1.org1.example.com/msp --csr.hosts peer1.org1.example.com --tls.certfiles /home/h2kim/fabric-samples/test-network-org2peer2/organizations/fabric-ca/org1/tls-cert.pem
2021/05/31 15:23:28 [INFO] TLS Enabled
2021/05/31 15:23:28 [INFO] generating key: &[A:ecdsa S:256]
2021/05/31 15:23:28 [INFO] encoded CSR
Error: POST failure of request: POST https://localhost:7154/enroll
{"hosts":["peer1.org1.example.com"],"certificate_request":"-----BEGIN CERTIFICATE REQUEST-----\nMIIBTDCC8wIBADBDMQswCQYDVQQGEwJVUzEXMBIGA1UECBMTm9ydGggQ2Fyb2xpbnbmExFDASBgNVBAoTC0h5cGVybGVkZ2ZyMQ8wDQYD
VQLEwZGYWJyaWxkZjAMBGNV\nBAMTBXB1ZXIwMFkwEwYHKoZIzj0CAQYIKoZIzj0DAQcDQgAEQP31QFMkrL1WDrh\nn8ateZVwzp
zN9WUEf4XA6fskKAPkseB1VbrJbbapHfllKpozRW2G9DDmjc9+WEPPY\n7C2heaA0MDIGCSqGSIb3DQEJDDjELMCMwIQYDVR0RBBo
wGIIWcGVlcjEub3JnMS5l\nneGftcGx1LmNvbTAKBggqhkJOPQDAGNIADBFaIEA7tFxLtko5p23xRCAR2buQGyd\nnMBr2wHqtTIsmo
E4FxaocICQFJilks1eeNsQ/ens6qckGH6hmWMvVzXyGulH1xD4r\n-----END CERTIFICATE REQUEST-----\n","profile":
"","crl_override":"","label":"","NotBefore":"0001-01-01T00:00:00Z","NotAfter":"0001-01-01T00:00:00Z",
"CAName":"ca-org1"}: Post https://localhost:7154/enroll: dial tcp 127.0.0.1:7154: connect: connection
refused
```

명령어를 실행시 새롭게 등록한 피어를 정보를 보낼 때 인증서를 출력한 이후에 연결이 거부되었다는 로그를 확인할 수 있음.

CONTAINER ID	IMAGE	COMMAND	CREATED	STA
TUS	PORTS	NAMES		
9128cd17d8a8	hyperledger/fabric-peer:2.2	"peer node start"	3 seconds ago	Up
Less than a second	0.0.0.0:7051->7051/tcp	peer0.org1.example.com		
79d49764ff88	hyperledger/fabric-peer:2.2	"peer node start"	7 seconds ago	Exi
ted (1) 3 seconds ago		peer1.org1.example.com		
cdde3819b7bb	hyperledger/fabric-peer:2.2	"peer node start"	8 seconds ago	Exi
ted (1) 1 second ago		peer1.org2.example.com		
1b6bc7f91c40	hyperledger/fabric-peer:2.2	"peer node start"	11 seconds ago	Up
3 seconds	7051/tcp, 0.0.0.0:9051->9051/tcp	peer0.org2.example.com		
67c4097946db	couchdb:3.1	"tini -- /docker-ent..."	13 seconds ago	Up
7 seconds	4369/tcp, 9100/tcp, 0.0.0.0:9984->5984/tcp	couchdb3		
93cd4eae594c	couchdb:3.1	"tini -- /docker-ent..."	13 seconds ago	Up
6 seconds	4369/tcp, 9100/tcp, 0.0.0.0:7984->5984/tcp	couchdb1		
92c4652eb595	couchdb:3.1	"tini -- /docker-ent..."	13 seconds ago	Up
2 seconds	4369/tcp, 9100/tcp, 0.0.0.0:5984->5984/tcp	couchdb0		
9a0c8898ec0a	hyperledger/fabric-orderer:2.2	"orderer"	13 seconds ago	Up
5 seconds	0.0.0.0:7050->7050/tcp	orderer.example.com		
6702e114a49f	couchdb:3.1	"tini -- /docker-ent..."	14 seconds ago	Up
10 seconds	4369/tcp, 9100/tcp, 0.0.0.0:8984->5984/tcp	couchdb2		
e79f3f15bd59	hyperledger/fabric-ca:latest	"sh -c 'fabric-ca-se..."	23 seconds ago	Up
21 seconds	0.0.0.0:7054->7054/tcp	ca_org1		
0ec5c2b1209c	hyperledger/fabric-ca:latest	"sh -c 'fabric-ca-se..."	23 seconds ago	Up
19 seconds	7054/tcp, 0.0.0.0:8054->8054/tcp	ca_org2		
42a31a997dc0	hyperledger/fabric-ca:latest	"sh -c 'fabric-ca-se..."	23 seconds ago	Up
20 seconds	7054/tcp, 0.0.0.0:9054->9054/tcp	ca_orderer		
Generating channel create transaction 'mychannel.tx'				

\$docker ps 명령어를 실행하면 STA(state)에 Exited 종료되었다는 것을 확인할 수 있음.

```
Anchor peers updated for org 'Org1MSP' on channel 'mychannel'
Updating anchor peers for org2...
Using organization 2
+ peer channel update -o localhost:7050 --ordererTLSHostnameOverride orderer.example.com -c mychannel
-f ./channel-artifacts/Org1MSPanchors.tx --tls --cafile /home/h2kim/fabric-samples/test-network-org2
peer2/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsc
a.example.com-cert.pem
+ res=1
+ peer channel update -o localhost:7050 --ordererTLSHostnameOverride orderer.example.com -c mychannel
-f ./channel-artifacts/Org1MSPanchors.tx --tls --cafile /home/h2kim/fabric-samples/test-network-org2
peer2/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsc
a.example.com-cert.pem
+ res=1
+ peer channel update -o localhost:7050 --ordererTLSHostnameOverride orderer.example.com -c mychannel
-f ./channel-artifacts/Org1MSPanchors.tx --tls --cafile /home/h2kim/fabric-samples/test-network-org2
peer2/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsc
a.example.com-cert.pem
+ res=1
+ peer channel update -o localhost:7050 --ordererTLSHostnameOverride orderer.example.com -c mychannel
-f ./channel-artifacts/Org1MSPanchors.tx --tls --cafile /home/h2kim/fabric-samples/test-network-org2
peer2/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsc
a.example.com-cert.pem
+ res=1
2021-05-31 15:38:44.209 KST [channelCmd] InitCmdFactory -> INFO 001 Endorser and orderer connections
initialized
Error: got unexpected status: BAD_REQUEST -- error applying config update to existing channel 'mychan
nel': error authorizing update: error validating ReadSet: proposed update requires that key [Group]
/Channel/Application/Org1MSP be at version 0, but it is currently at version 1
Anchor peer update failed
Create channel failed
```

도커 컨테이너가 제대로 작동하지 않고 있기 때문에 네트워크 생성 명령이 작동하지 않고 있음을 확인할 수 있음.

```

140  ## Set the anchor peers for each org in the channel
141  infoLn "Updating anchor peers for org1..."
142  updateAnchorPeers 1
143  infoLn "Updating anchor peers for org2..."
144  updateAnchorPeers 2
145
146  successLn "Channel successfully joined"
147
148  exit 0

```

앵커피어(Anchor peer)를 업데이트 할 때 org1의 peer0가 1이었고 org2의 peer0가 2였으나 기존에 값에서 org1의 peer1이 2로 업데이트 되었기 때문에 변경된 값을 입력하여 명령어가 작동되는 것을 확인하기로 함.

```

Updating anchor peers for org1...
Using organization 1
+ peer channel update -o localhost:7050 --ordererTLSHostnameOverride orderer.example.com -c mychannel
-f ./channel-artifacts/Org1MSPanchors.tx --tls --cafile /home/h2kim/fabric-samples/test-network-org2
peer2/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsca
a.example.com-cert.pem
+ res=0
2021-05-31 15:52:46.416 KST [channelCmd] InitCmdFactory -> INFO 001 Endorser and orderer connections
initialized
2021-05-31 15:52:46.440 KST [channelCmd] update -> INFO 002 Successfully submitted channel update
Anchor peers updated for org 'Org1MSP' on channel 'mychannel'
Updating anchor peers for org2...
Using organization 3
+ peer channel update -o localhost:7050 --ordererTLSHostnameOverride orderer.example.com -c mychannel
-f ./channel-artifacts/Org2MSPanchors.tx --tls --cafile /home/h2kim/fabric-samples/test-network-org2
peer2/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsca
a.example.com-cert.pem
+ res=0
2021-05-31 15:52:52.525 KST [channelCmd] InitCmdFactory -> INFO 001 Endorser and orderer connections
initialized
2021-05-31 15:52:52.551 KST [channelCmd] update -> INFO 002 Successfully submitted channel update
Anchor peers updated for org 'Org2MSP' on channel 'mychannel'
Channel successfully joined
h2kim@h2kim-VBox:~/fabric-samples/test-network-org2peer2$

```

네트워크를 생성하는 명령어를 작동하면 채널생성을 마친 후 앵커피어를 업데이트 한 이후 채널생성이 끝났다는 로그를 남기는 것을 확인할 수 있음.

```

Checking the commit readiness of the chaincode definition successful on peer0.org2 on channel 'mychan
nel'
Using organization 2
+ peer lifecycle chaincode approveformyorg -o localhost:7050 --ordererTLSHostnameOverride orderer.exa
mple.com --tls --cafile /home/h2kim/fabric-samples/test-network-org2peer2/organizations/ordererOrgani
zations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsca.example.com-cert.pem --channelID
mychannel --name marbles --version 1.0 --package-id marbles_1.0:3dd17b9580f3e9ee76d88999860c5e96694
7efc54666997ad17d9cbe6ff3c516 --sequence 1
+ res=1
Error: proposal failed with status: 500 - failed to invoke backing implementation of 'ApproveChaincod
eDefinitionForMyOrg': attempted to redefine uncommitted sequence (1) for namespace marbles with uncha
nged content
Chaincode definition approved on peer0.org2 on channel 'mychannel' failed
Deploying chaincode failed
h2kim@h2kim-VBox:~/fabric-samples/test-network-org2peer2$

```

피어를 추가하고 체인코드 배포를 하게 되면 체인코드를 접근가능하게 하는 명령어를 실행시 실패를 한다는 에러를 남기고 정지함.


```

328  ## query whether the chaincode is installed
329  queryInstalled 1
330
331  ## approve the definition for org1
332  approveForMyOrg 1
333
334  ## check whether the chaincode definition is ready to be committed
335  ## expect org1 to have approved and org2 not to
336  checkCommitReadiness 1 "\"Org1MSP\": true" "\"Org2MSP\": false"
337  checkCommitReadiness 3 "\"Org1MSP\": true" "\"Org2MSP\": false"
338
339  ## now approve also for org2
340  approveForMyOrg 3
341
342  ## check whether the chaincode definition is ready to be committed
343  ## expect them both to have approved
344  checkCommitReadiness 1 "\"Org1MSP\": true" "\"Org2MSP\": true"
345  checkCommitReadiness 3 "\"Org1MSP\": true" "\"Org2MSP\": true"
346
347  ## now that we know for sure both orgs have approved, commit the definition
348  commitChaincodeDefinition 1 3
349
350  ## query on both orgs to see that the definition committed successfully
351  queryCommitted 1
352  queryCommitted 3
353
354  ## Invoke the chaincode - this does require that the chaincode have the 'initLedger'
355  ## method defined
356  if [ "$CC_INIT_FCN" = "NA" ]; then
357  |   infoln "Chaincode initialization is not required"
358  else
359  |   chaincodeInvokeInit 1 3
360  fi

```

앵커피어를 업데이트 하는 것과 같이 피어 변경된 피어 정보에 따라서 deployCC.sh 쉘스크립트를 변경함.

```

h2kim@h2kim-VBox:~/fabric-samples/test-network-org2peer2$ ./network.sh deployCC -ccn marbles -ccl go
-ccp ../../fabric-samples/chaincode/marbles02/go
deploying chaincode on channel 'mychannel'
executing with the following
- CHANNEL_NAME: mychannel
- CC_NAME: marbles
- CC_SRC_PATH: ../../fabric-samples/chaincode/marbles02/go
- CC_SRC_LANGUAGE: go
- CC_VERSION: 1.0
- CC_SEQUENCE: 1
- CC_END_POLICY: NA
- CC_COLL_CONFIG: NA
- CC_INIT_FCN: NA
- DELAY: 3
- MAX_RETRY: 5
- VERBOSE: false
Vendoring Go dependencies at ../../fabric-samples/chaincode/marbles02/go
~/fabric-samples/chaincode/marbles02/go ~/fabric-samples/test-network-org2peer2
~/fabric-samples/test-network-org2peer2
Finished vendoring Go dependencies
Using organization 1
+ peer lifecycle chaincode package marbles.tar.gz --path ../../fabric-samples/chaincode/marbles02/go
--lang golang --label marbles_1.0
+ res=0
Chaincode is packaged on peer0.org1
Installing chaincode on peer0.org1...
Using organization 1
+ peer lifecycle chaincode install marbles.tar.gz

```

```
Chaincode definition committed on channel 'mychannel'
Using organization 1
Querying chaincode definition on peer0.org1 on channel 'mychannel'...
Attempting to Query committed status on peer0.org1, Retry after 3 seconds.
+ peer lifecycle chaincode querycommitted --channelID mychannel --name marbles
+ res=0
Committed chaincode definition for chaincode 'marbles' on channel 'mychannel':
Version: 1.0, Sequence: 1, Endorsement Plugin: escc, Validation Plugin: vscc, Approvals: [Org1MSP: true, Org2MSP: true]
Query chaincode definition successful on peer0.org1 on channel 'mychannel'
Using organization 2
Querying chaincode definition on peer0.org2 on channel 'mychannel'...
Attempting to Query committed status on peer0.org2, Retry after 3 seconds.
+ peer lifecycle chaincode querycommitted --channelID mychannel --name marbles
+ res=0
Committed chaincode definition for chaincode 'marbles' on channel 'mychannel':
Version: 1.0, Sequence: 1, Endorsement Plugin: escc, Validation Plugin: vscc, Approvals: [Org1MSP: true, Org2MSP: true]
Query chaincode definition successful on peer0.org2 on channel 'mychannel'
Chaincode initialization is not required
h2kim@h2kim-VBox:~/fabric-samples/test-network-org2peer2$
```

명령어를 실행하면 체인코드가 피어에 올라가서 종료되는 것을 확인할 수 있음.

```
h2kim@h2kim-VBox:~/caliper-benchmarks/networks/prometheus-grafana$ docker-compose -f docker-compose-bare.yaml -f docker-compose-fabric.yaml up
Creating node-exporter ...
Creating prometheus ...
Creating cadvisor ...
Creating node-exporter
Creating prometheus
Creating prometheus ... done
Creating grafana ...
Creating grafana ... done
Attaching to node-exporter, prometheus, cadvisor, grafana
node-exporter | level=info ts=2021-06-01T06:57:21.440Z caller=node_exporter.go:178 msg="Starting node_exporter" version="(version=1.1.2, branch=HEAD, revision=b597c1244d7bef49e6f3359c87a56dd7707f6719)"
node-exporter | level=info ts=2021-06-01T06:57:21.440Z caller=node_exporter.go:179 msg="Build context" build_context="(go=go1.15.8, user=root@f07de8ca602a, date=20210305-09:29:10)"
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=filesystem_common.go:74 collector=filesystem msg="Parsed flag --collector.filesystem.ignored-mount-points" flag="/^(sys|proc|dev|host|etc|rootfs/var/lib/docker/containers|rootfs/var/lib/docker/overlay2|rootfs/run/docker/netns|rootfs/var/lib/docker/aufs)($|/)"
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=filesystem_common.go:76 collector=filesystem msg="Parsed flag --collector.filesystem.ignored-fs-types" flag="^(autofs|binfmt_misc|bpf|cgroup2?|configfs|debugfs|devpts|devtmpfs|fusectl|hugetlbfs|iso9660|mqueue|nsfs|overlay|proc|procfs|pstore|rpc_pipefs|securityfs|selinuxfs|squashfs|sysfs|tracefs)$"
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:106 msg="Enabled collectors"
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=arp
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=bcache
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=bonding
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=btrfs
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=conntrack
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=cpu
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=cpufirmware
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=disks
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=edac
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=entropy
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=fibrechannel
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=filefd
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=filesystem
node-exporter | level=info ts=2021-06-01T06:57:21.442Z caller=node_exporter.go:113 collector=hwmon
```

~/caliper-benchmarks/networks/prometheus-grafana 폴더에서 docker-compose -f docker-compose-bare.yaml -f docker-compose-fabric.yaml up을 실행하여

prometheus와 grafana를 실행함.

```
h2kim@h2kim-VBox:~/fabric-samples/test-network$ ./network.sh up createChannel -ca -c mychannel -i 2.2
-s couchdb
Creating channel 'mychannel'.
If network is not up, starting nodes with CLI timeout of '5' tries and CLI delay of '3' seconds and u
sing database 'couchdb with crypto from 'Certificate Authorities'
Bringing up network
LOCAL_VERSION=2.2.0
DOCKER_IMAGE_VERSION=2.2.0
CA_LOCAL_VERSION=1.4.8
CA_DOCKER_IMAGE_VERSION=1.4.8
Generate certificates using Fabric CA's
Creating network "net_test" with the default driver
Creating ca_orderer ...
Creating ca_org2 ...
Creating ca_org1 ...
Creating ca_orderer
Creating ca_org1
Creating ca_org2 ... done
```

벤치마크를 확인하기 위한 네트워크를 생성함.

```
h2kim@h2kim-VBox:~/fabric-samples/test-network/addOrg3$ ./addOrg3.sh up -c mychannel -ca -s couchdb
Add Org3 to channel 'mychannel' with '10' seconds and CLI delay of '3' seconds and using database 'co
uchdb'

#####
#### Generate certificates using Fabric CA's ####
#####
Creating network "net_default" with the default driver
WARNING: Found orphan containers (peer0.org2.example.com, peer0.org1.example.com, orderer.example.com
, couchdb0, couchdb1, ca_org2, ca_orderer, ca_org1) for this project. If you removed or renamed this
service in your compose file, you can run this command with the --remove-orphans flag to clean it up.
Creating ca_org3 ...
Creating ca_org3 ... done
#####
##### Create Org3 Identities #####
#####

Enroll the CA admin

+ fabric-ca-client enroll -u https://admin:adminpw@localhost:11054 --caname ca-org3 --tls.certfiles /
home/h2kim/fabric-samples/test-network/addOrg3/fabric-ca/org3/tls-cert.pem
2021/06/01 16:00:32 [INFO] Created a default configuration file at /home/h2kim/fabric-samples/test-ne
twork/organizations/peerOrganizations/org3.example.com/fabric-ca-client-config.yaml
2021/06/01 16:00:32 [INFO] TLS Enabled
2021/06/01 16:00:32 [INFO] generating key: &{A:ecdsa S:256}
2021/06/01 16:00:32 [INFO] encoded CSR
2021/06/01 16:00:32 [INFO] Stored client certificate at /home/h2kim/fabric-samples/test-network/organ
izations/peerOrganizations/org3.example.com/msp/signcerts/cert.pem
2021/06/01 16:00:32 [INFO] Stored root CA certificate at /home/h2kim/fabric-samples/test-network/organ
izations/peerOrganizations/org3.example.com/msp/cacerts/localhost-11054-ca-org3.pem
2021/06/01 16:00:32 [INFO] Stored Issuer public key at /home/h2kim/fabric-samples/test-network/organ
izations/peerOrganizations/org3.example.com/msp/IssuerPublicKey
2021/06/01 16:00:32 [INFO] Stored Issuer revocation public key at /home/h2kim/fabric-samples/test-net
work/organizations/peerOrganizations/org3.example.com/msp/IssuerRevocationPublicKey

Register peer0

+ fabric-ca-client register --caname ca-org3 --id.name peer0 --id.secret peer0pw --id.type peer --tls
.certfiles /home/h2kim/fabric-samples/test-network/addOrg3/fabric-ca/org3/tls-cert.pem
2021/06/01 16:00:32 [INFO] Configuration file location: /home/h2kim/fabric-samples/test-network/organ
izations/peerOrganizations/org3.example.com/fabric-ca-client-config.yaml
2021/06/01 16:00:32 [INFO] TLS Enabled
2021/06/01 16:00:32 [INFO] TLS Enabled
Password: peer0pw

Register user

+ fabric-ca-client register --caname ca-org3 --id.name user1 --id.secret user1pw --id.type client --t
```

기존 org1, org2를 제외한 3개의 조직(org)를 가정하고 체인코드를 작성했으므로
~/fabric-samples/test-network/addOrg3에 있는 명령어를 사용하여 3번째 조직을

추가함.

```
+ peer channel signconfigtx -f org3_update_in_envelope.pb
2021-06-01 07:00:42.752 UTC [channelCmd] InitCmdFactory -> INFO 001 Endorser and orderer connections
initialized

===== Submitting transaction from a different peer (peer0.org2) which also signs it =====

+ peer channel update -f org3_update_in_envelope.pb -c mychannel -o orderer.example.com:7050 --orderer
rTLSHostnameOverride orderer.example.com --tls --cafile /opt/gopath/src/github.com/hyperledger/fabric
/peer/organizations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsca
a.example.com-cert.pem
2021-06-01 07:00:42.935 UTC [channelCmd] InitCmdFactory -> INFO 001 Endorser and orderer connections
initialized
2021-06-01 07:00:43.000 UTC [channelCmd] update -> INFO 002 Successfully submitted channel update

===== Config transaction to add org3 to network submitted! =====

#####
##### Have Org3 peers join network #####
#####

===== Getting Org3 on to your test network =====

Fetching channel config block from orderer...
+ peer channel fetch 0 mychannel.block -o orderer.example.com:7050 --ordererTLSHostnameOverride order
er.example.com -c mychannel --tls --cafile /opt/gopath/src/github.com/hyperledger/fabric/peer/organiz
ations/ordererOrganizations/example.com/orderers/orderer.example.com/msp/tlscacerts/tlsca.example.com
-cert.pem
+ res=0
2021-06-01 07:00:43.777 UTC [channelCmd] InitCmdFactory -> INFO 001 Endorser and orderer connections
initialized
2021-06-01 07:00:43.779 UTC [cli.common] readBlock -> INFO 002 Received block: 0
+ peer channel join -b mychannel.block
+ res=1
Error: error getting endorser client for channel: endorser client failed to connect to peer0.org3.exa
mple.com:11051: failed to create new connection: connection error: desc = "transport: error while dia
ling: dial tcp 172.23.0.11:11051: connect: connection refused"
peer0.org3 failed to join the channel, Retry after 3 seconds
+ peer channel join -b mychannel.block
+ res=0
2021-06-01 07:00:46.957 UTC [channelCmd] InitCmdFactory -> INFO 001 Endorser and orderer connections
initialized
2021-06-01 07:00:47.507 UTC [channelCmd] executeJoin -> INFO 002 Successfully submitted proposal to j
oin channel
===== peer0.org3 joined channel 'mychannel' =====

===== Finished adding Org3 to your test network! =====

h2kim@h2kim-VBox:~/fabric-samples/test-network/addOrg3$
```

셸 스크립트를 수행하는 것에 따른 로그와 결과를 확인할 수 있음.


```

h2kim@h2kim-VBox:~/fabric-samples/test-network/addOrg3$ docker ps
CONTAINER ID        IMAGE                                     COMMAND                  CREATED            STATUS
ATUS                PORTS                                     NAMES                   2 minutes ago     Up
751635b869ad        hyperledger/fabric-tools:latest        "/bin/bash"            2 minutes ago     Up
2 minutes          Org3cli
3499438875fe        hyperledger/fabric-peer:latest         "peer node start"      2 minutes ago     Up
2 minutes          peer0.org3.example.com
2fe7c7bac7a4        couchdb:3.1                             "tini -- /docker-ent..." 2 minutes ago     Up
2 minutes          couchdb4
eec64f032c7d        hyperledger/fabric-ca:latest           "sh -c 'fabric-ca-se..." 2 minutes ago     Up
2 minutes          ca_org3
a993564bb9f2        hyperledger/fabric-peer:2.2            "peer node start"      3 minutes ago     Up
3 minutes          peer0.org2.example.com
3ffca08d4a12        hyperledger/fabric-peer:2.2            "peer node start"      3 minutes ago     Up
3 minutes          peer0.org1.example.com
c326423b2d67        hyperledger/fabric-orderer:2.2         "orderer"              3 minutes ago     Up
3 minutes          orderer.example.com
1a160775ef8a        couchdb:3.1                             "tini -- /docker-ent..." 3 minutes ago     Up
3 minutes          couchdb0
af5841547cef        couchdb:3.1                             "tini -- /docker-ent..." 3 minutes ago     Up
3 minutes          couchdb1
a09b45b42837        hyperledger/fabric-ca:latest           "sh -c 'fabric-ca-se..." 4 minutes ago     Up
4 minutes          ca_org2
6a7de802e1bf        hyperledger/fabric-ca:latest           "sh -c 'fabric-ca-se..." 4 minutes ago     Up
4 minutes          ca_orderer
4b5ee1ed1212        hyperledger/fabric-ca:latest           "sh -c 'fabric-ca-se..." 4 minutes ago     Up
4 minutes          ca_org1
c33cc72be10a        grafana/grafana                         "/run.sh"              5 minutes ago     Up
5 minutes          grafana
ef836d9ed65d        google/cadvisor:v0.27.4                "/usr/bin/cadvisor -..." 5 minutes ago     Up
5 minutes          cadvisor
5371eff3821f        prom/prometheus                         "/bin/prometheus --c..." 5 minutes ago     Up
5 minutes          prometheus
4ddd1c8b7f92        prom/node-exporter                      "/bin/node_exporter ..." 5 minutes ago     Up
5 minutes          node-exporter
h2kim@h2kim-VBox:~/fabric-samples/test-network/addOrg3$ docker network connect net_test 5371eff3821f
h2kim@h2kim-VBox:~/fabric-samples/test-network/addOrg3$

```

docker ps명령어를 사용하여 도커 컨테이너 리스트를 확인한 후에 prometheus 컨테이너를 net_test의 네트워크에 연결시킴.



grafana 대시보드를 열어보면 올라간 컨테이너의 컴퓨터 자원을 사용량을 표시해줌.


```
EXPLORER
...
e2enterenc.go 2, U X
chaincode > e2enterenc.go > ...
1 package chaincode
2
3 import (
4     "crypto/rand"
5     "crypto/rsa"
6     "crypto/sha256"
7     "crypto/x509"
8     "encoding/pem"
9     "encoding/json"
10    "fmt"
11    "io/ioutil"
12    "log"
13    "os"
14    "github.com/hyperledger/fabric-contract-api-go/contractapi"
15 )
16
17 type PKI struct {
18     ID          string `json:"ID"`
19     PrivateKey  string `json:"privateKey"`
20     PublicKey   string `json:"publicKey"`
21 }
22
23 func (s *SmartContract) CreatePKI(ctx contractapi.TransactionContextInterface, id string, privateKey string, publicKey string) error {
24     exists, err := s.PKIExists(ctx, id)
25     if err != nil {
26         return err
27     }
28     if exists {
29         return fmt.Errorf("the pki %s already exists", id)
30     }
31     pki := PKI{
32         ID:          id,
33         PrivateKey:  privateKey,
34         PublicKey:   publicKey,
35     }
36     pkiJSON, err := json.Marshal(pki)
37     if err != nil {
38         return err
39     }
40     cipherText, err := rsa.EncryptOAEP(sha256.New(), rand.Reader, pubKey, []byte(string(pkiJSON)), nil)
41     if err != nil {
42         return err
43     }
44     return ctx.GetStub().PutState(id, cipherText)
45 }
```

pki 테스트를 하던 예제파일을 체인코드에 적용하여 벤치마크를 진행하기로 함.

```
14
15 func (s *SmartContract) Createvisit(ctx contractapi.TransactionContextInterface, pkiid string, id string, shopid string, civilid string, visittime string) error {
16     exists, err := s.StateExists(ctx, id)
17     if err != nil {
18         return err
19     }
20     if exists {
21         return fmt.Errorf("the visit %s already exists", id)
22     }
23     pkiexists, err := s.PKIExists(ctx, pkiid)
24     if err != nil {
25         return err
26     }
27     if !pkiexists {
28         return fmt.Errorf("the pki %s not exists", pkiid)
29     }
30     visit := StoreVisit{
31         ID:          id,
32         ShopID:      shopid,
33         CivilID:     civilid,
34         VisitTime:   visittime,
35     }
36     visitJSON, err := json.Marshal(visit)
37     if err != nil {
38         return err
39     }
40     pki, err := s.ReadPKI(ctx, pkiid)
41     pubKey, err := ParseRsaPublicKeyFromPemStr(pki.PublicKey)
42     if err != nil {
43         return err
44     }
45     cipherText, err := rsa.EncryptOAEP(sha256.New(), rand.Reader, pubKey, []byte(string(visitJSON)), nil)
46     if err != nil {
47         return err
48     }
49     return ctx.GetStub().PutState(id, cipherText)
50 }
```

입력하는 값을 공개키 암호화를 통과 후에 정보를 암호화하여 알아볼 수 없도록 하는 변환과정 이후 데이터베이스에 저장하는 체인코드를 작성함.

```

49 func (s *SmartContract) ReadVisit(ctx contractapi.TransactionContextInterface, pkiid string, id string) (*StoreVisit, error) {
50     encryptvisitJSON, err := ctx.GetStub().GetState(id)
51     if err != nil {
52         return nil, fmt.Errorf("failed to read from world state: %v", err)
53     }
54     if encryptvisitJSON == nil {
55         return nil, fmt.Errorf("the visit %s does not exist", id)
56     }
57     pkiexists, err := s.PKIExists(ctx, pkiid)
58     if err != nil {
59         return nil, err
60     }
61     if !pkiexists {
62         return nil, fmt.Errorf("the pki %s not exists", pkiid)
63     }
64     pki, err := s.ReadPKI(ctx, pkiid)
65     privKey, err := ParseRsaPrivateKeyFromPemStr(pki.PrivateKey)
66     decipherText, err := rsa.DecryptOAEP(sha256.New(), rand.Reader, privKey, encryptvisitJSON, nil)
67     var visit StoreVisit
68     err = json.Unmarshal(decipherText, &visit)
69     if err != nil {
70         return nil, err
71     }
72
73     return &visit, nil
74 }

```

암호화된 값을 읽어올 때는 공개키로 암호화된 값을 개인키로 복호화하여 값을 보여줄 수 있는 함수를 작성함.

3. 차주 계획

- calliper-benchmark를 통한 체인코드 성능측정

4. 참고 자료

- [1] https://hyperledger-fabric.readthedocs.io/en/release-2.2/channel_update_tutorial.html