2STON™ SPN v3.0

IoTSec : 2ip IoT Security Solution

SPNBox Star Console

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2ip Inc,
Doc. Revision: 1.3

SPN v3.0

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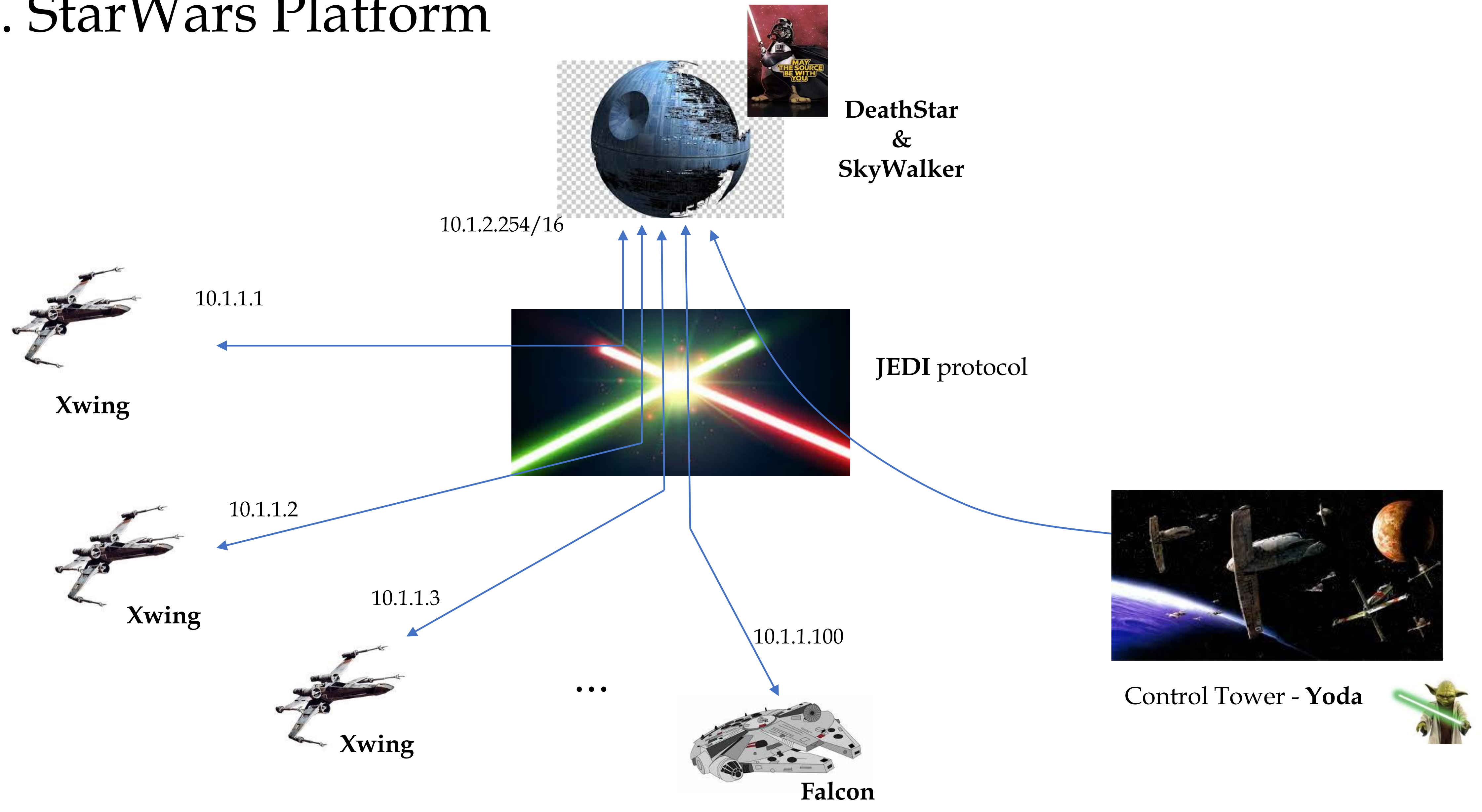
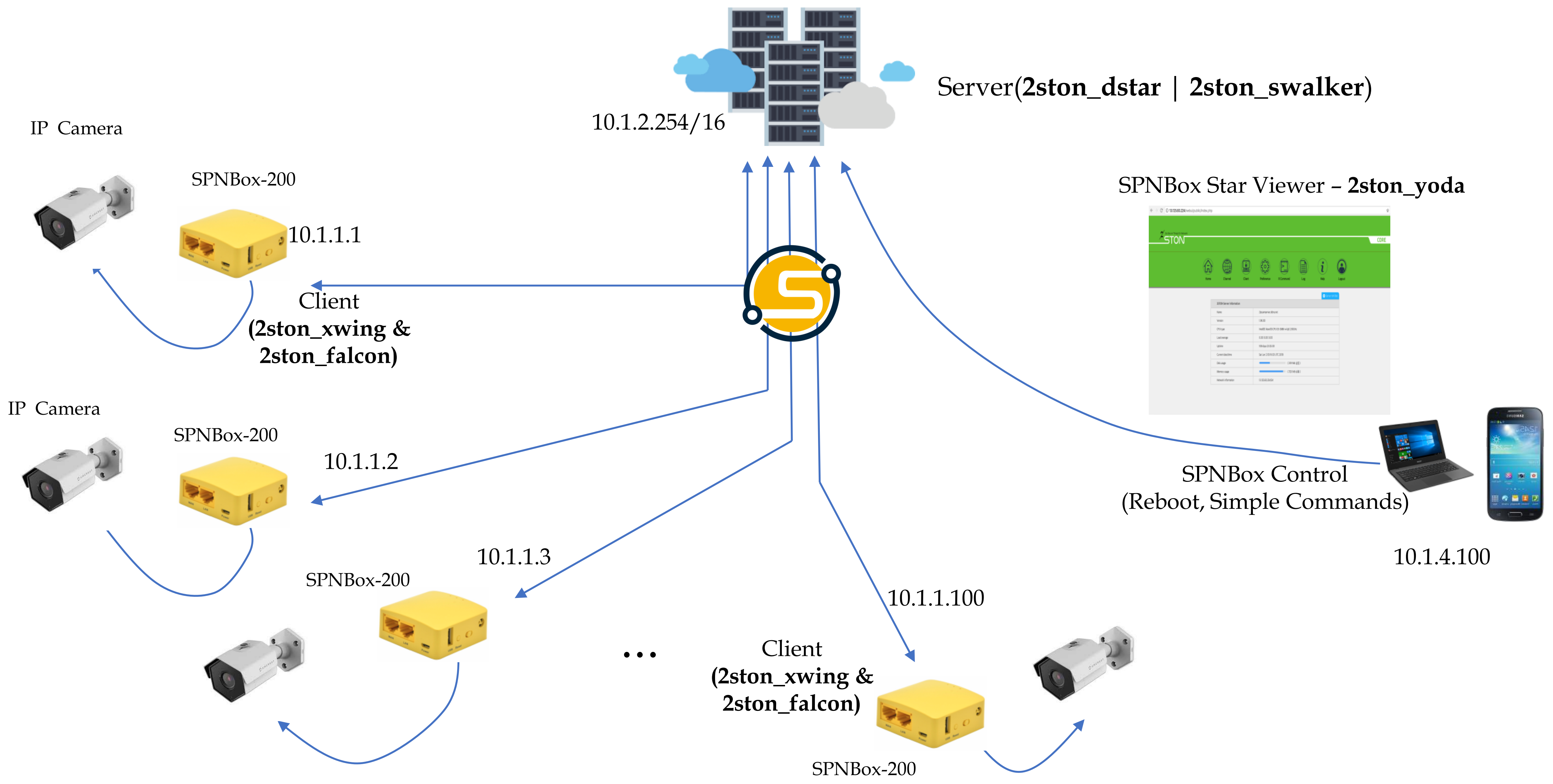
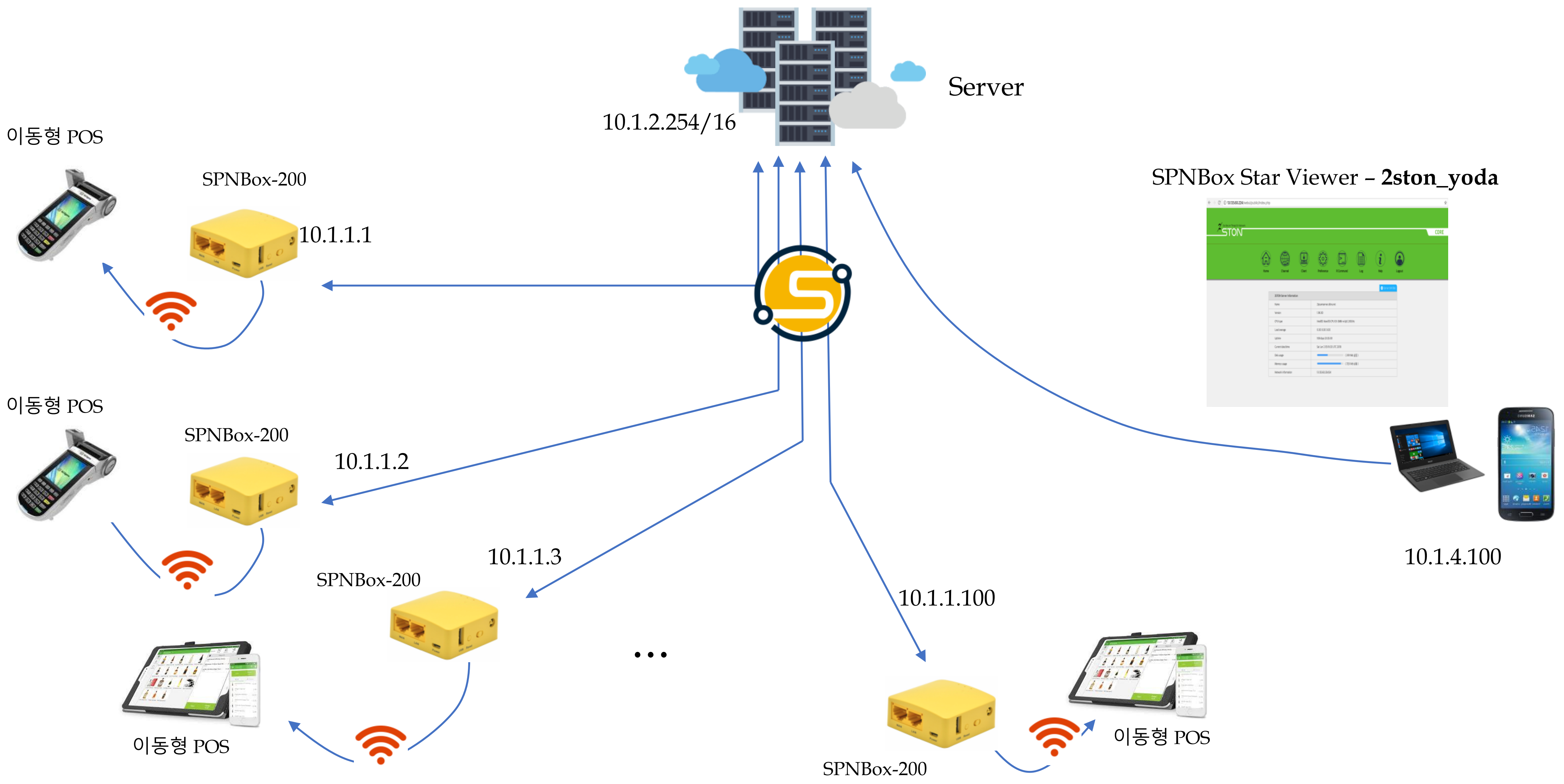


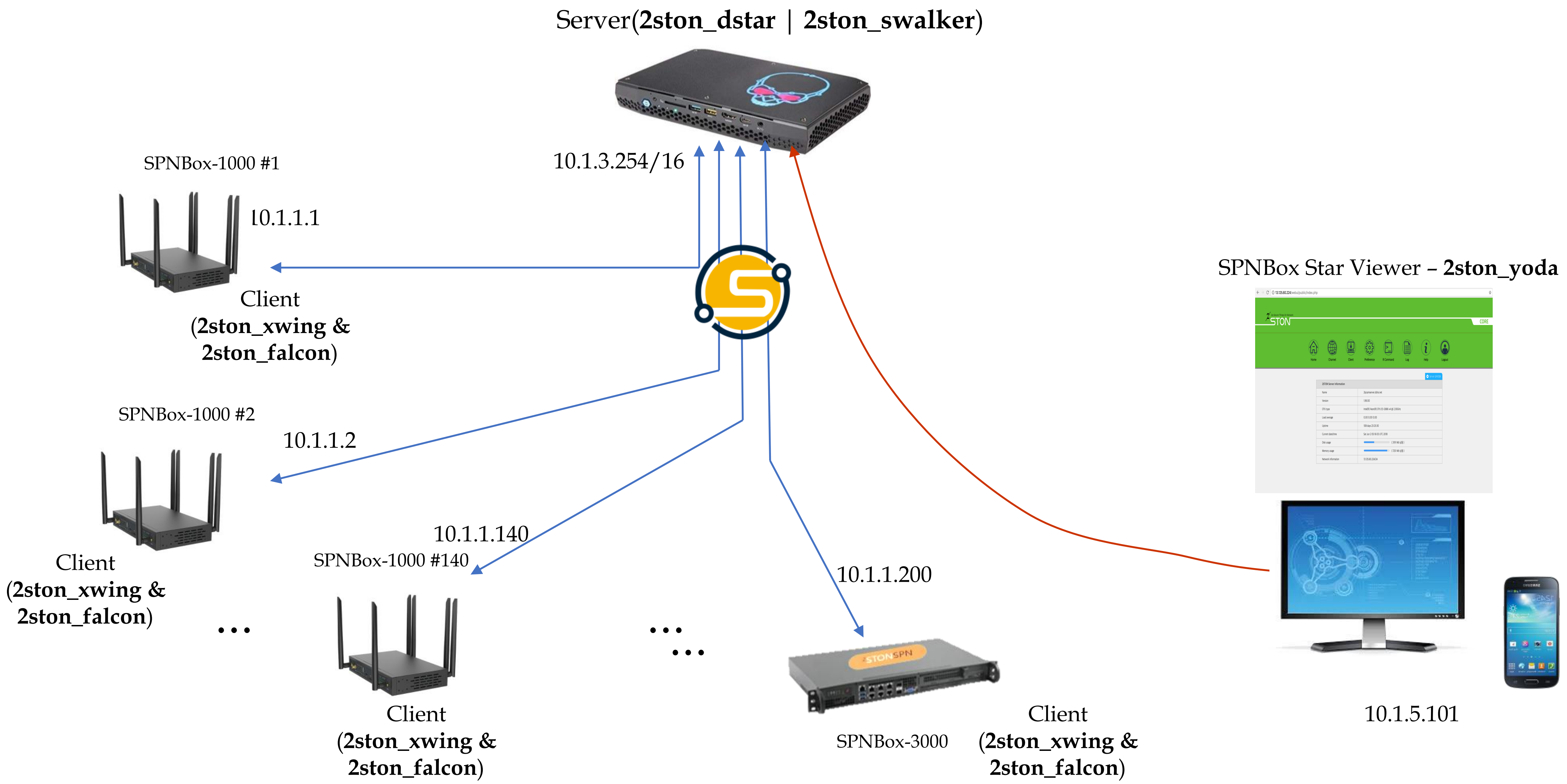
2. SPNBox Star Console Architecture(1)



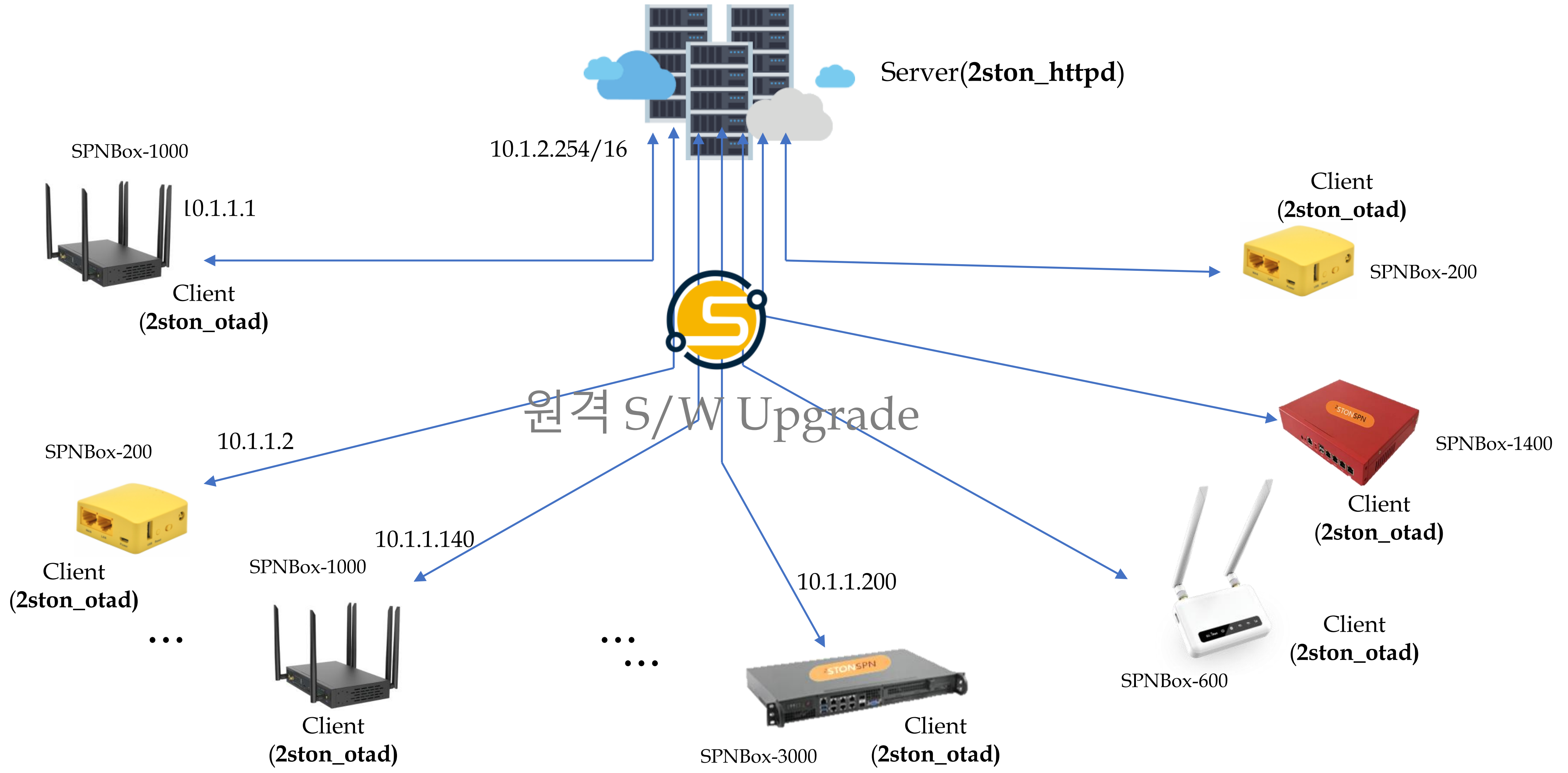
2. SPNBox Star Console Architecture(2)



2. SPNBox Star Console Architecture(3)



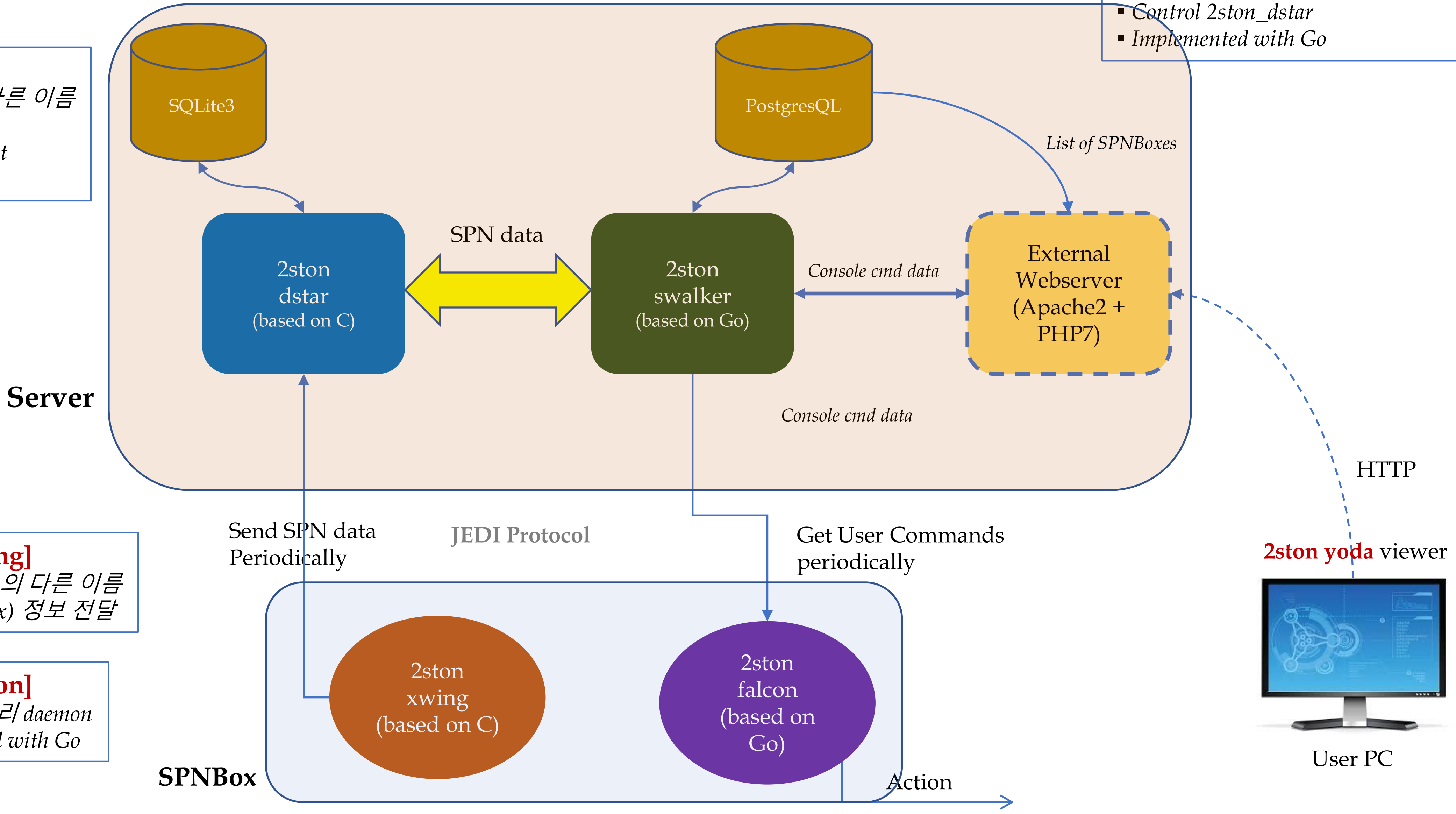
2. SPNBox Star Console Architecture(4)



2. SPNBox Star Console Architecture(5-1)

[2ston_swalker]
- *DB Manager*
- *User Command Queue Management*
- *Communication w/ 2ston_dstar*
- *Control 2ston_dstar*
- *Implemented with Go*

[2ston_dstar]
- *2ston_spnd2의 다른 이름*
- *ip 동적 할당*
- *client management*
- *sqlite3 db table*



[2ston_xwing]
- *2ston_spnc2의 다른 이름*
- *client(spnbox) 정보 전달*

[2ston_falcon]
- *user cmd 처리 daemon*
- *Implemented with Go*

2. SPNBox Star Console Architecture(5-2)

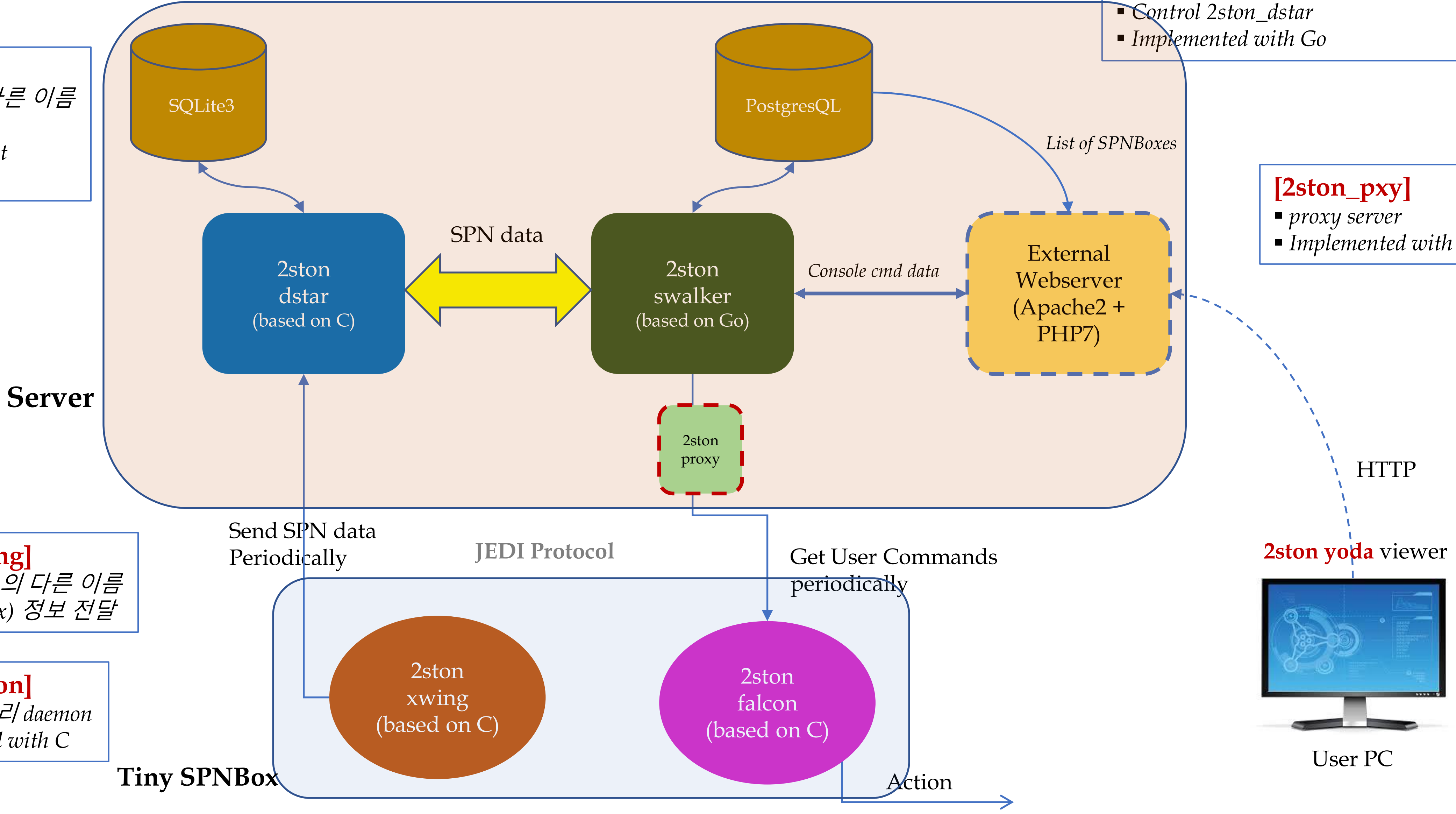
[2ston_swalker]
- *DB Manager*
- *User Command Queue Management*
- *Communication w/ 2ston_dstar*
- *Control 2ston_dstar*
- *Implemented with Go*

[2ston_dstar]
- *2ston_spnd2의 다른 이름*
- *ip 동적 할당*
- *client management*
- *sqlite3 db table*

[2ston_pxy]
- *proxy server*
- *Implemented with C*

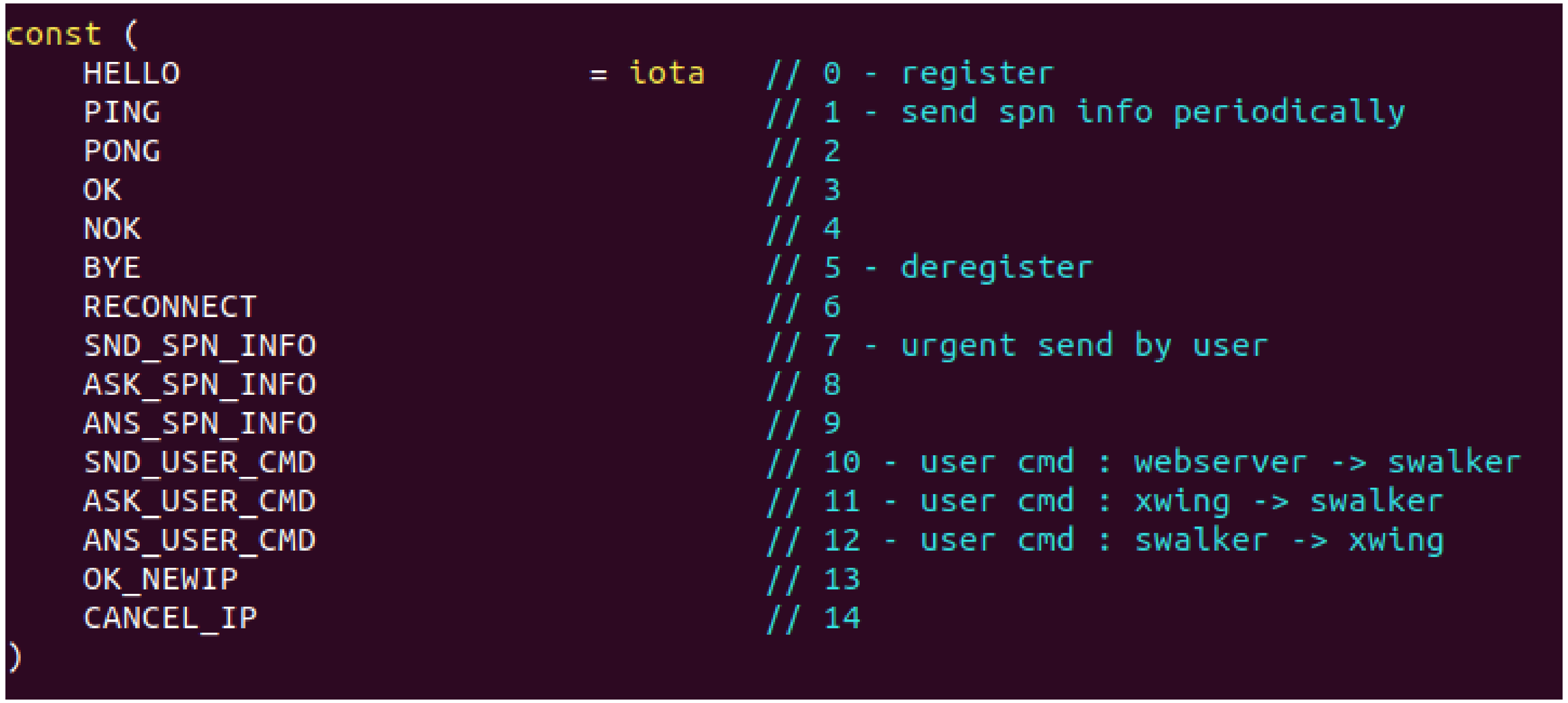
[2ston_xwing]
- *2ston_spnc2의 다른 이름*
- *client(spnbox) 정보 전달*

[2ston_falcon]
- *user cmd 처리 daemon*
- *Implemented with C*



Star Console Protocol

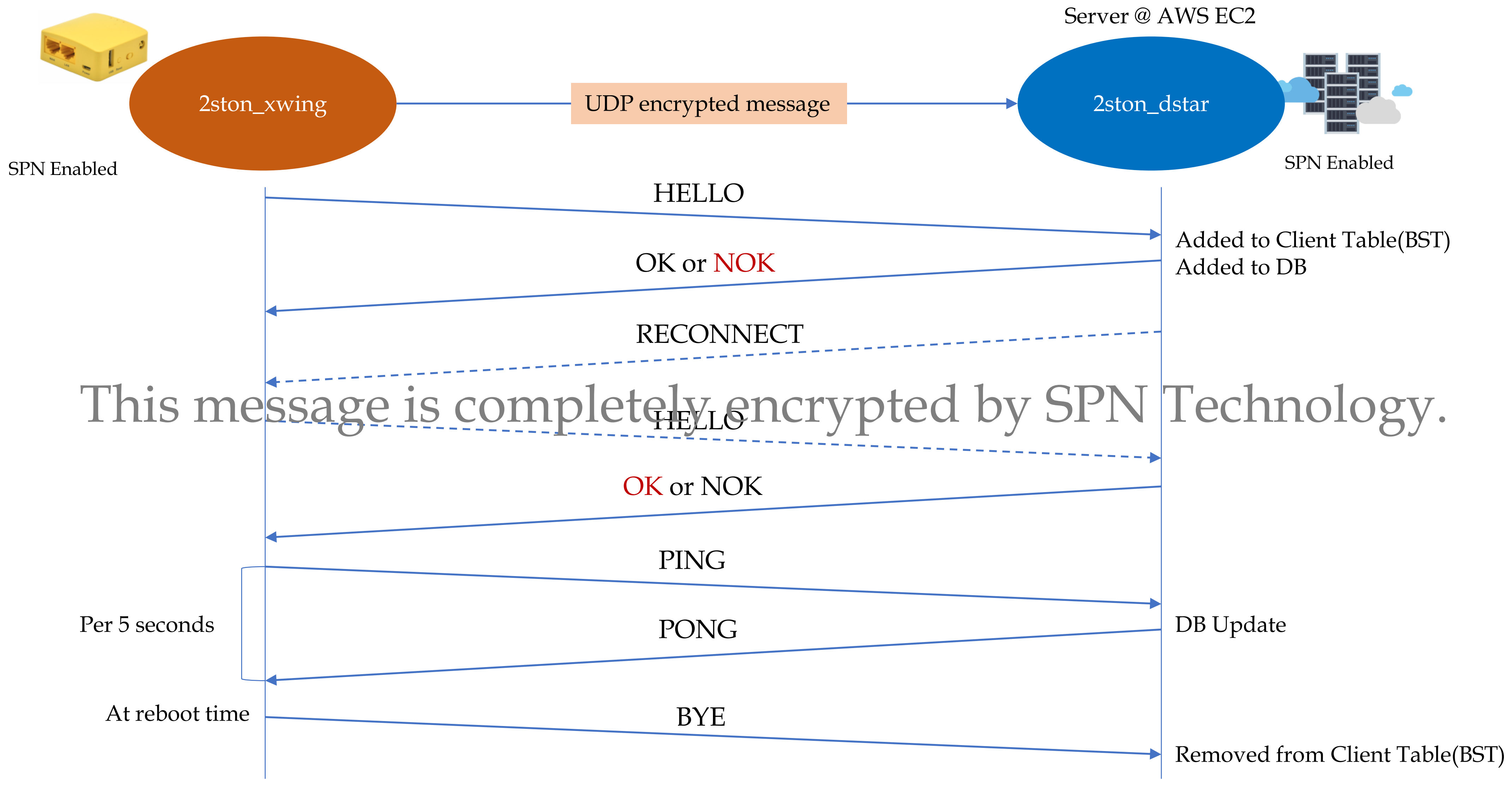
3. SPNBox Star Console Protocol(1)



```
const (
    HELLO                     = iota   // 0 - register
    PING                               // 1 - send spn info periodically
    PONG                               // 2
    OK                                 // 3
    NOK                                // 4
    BYE                                // 5 - deregister
    RECONNECT                          // 6
    SND_SPN_INFO                       // 7 - urgent send by user
    ASK_SPN_INFO                       // 8
    ANS_SPN_INFO                       // 9
    SND_USER_CMD                       // 10 - user cmd : webserver -> swalker
    ASK_USER_CMD                       // 11 - user cmd : xwing -> swalker
    ANS_USER_CMD                       // 12 - user cmd : swalker -> xwing
    OK_NEWIP                           // 13
    CANCEL_IP                          // 14
)
```

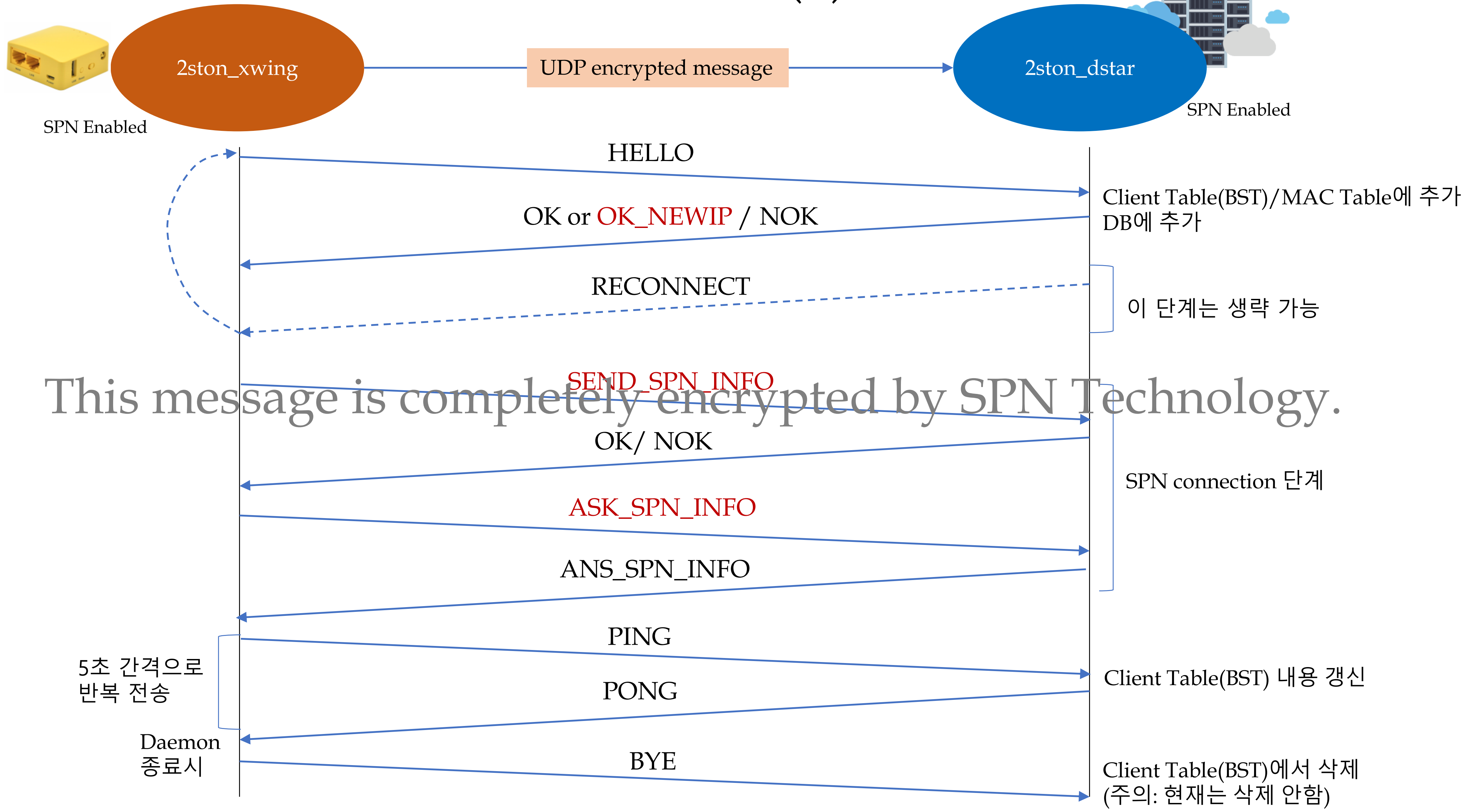
JEDI(Just Embedded Device Interface) Protocol Commands

3. SPNBox Star Console Protocol(2)



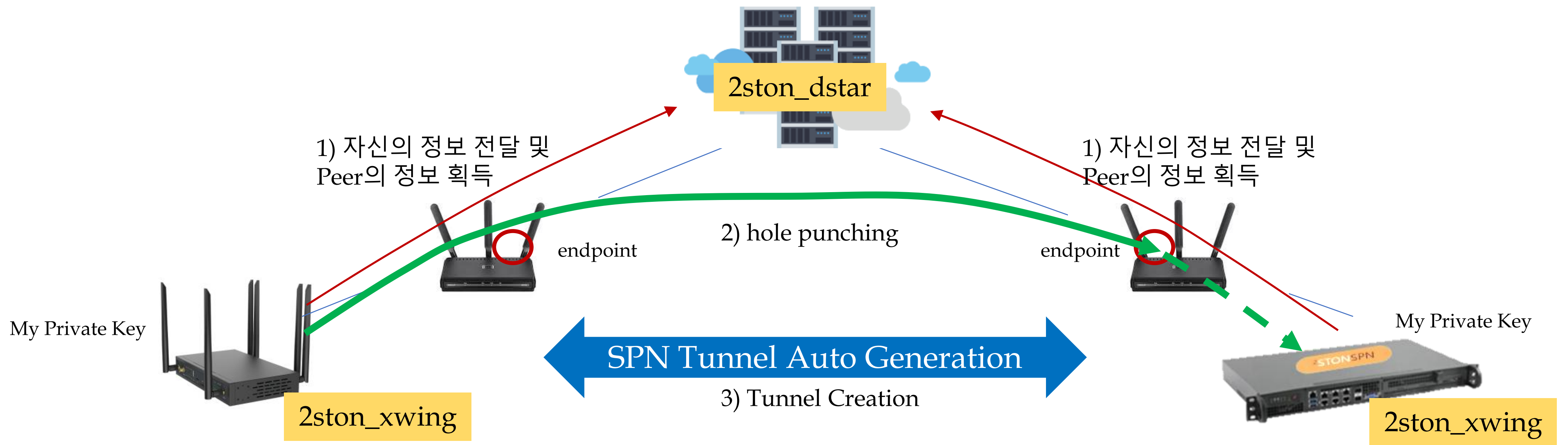
JEDI Protocol

3. SPNBox Star Console Protocol(3)



DeathStar Daemon

4. DeathStar Daemon(1) – Auto Connection(1)



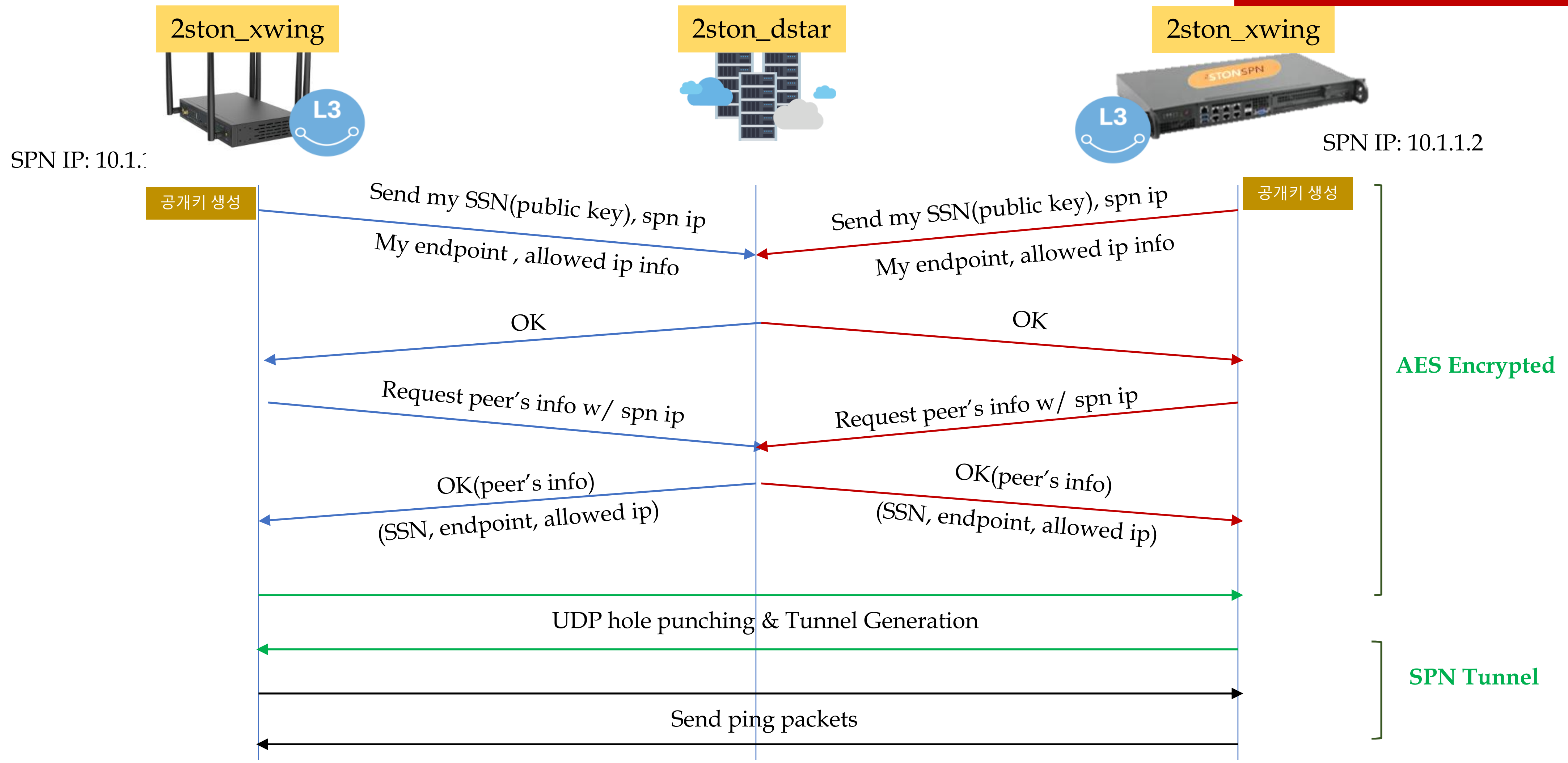
Peer's Public key(= SSN)	Peer's Public key(= SSN)
Peer's SPN IP Address	Peer's SPN IP Address
Peer's Endpoint(RealIP:Port)	Peer's Endpoint(RealIP:Port)
Peer's Allowed Networks	Peer's Allowed Networks

1) Peer's information 획득
2) UDP Hole Punching
3) Automatic Tunnel Creation

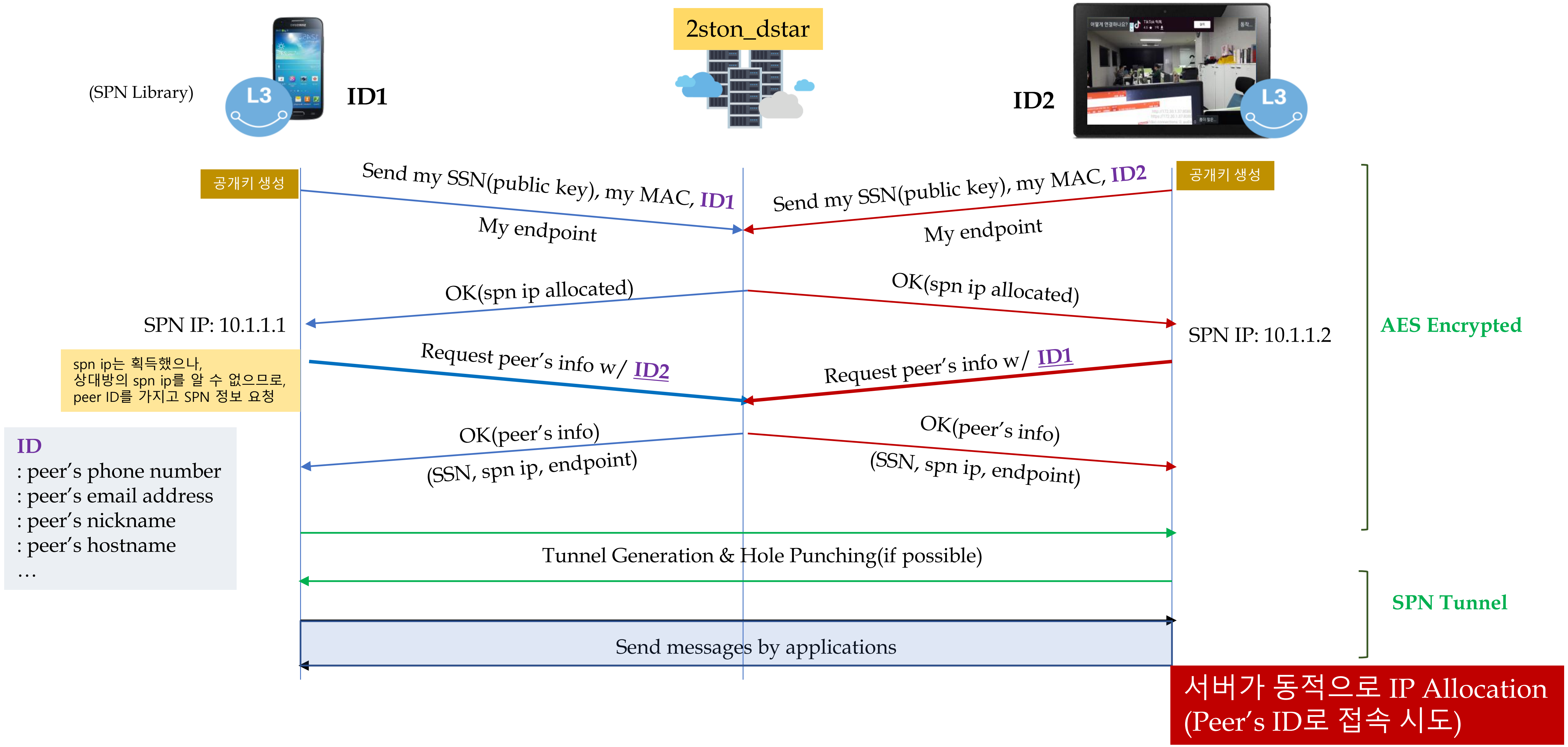
Full ConeNAT Only

4. DeathStar Daemon(1) – Auto Connection(2)

Client가 공개키를 생성하는 방식


2ston_xwing
2ston_dstar
2ston_xwing
L3
L3
SPN IP: 10.1.1
SPN IP: 10.1.1.2
공개키 생성
공개키 생성
Send my SSN(public key), spn ip
My endpoint , allowed ip info
Send my SSN(public key), spn ip
My endpoint, allowed ip info
OK
OK
Request peer's info w/ spn ip
Request peer's info w/ spn ip
OK(peer's info)
(SSN, endpoint, allowed ip)
OK(peer's info)
(SSN, endpoint, allowed ip)
UDP hole punching & Tunnel Generation
Send ping packets
AES Encrypted
SPN Tunnel

4. DeathStar Daemon(1) – Auto Connection(3)

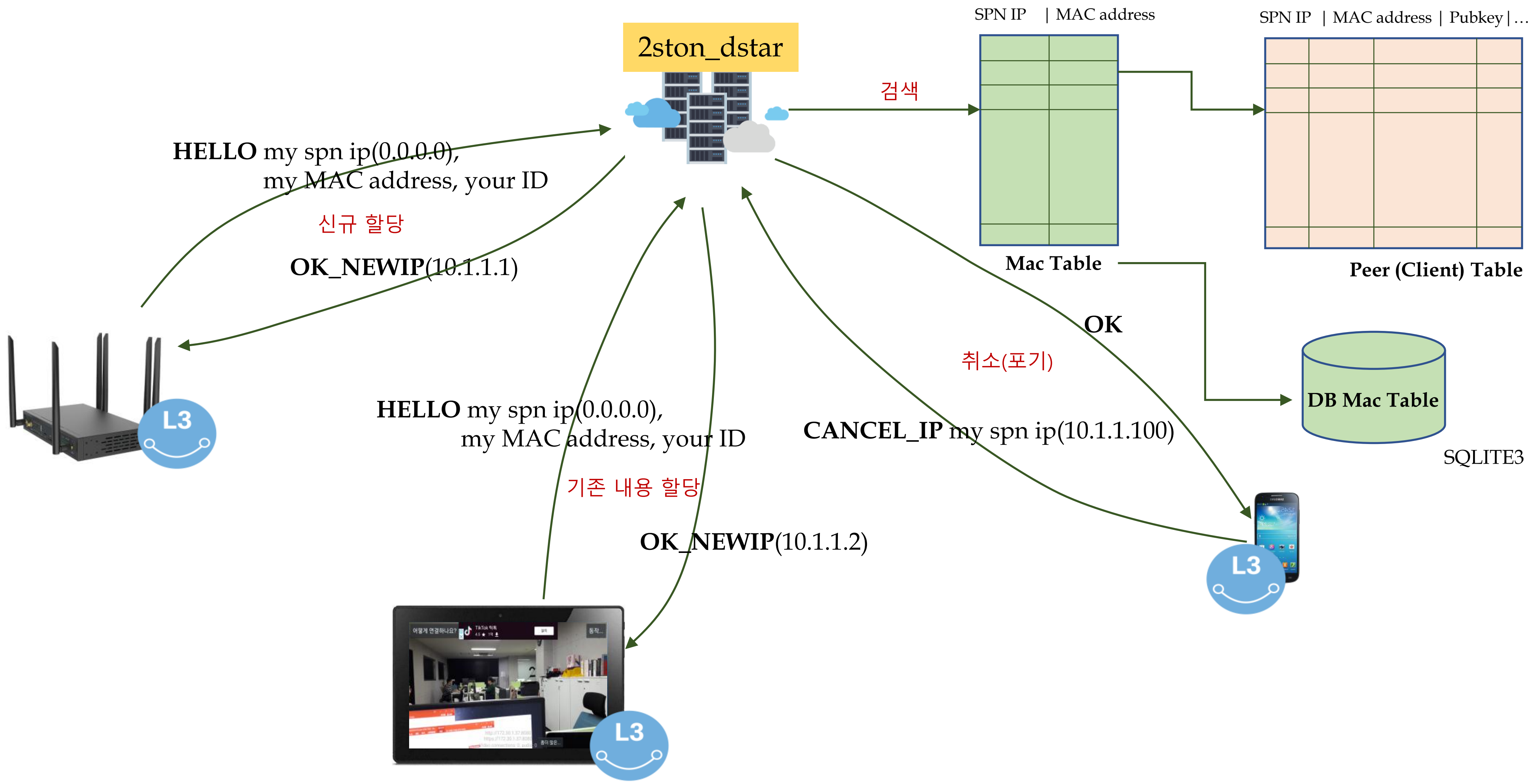


spn ip는 획득했으나,
상대방의 spn ip를 알 수 없으므로,
peer ID를 가지고 SPN 정보 요청

ID
: peer's phone number
: peer's email address
: peer's nickname
: peer's hostname
…

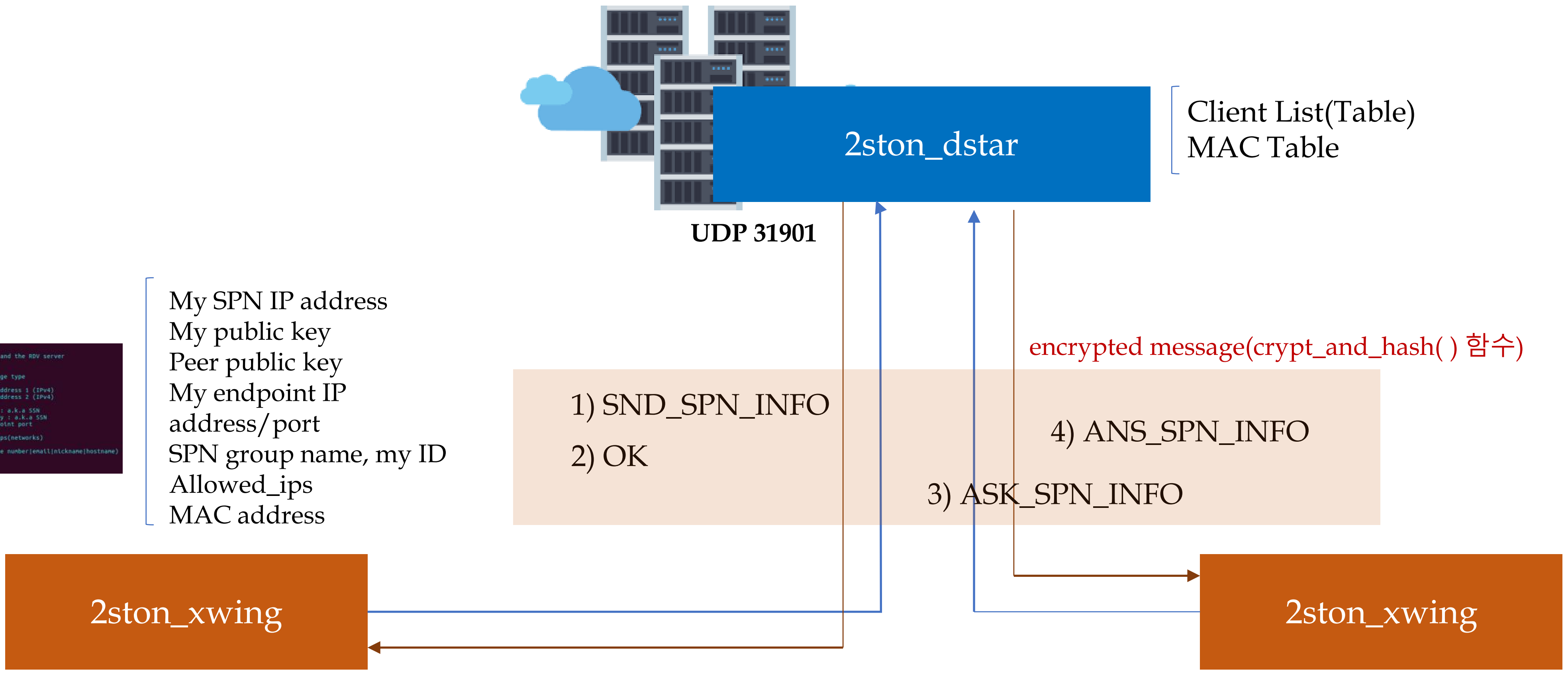
서버가 동적으로 IP Allocation
(Peer's ID로 접속 시도)

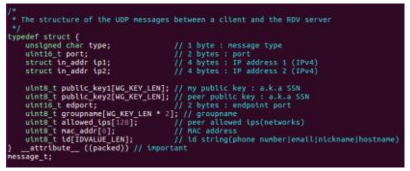
4. DeathStar Daemon(1) – Auto Connection(4)


2ston_dstar
검색
SPN IP | MAC address
SPN IP | MAC address | Pubkey | …
Mac Table
Peer (Client) Table
DB Mac Table
SQLITE3
HELLO my spn ip(0.0.0.0), my MAC address, your ID
신규 할당
OK_NEWIP(10.1.1.1)
HELLO my spn ip(0.0.0.0), my MAC address, your ID
기존 내용 할당
OK_NEWIP(10.1.1.2)
OK
취소(포기)
CANCEL_IP my spn ip(10.1.1.100)
L3
L3
L3

DHCP 처럼, 2ston_server가 SPN IP 주소를 자동으로 할당 & 관리해 줍니다.

4. DeathStar Daemon(2) – Communications(1)




```
/*
 * The structure of the UDP messages between a client and the RDV server
 */
typedef struct {
    unsigned char type;                 // 1 byte : message type
    uint16_t port;                      // 2 bytes : port
    struct in_addr ip1;                 // 4 bytes : IP address 1 (IPv4)
    struct in_addr ip2;                 // 4 bytes : IP address 2 (IPv4)

    uint8_t public_key1[WG_KEY_LEN]; // my public key : a.k.a SSN
    uint8_t public_key2[WG_KEY_LEN]; // peer public key : a.k.a SSN
    uint16_t edport;                    // 2 bytes : endpoint port
    uint8_t groupname[WG_KEY_LEN * 2]; // groupname
    uint8_t allowed_ips[128];           // peer allowed ips(networks)
    uint8_t mac_addr[6];                // MAC address
    uint8_t id[IDVALUE_LEN];            // id string(phone number|email|nickname|hostname)
}  __attribute__ ((packed)) // important
message_t;
```

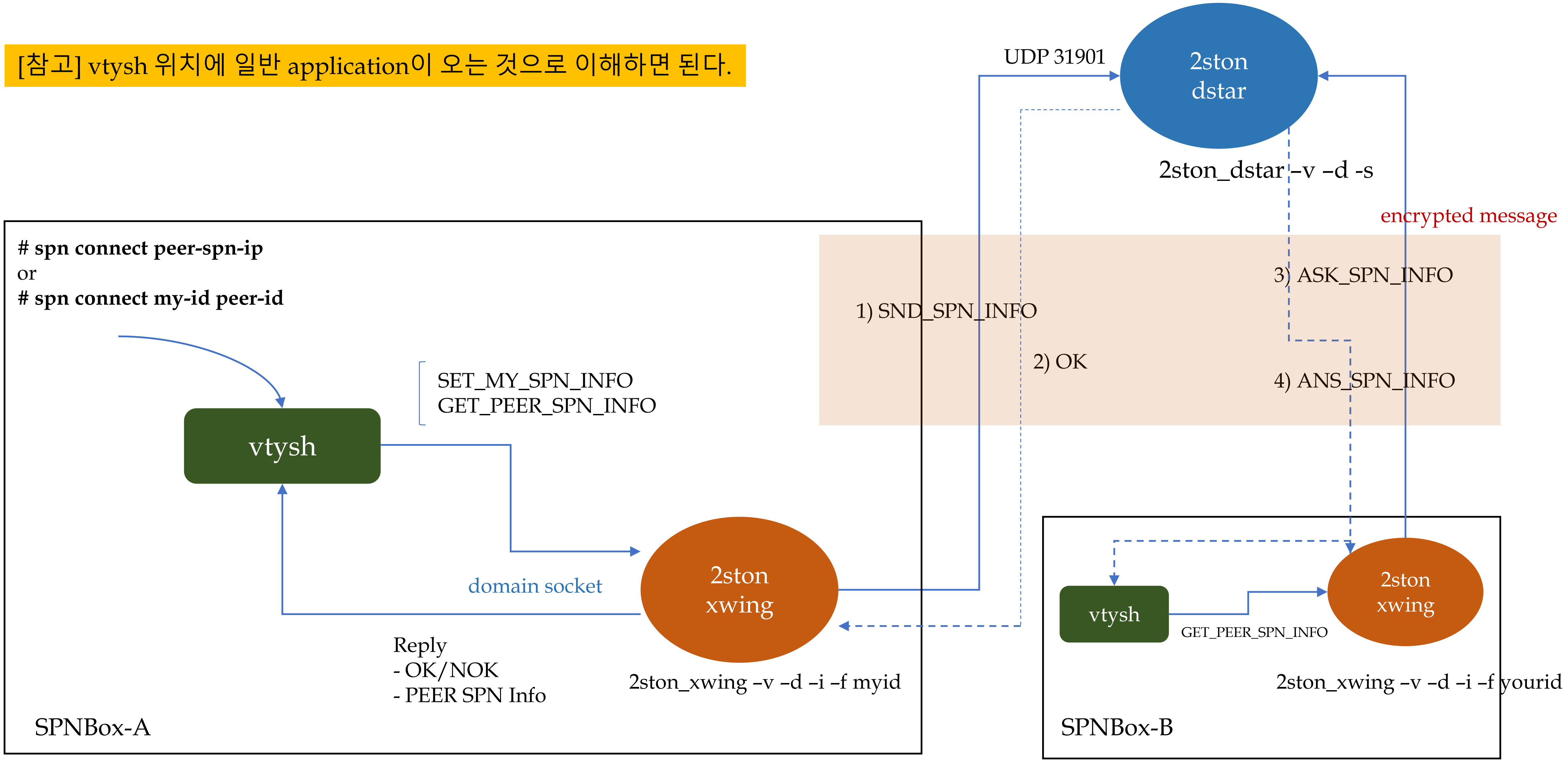
My SPN IP address
My public key
Peer public key
My endpoint IP address/port
SPN group name, my ID
Allowed_ips
MAC address

<u>명령 type 값</u>

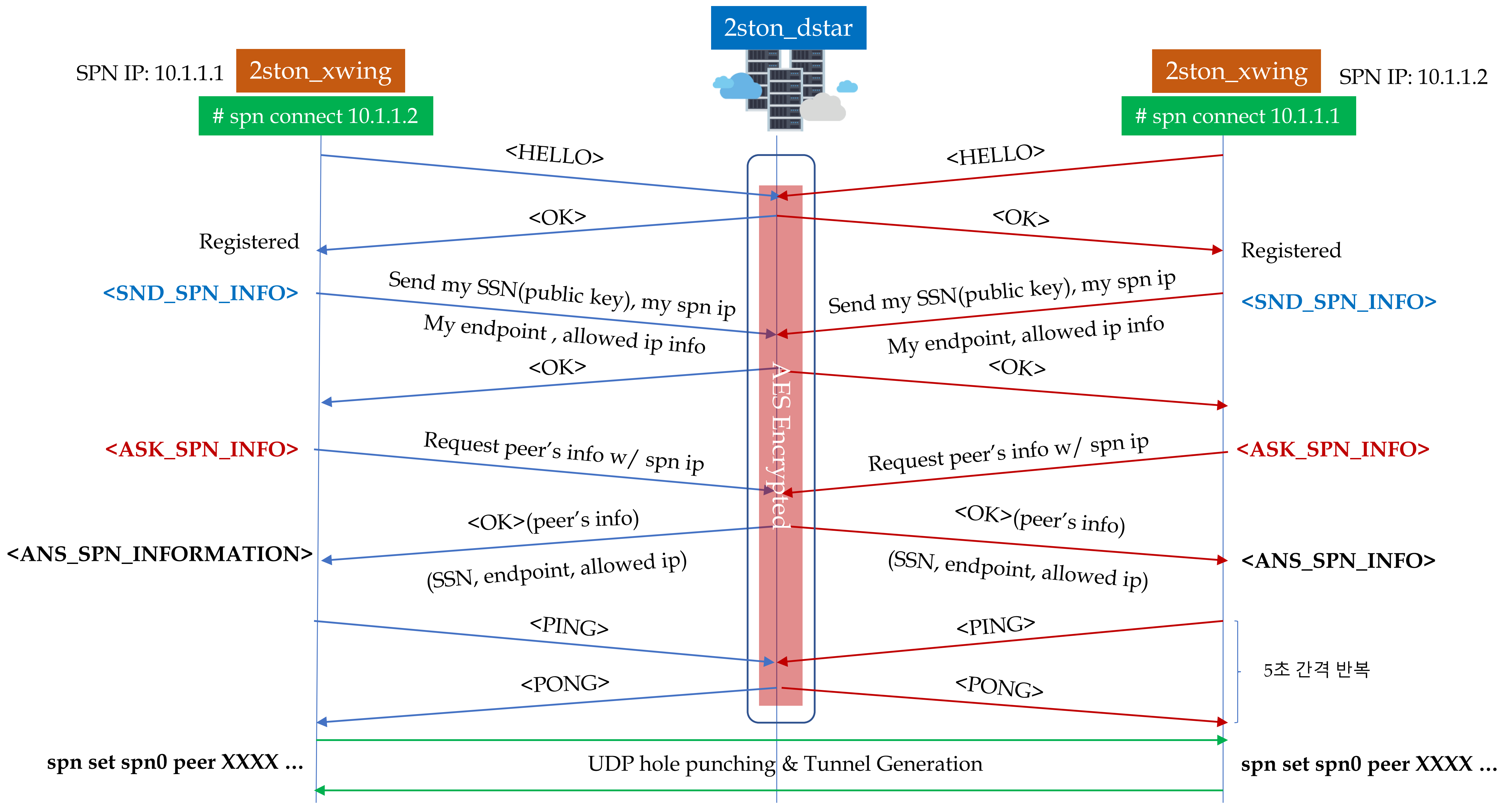
- ✓ HELLO ⇔ OK/NOK or OK_NEWIP/NOK : registration 시 or IP 할당 후 registration 시
- ✓ PING ⇔ PONG : 상태 정보 유지(갱신) 시
- ✓ SND_SPN_INFO ⇔ OK/NOK : my SPN 정보 등록 시
- ✓ ASK_SPN_INFO ⇔ ANS_SPN_INFORMATION : peer SPN 정보 요청 시
- ✓ BYE ⇔ [OK/NOK] : registration 해제 시(종료시)

4. DeathStar Daemon(2) – Communications(2)

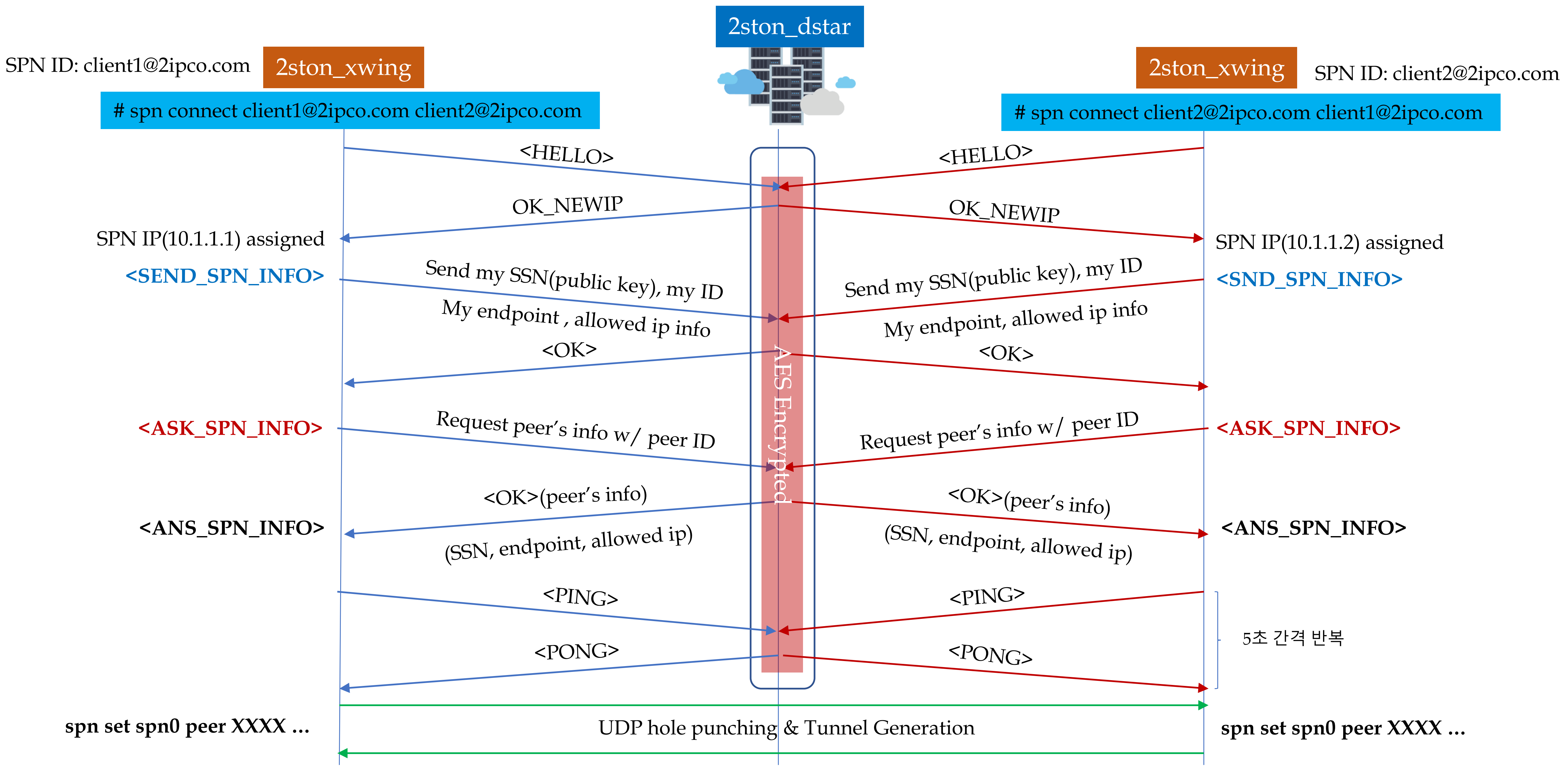
[참고] vtysh 위치에 일반 application이 오는 것으로 이해하면 된다.



4. DeathStar Daemon(3) – Protocol(1)

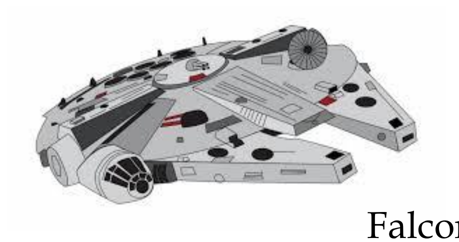


4. DeathStar Daemon(3) – Protocol(2)


2ston_dstar
SPN ID: client1@2ipco.com
2ston_xwing
# spn connect client1@2ipco.com client2@2ipco.com
2ston_xwing
SPN ID: client2@2ipco.com
# spn connect client2@2ipco.com client1@2ipco.com
<HELLO>
<HELLO>
OK_NEWIP
OK_NEWIP
SPN IP(10.1.1.1) assigned
SPN IP(10.1.1.2) assigned
<SEND_SPN_INFO>
Send my SSN(public key), my ID
My endpoint , allowed ip info
<SND_SPN_INFO>
Send my SSN(public key), my ID
My endpoint, allowed ip info
<OK>
<OK>
AES Encrypted
<ASK_SPN_INFO>
Request peer's info w/ peer ID
<ASK_SPN_INFO>
Request peer's info w/ peer ID
<ANS_SPN_INFO>
<OK>(peer's info)
(SSN, endpoint, allowed ip)
<ANS_SPN_INFO>
<OK>(peer's info)
(SSN, endpoint, allowed ip)
<PING>
<PING>
<PONG>
<PONG>
5초 간격 반복
spn set spn0 peer XXXX …
UDP hole punching & Tunnel Generation
spn set spn0 peer XXXX …

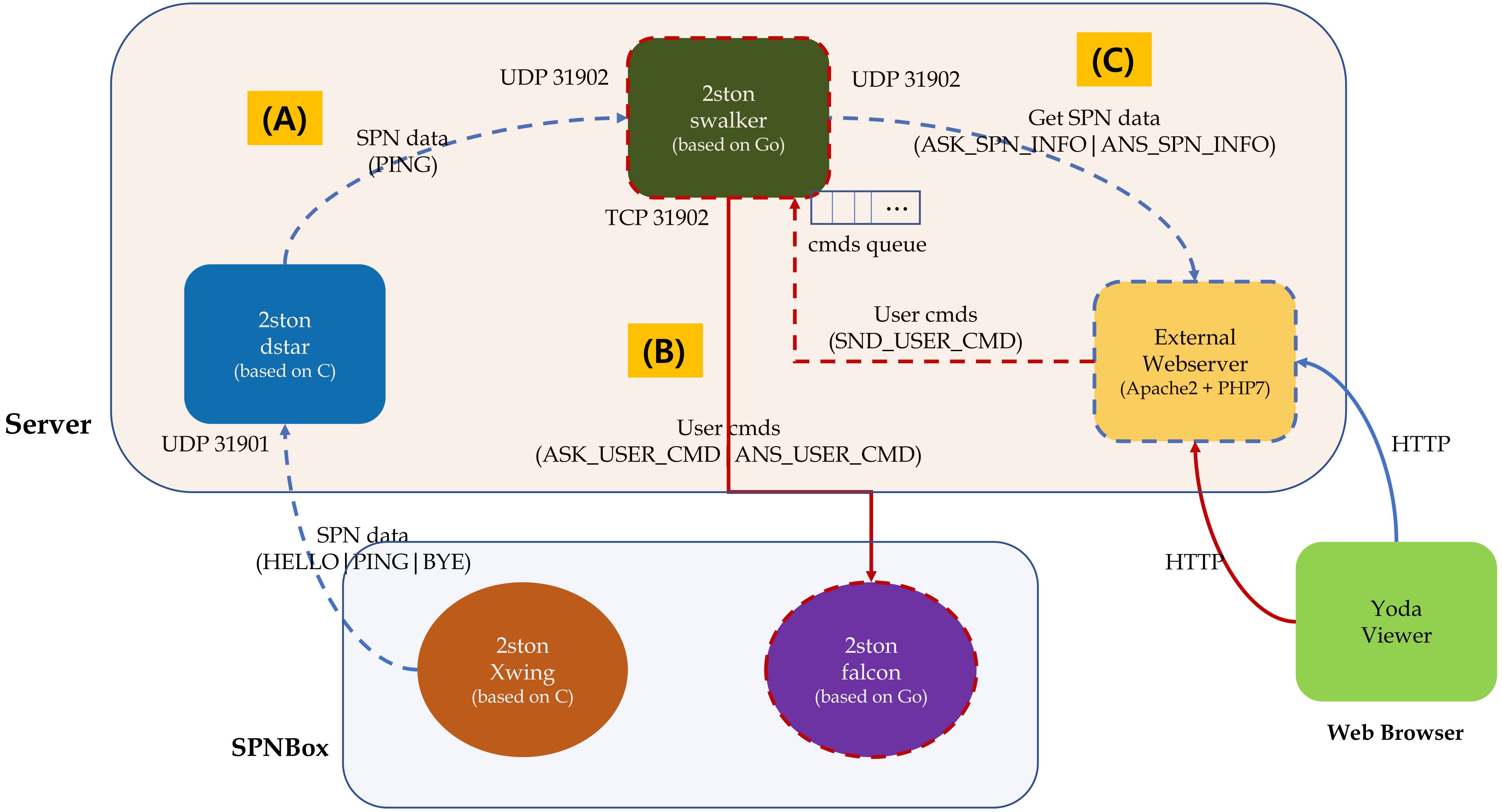
SkyWalker Daemon

Go

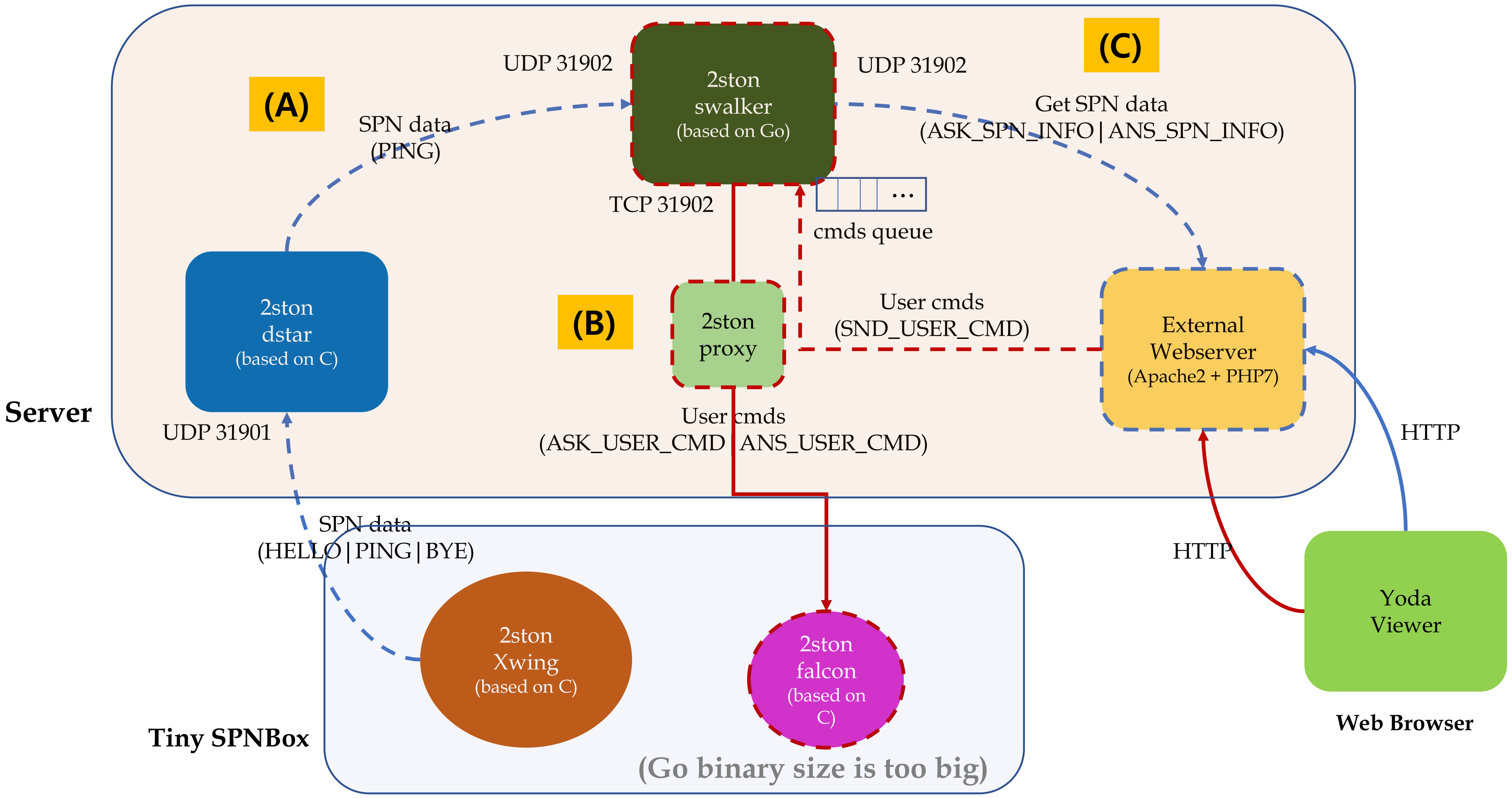

Falcon

SkyWalker

5. SkyWalker Daemon(1) – Architecture(1)



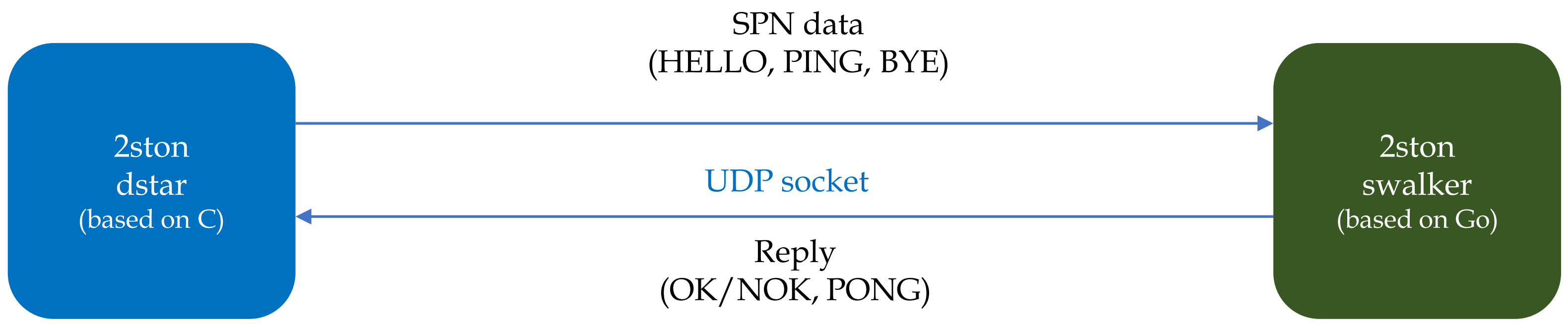
5. SkyWalker Daemon(1) – Architecture(2)



(A)
(B)
(C)
2ston swalker (based on Go)
UDP 31902
UDP 31902
SPN data (PING)
Get SPN data (ASK_SPN_INFO | ANS_SPN_INFO)
TCP 31902
cmds queue
…
2ston dstar (based on C)
UDP 31901
2ston proxy
User cmds (SND_USER_CMD)
External Webserver (Apache2 + PHP7)
User cmds (ASK_USER_CMD | ANS_USER_CMD)
Server
HTTP
HTTP
SPN data (HELLO | PING | BYE)
2ston Xwing (based on C)
2ston falcon (based on C)
Yoda Viewer
Web Browser
Tiny SPNBox
(Go binary size is too big)

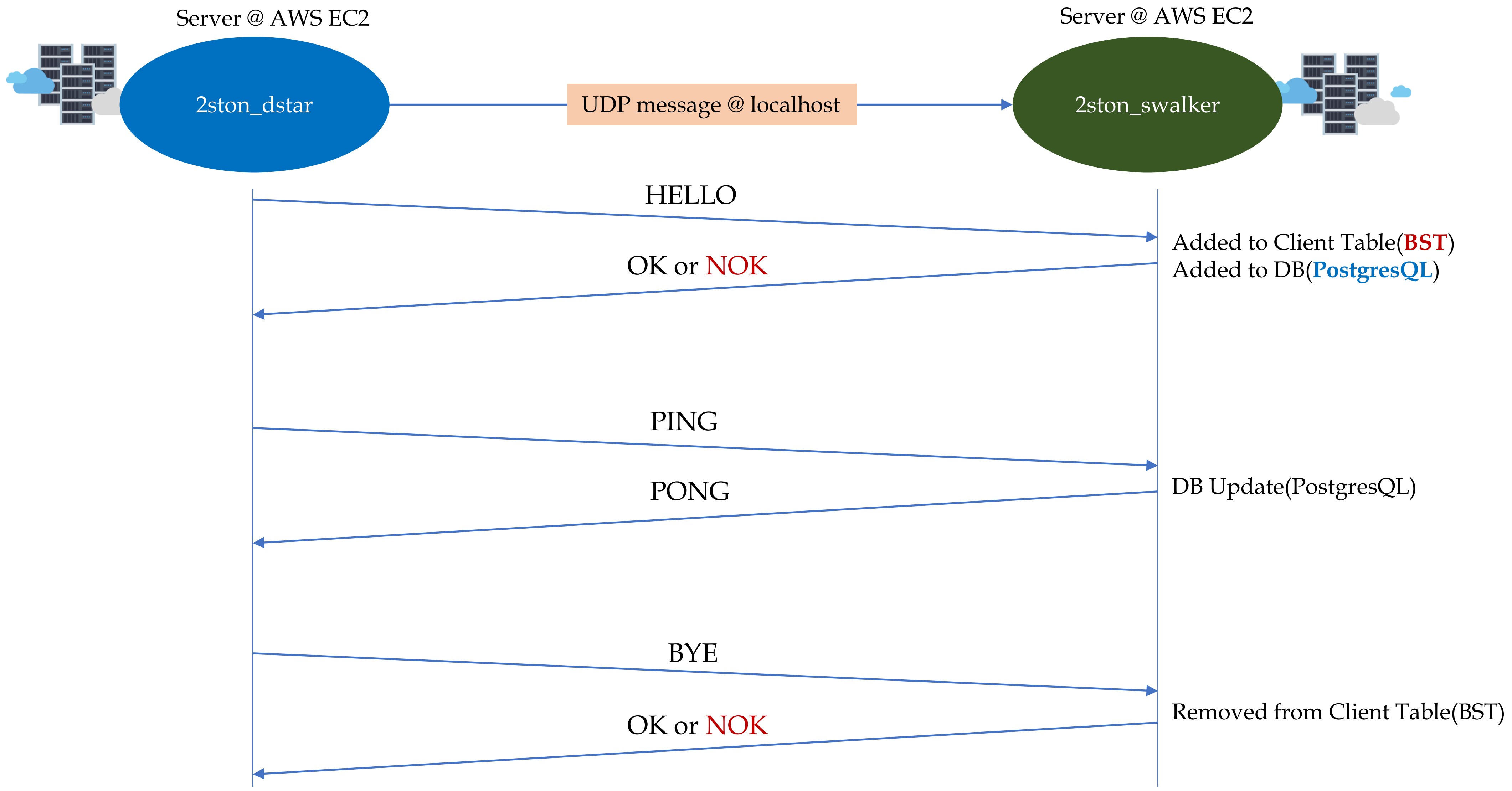
5. SkyWalker Daemon(2) – DSTAR interface(1)

(A)



Client(SPNBox) 2ston_xwing으로 부터 전달 받은 SPNBox 상태 정보를 2ston_swalker에게 그대로 넘긴다.

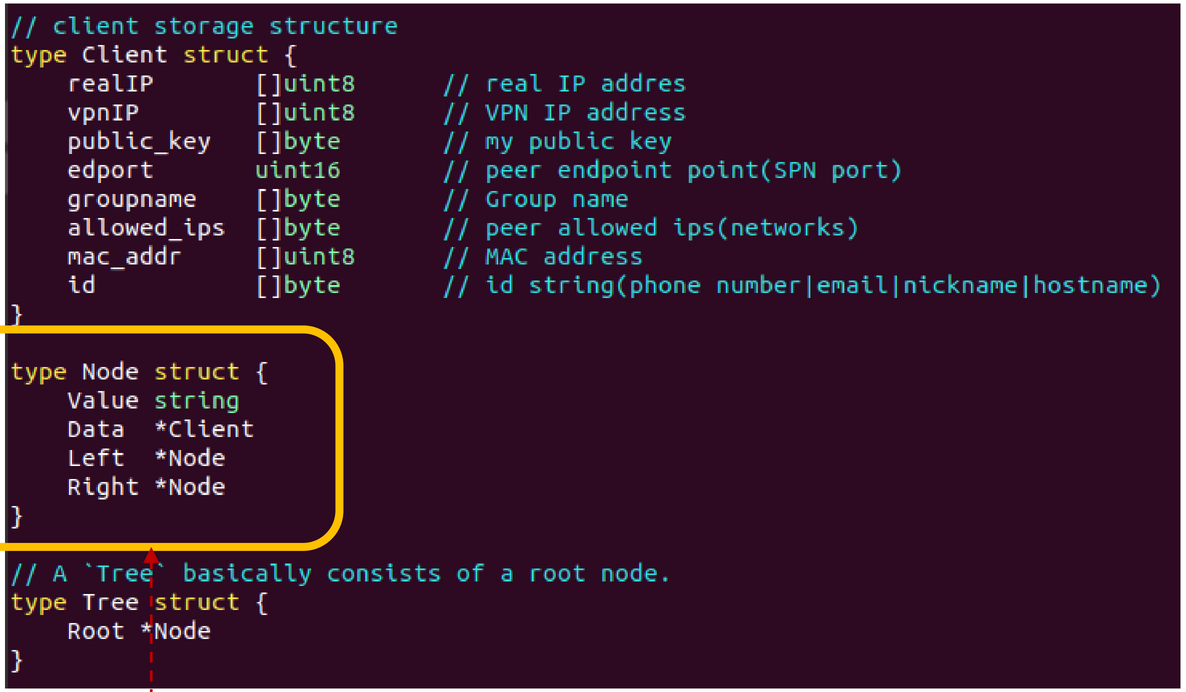
5. SkyWalker Daemon(2) – DSTAR interface(2)



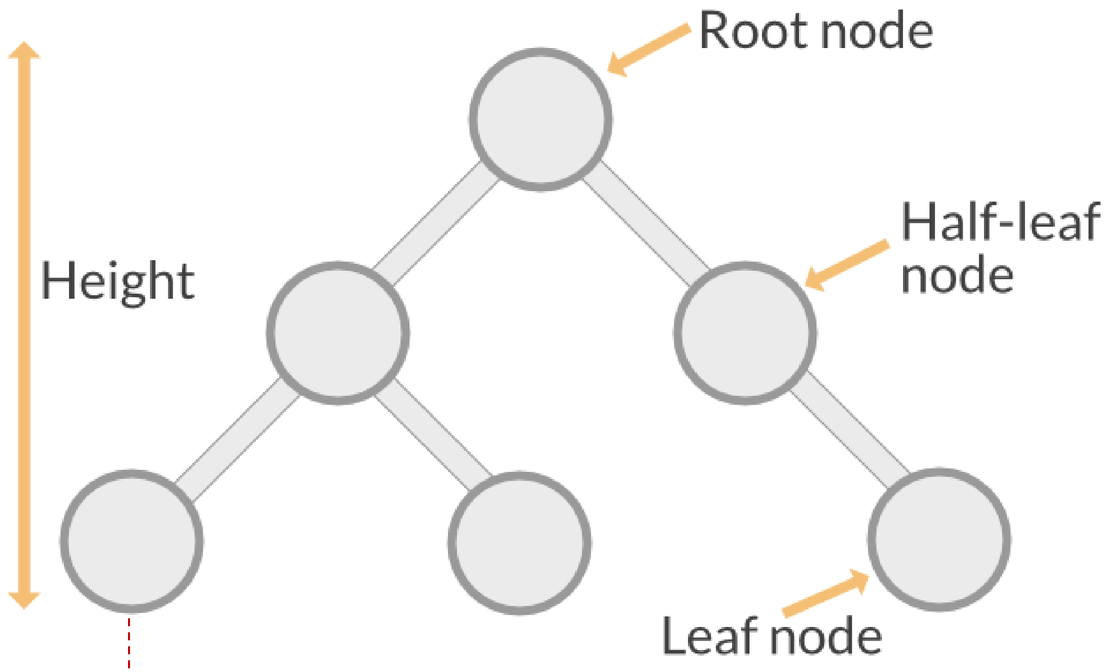
5. SkyWalker Daemon(2) – DSTAR interface(3)

Binary Search Tree

- Clients(SPNBoxes) 상태 정보 저장



```
// client storage structure
type Client struct {
    realIP        []uint8      // real IP addres
    vpnIP         []uint8      // VPN IP address
    public_key    []byte       // my public key
    edport        uint16       // peer endpoint point(SPN port)
    groupname     []byte       // Group name
    allowed_ips   []byte       // peer allowed ips(networks)
    mac_addr      []uint8      // MAC address
    id            []byte       // id string(phone number|email|nickname|hostname)
}

type Node struct {
    Value string
    Data  *Client
    Left  *Node
    Right *Node
}

// A `Tree` basically consists of a root node.
type Tree struct {
    Root *Node
}
```



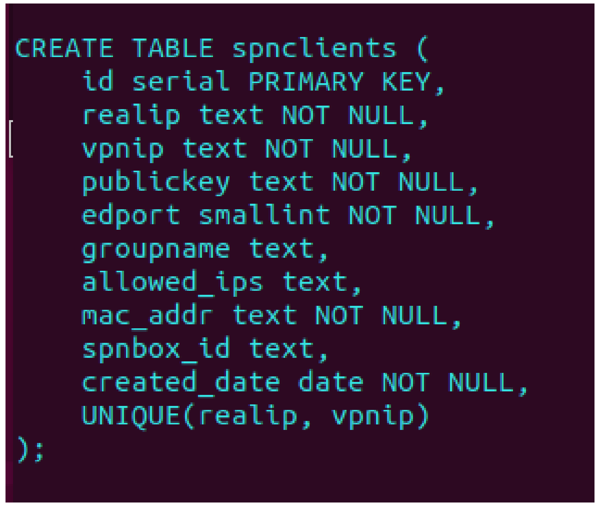
Binary Search Tree

- Value(검색 key 값): vpnIP string
- Data(실제 data) : Client struct

5. SkyWalker Daemon(2) – DSTAR interface(4)

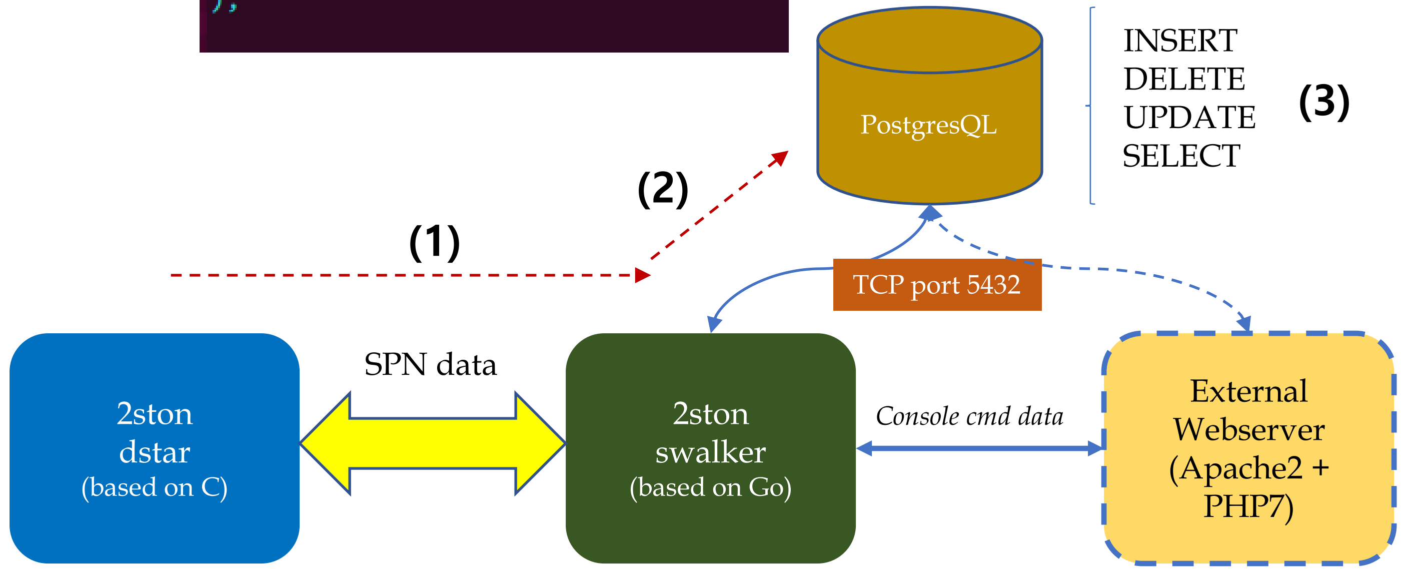
PostgresQL DBMS

- Clients(SPNBoxes) 상태 정보 저장

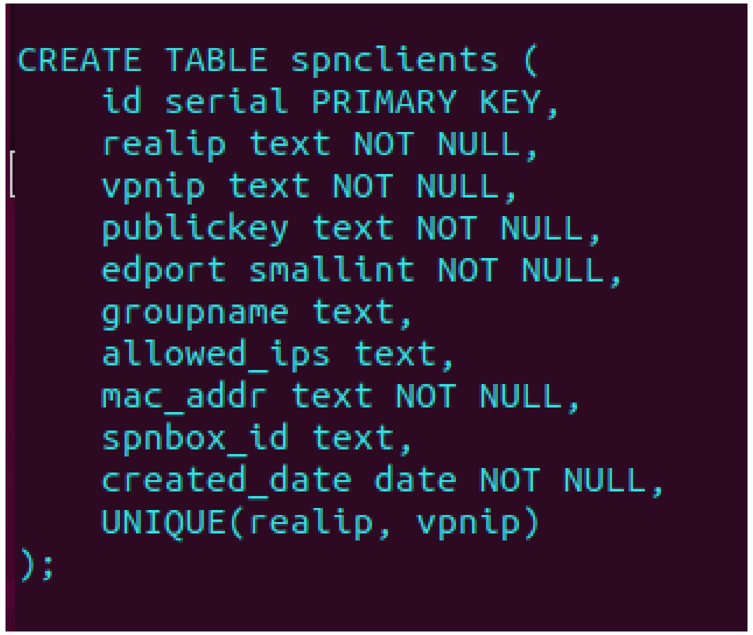


```
CREATE TABLE spnclients (
    id serial PRIMARY KEY,
    realip text NOT NULL,
    vpnip text NOT NULL,
    publickey text NOT NULL,
    edport smallint NOT NULL,
    groupname text,
    allowed_ips text,
    mac_addr text NOT NULL,
    spnbox_id text,
    created_date date NOT NULL,
    UNIQUE(realip, vpnip)
);
```

spnclients PostgresQL DB table

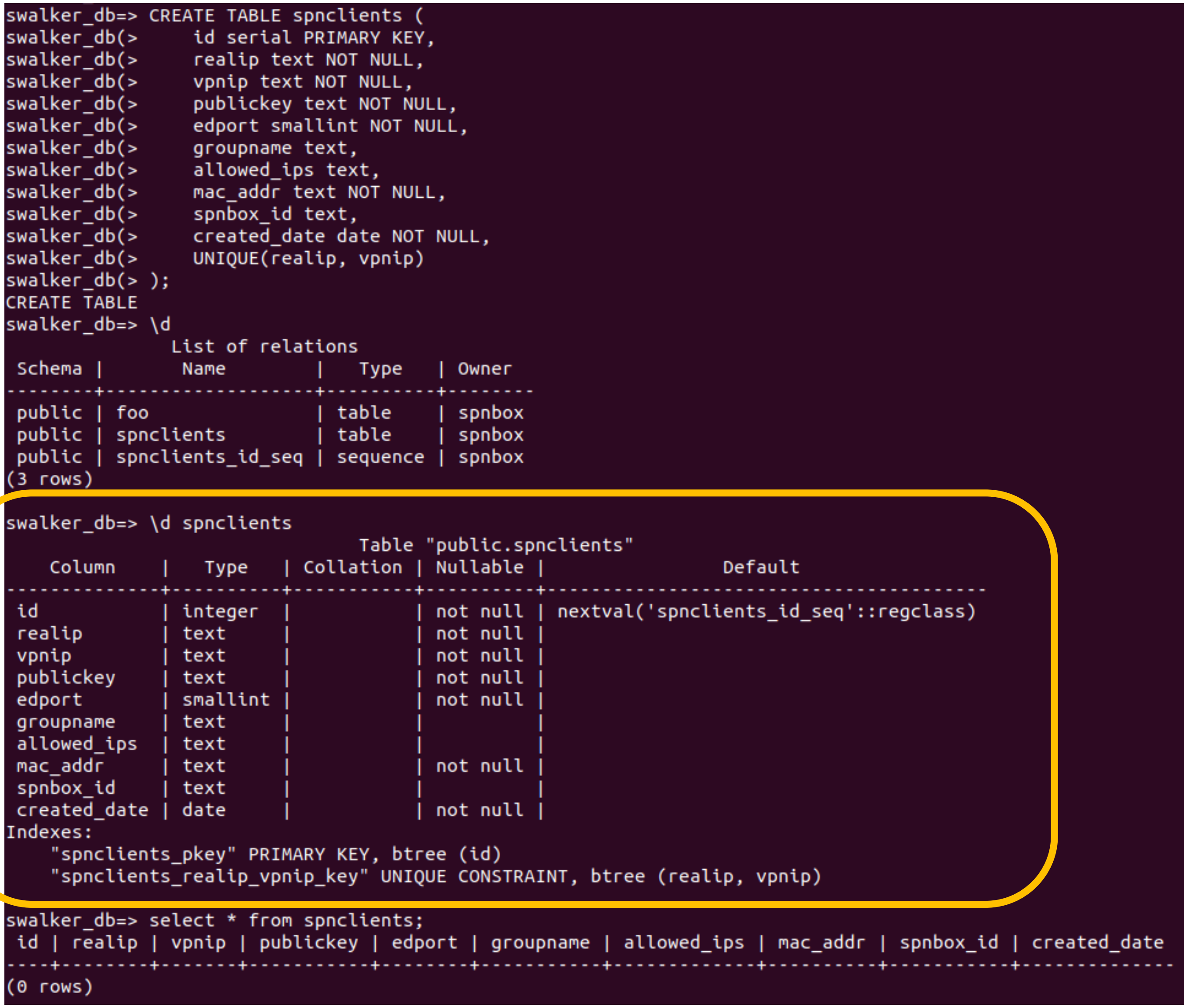


5. SkyWalker Daemon(3) – PostgresQL DBMS(1)



```
CREATE TABLE spnclients (
    id serial PRIMARY KEY,
    realip text NOT NULL,
    vpnip text NOT NULL,
    publickey text NOT NULL,
    edport smallint NOT NULL,
    groupname text,
    allowed_ips text,
    mac_addr text NOT NULL,
    spnbox_id text,
    created_date date NOT NULL,
    UNIQUE(realip, vpnip)
);
```

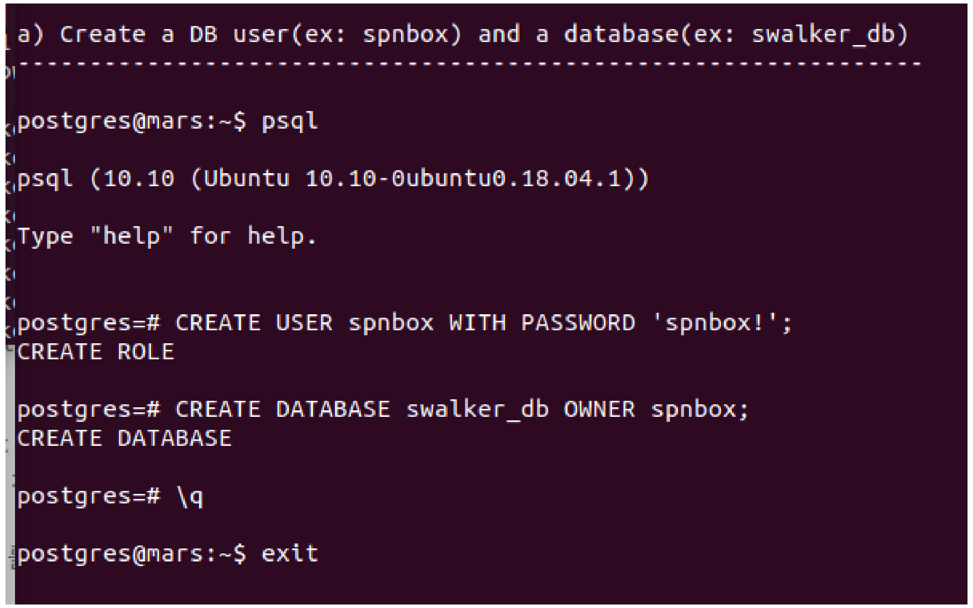
spnclients PostgresQL DB table



```
swalker_db=> CREATE TABLE spnclients (
swalker_db(>     id serial PRIMARY KEY,
swalker_db(>     realip text NOT NULL,
swalker_db(>     vpnip text NOT NULL,
swalker_db(>     publickey text NOT NULL,
swalker_db(>     edport smallint NOT NULL,
swalker_db(>     groupname text,
swalker_db(>     allowed_ips text,
swalker_db(>     mac_addr text NOT NULL,
swalker_db(>     spnbox_id text,
swalker_db(>     created_date date NOT NULL,
swalker_db(>     UNIQUE(realip, vpnip)
swalker_db(> );
CREATE TABLE
swalker_db=> \d
               List of relations
 Schema |        Name        |   Type   | Owner
--------+--------------------+----------+--------
 public | foo                | table    | spnbox
 public | spnclients         | table    | spnbox
 public | spnclients_id_seq  | sequence | spnbox
(3 rows)

swalker_db=> \d spnclients
                                   Table "public.spnclients"
    Column    |   Type   | Collation | Nullable |                Default
--------------+----------+-----------+----------+----------------------------------------
 id           | integer  |           | not null | nextval('spnclients_id_seq'::regclass)
 realip       | text     |           | not null |
 vpnip        | text     |           | not null |
 publickey    | text     |           | not null |
 edport       | smallint |           | not null |
 groupname    | text     |           |          |
 allowed_ips  | text     |           |          |
 mac_addr     | text     |           | not null |
 spnbox_id    | text     |           |          |
 created_date | date     |           | not null |
Indexes:
    "spnclients_pkey" PRIMARY KEY, btree (id)
    "spnclients_realip_vpnip_key" UNIQUE CONSTRAINT, btree (realip, vpnip)

swalker_db=> select * from spnclients;
 id | realip | vpnip | publickey | edport | groupname | allowed_ips | mac_addr | spnbox_id | created_date
----+--------+-------+-----------+--------+-----------+-------------+----------+-----------+--------------
(0 rows)
```

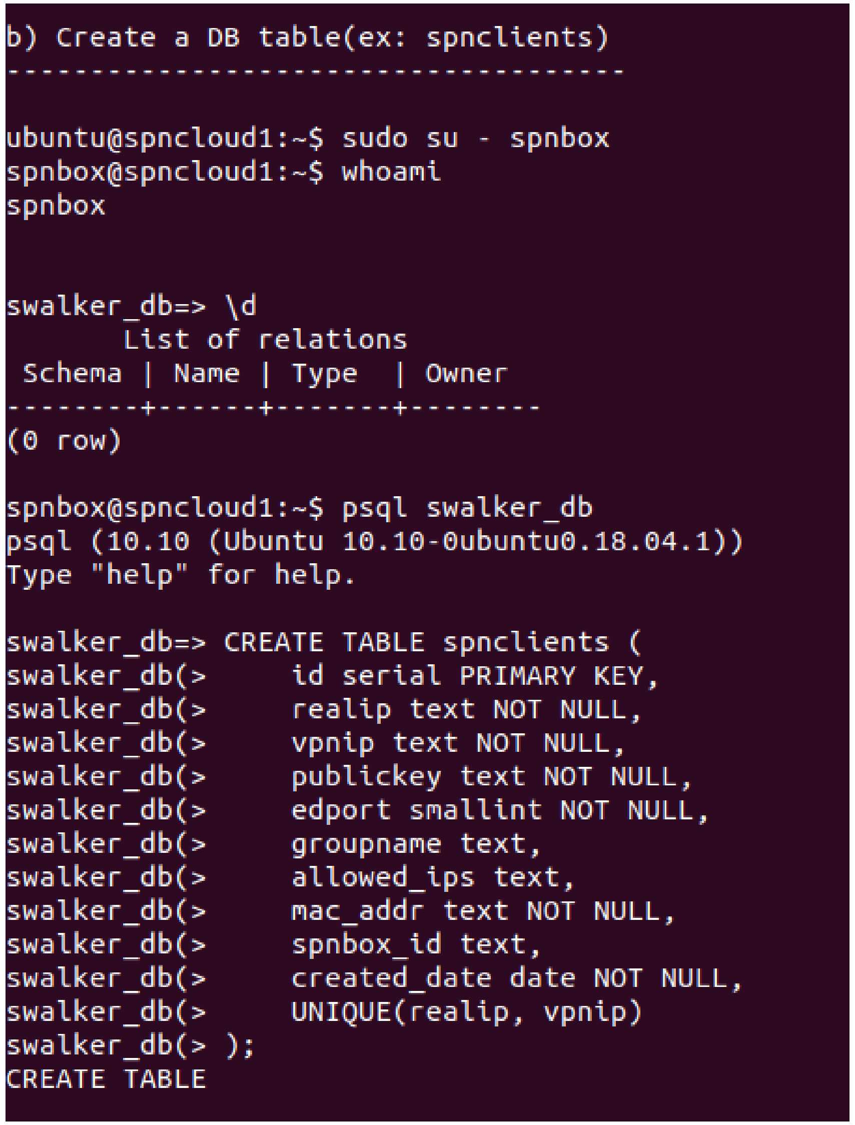
$ psql swalker_db

5. SkyWalker Daemon(3) – PostgresQL DBMS(2)



```
a) Create a DB user(ex: spnbox) and a database(ex: swalker_db)
---------------------------------------------------------------

postgres@mars:~$ psql

psql (10.10 (Ubuntu 10.10-0ubuntu0.18.04.1))

Type "help" for help.


postgres=# CREATE USER spnbox WITH PASSWORD 'spnbox!';
CREATE ROLE

postgres=# CREATE DATABASE swalker_db OWNER spnbox;
CREATE DATABASE

postgres=# \q

postgres@mars:~$ exit
```

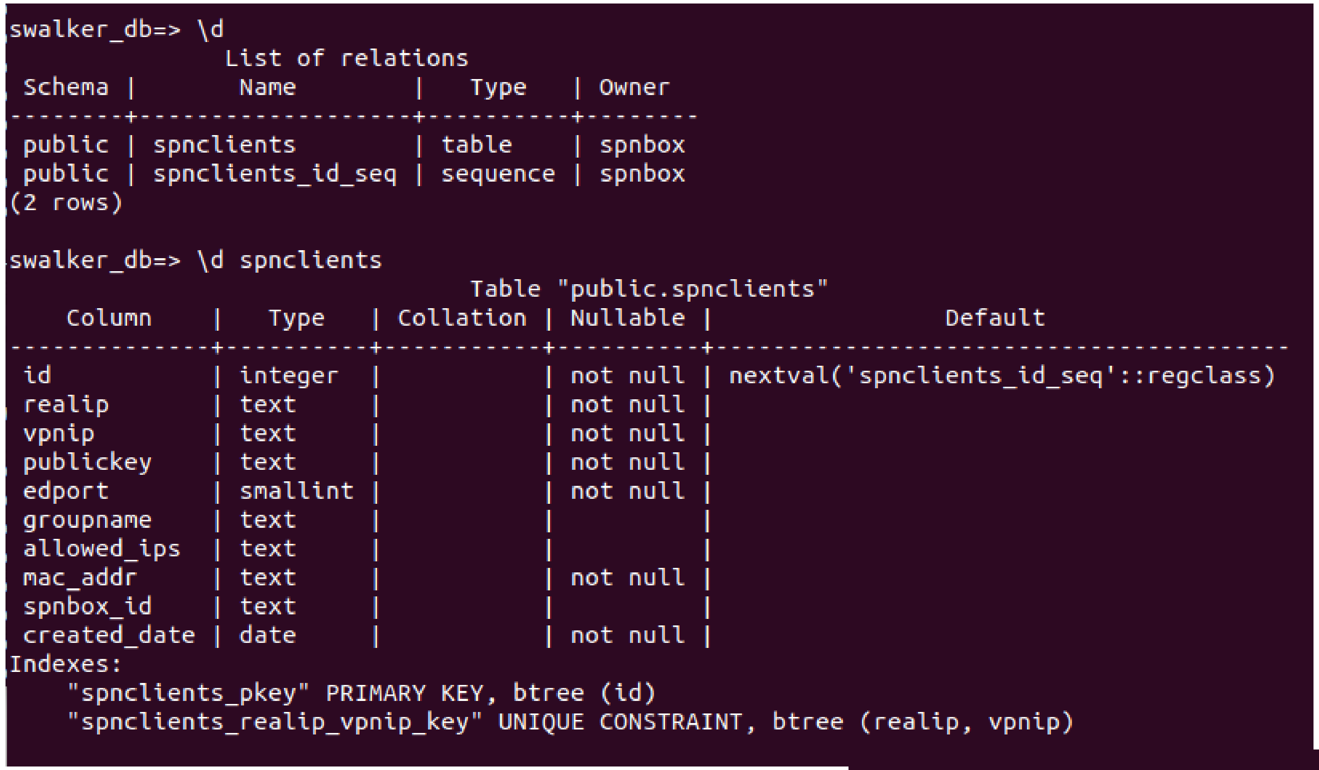
[1] PostgresQL DB user(spnbox) 추가 및 DB(swalker_db) 추가



```
b) Create a DB table(ex: spnclients)
-------------------------------------

ubuntu@spncloud1:~$ sudo su - spnbox
spnbox@spncloud1:~$ whoami
spnbox


swalker_db=> \d
       List of relations
 Schema | Name | Type  | Owner
--------+------+-------+--------
(0 row)

spnbox@spncloud1:~$ psql swalker_db
psql (10.10 (Ubuntu 10.10-0ubuntu0.18.04.1))
Type "help" for help.

swalker_db=> CREATE TABLE spnclients (
swalker_db(>     id serial PRIMARY KEY,
swalker_db(>     realip text NOT NULL,
swalker_db(>     vpnip text NOT NULL,
swalker_db(>     publickey text NOT NULL,
swalker_db(>     edport smallint NOT NULL,
swalker_db(>     groupname text,
swalker_db(>     allowed_ips text,
swalker_db(>     mac_addr text NOT NULL,
swalker_db(>     spnbox_id text,
swalker_db(>     created_date date NOT NULL,
swalker_db(>     UNIQUE(realip, vpnip)
swalker_db(> );
CREATE TABLE
```

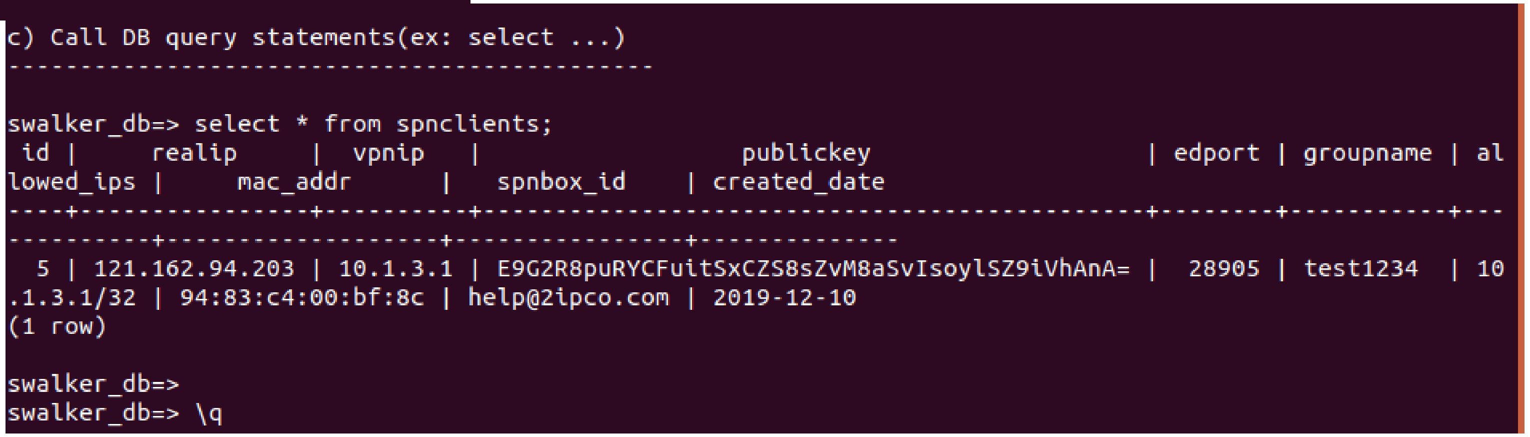
[2] PostgresQL DB Table(spnclients) 추가

5. SkyWalker Daemon(3) – PostgresQL DBMS(3)



```
swalker_db=> \d
               List of relations
 Schema |        Name         |   Type   | Owner
--------+---------------------+----------+--------
 public | spnclients          | table    | spnbox
 public | spnclients_id_seq   | sequence | spnbox
(2 rows)

swalker_db=> \d spnclients
                                 Table "public.spnclients"
   Column     |   Type   | Collation | Nullable |                Default
--------------+----------+-----------+----------+----------------------------------------
 id           | integer  |           | not null | nextval('spnclients_id_seq'::regclass)
 realip       | text     |           | not null |
 vpnip        | text     |           | not null |
 publickey    | text     |           | not null |
 edport       | smallint |           | not null |
 groupname    | text     |           |          |
 allowed_ips  | text     |           |          |
 mac_addr     | text     |           | not null |
 spnbox_id    | text     |           |          |
 created_date | date     |           | not null |
Indexes:
    "spnclients_pkey" PRIMARY KEY, btree (id)
    "spnclients_realip_vpnip_key" UNIQUE CONSTRAINT, btree (realip, vpnip)
```

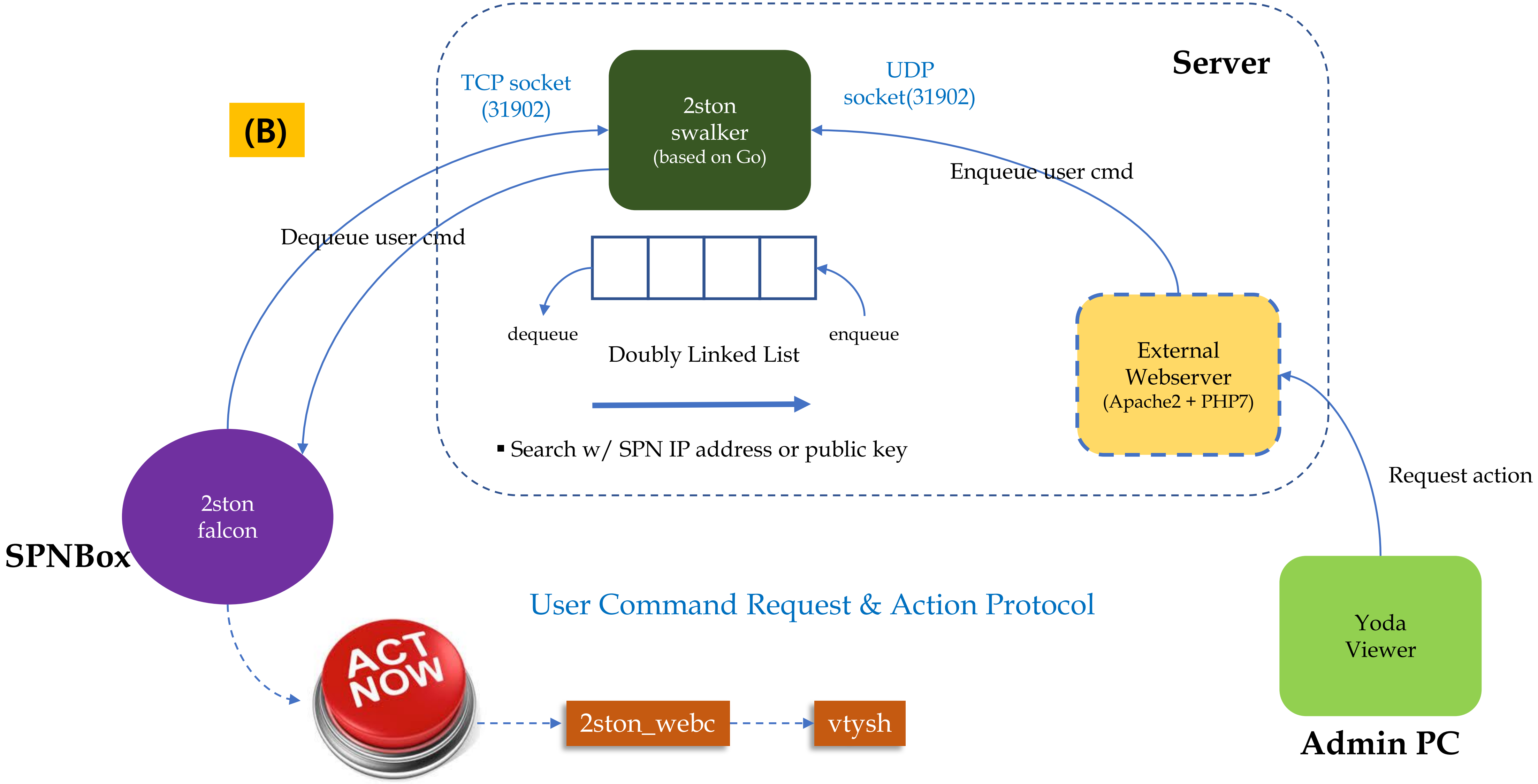
[3] PostgresQL DB Table(spnclients) 내용 확인



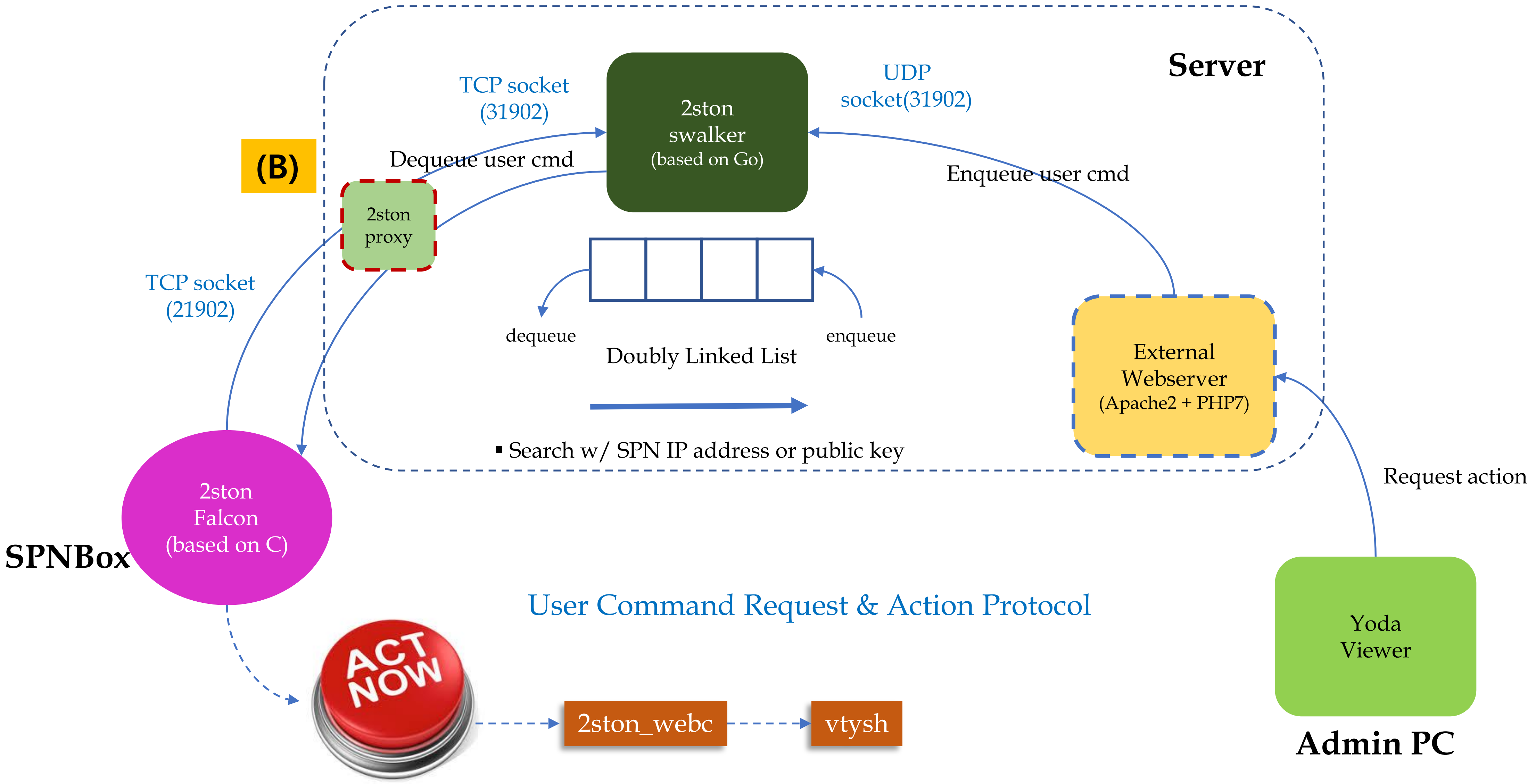
```
c) Call DB query statements(ex: select ...)
---------------------------------------------

swalker_db=> select * from spnclients;
 id |     realip     |  vpnip   |                  publickey                   | edport | groupname | al
lowed_ips |     mac_addr      |   spnbox_id    | created_date
----+----------------+----------+----------------------------------------------+--------+-----------+---
----------+-------------------+----------------+--------------
  5 | 121.162.94.203 | 10.1.3.1 | E9G2R8puRYCFuitSxCZS8sZvM8aSvIsoylSZ9iVhAnA= |  28905 | test1234  | 10
.1.3.1/32 | 94:83:c4:00:bf:8c | help@2ipco.com | 2019-12-10
(1 row)

swalker_db=>
swalker_db=> \q
```

[4] PostgresQL DB Table 검색(select 명령 실행)

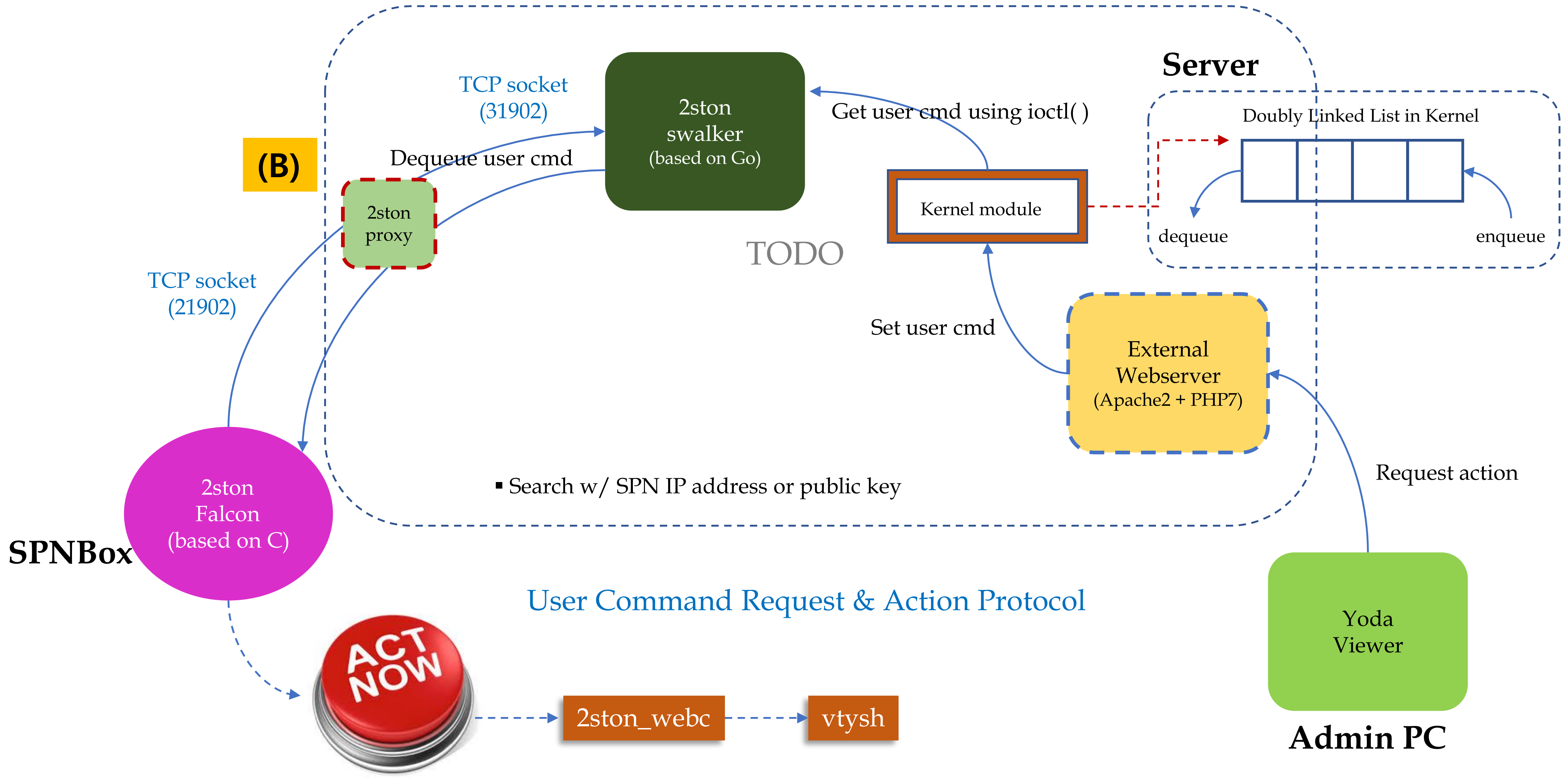
5. SkyWalker Daemon(4) – FALCON Interface(1-1)



5. SkyWalker Daemon(4) – FALCON Interface(1-2)



5. SkyWalker Daemon(4) – FALCON Interface(1-3)



5. SkyWalker Daemon(4) – FALCON Interface(2)

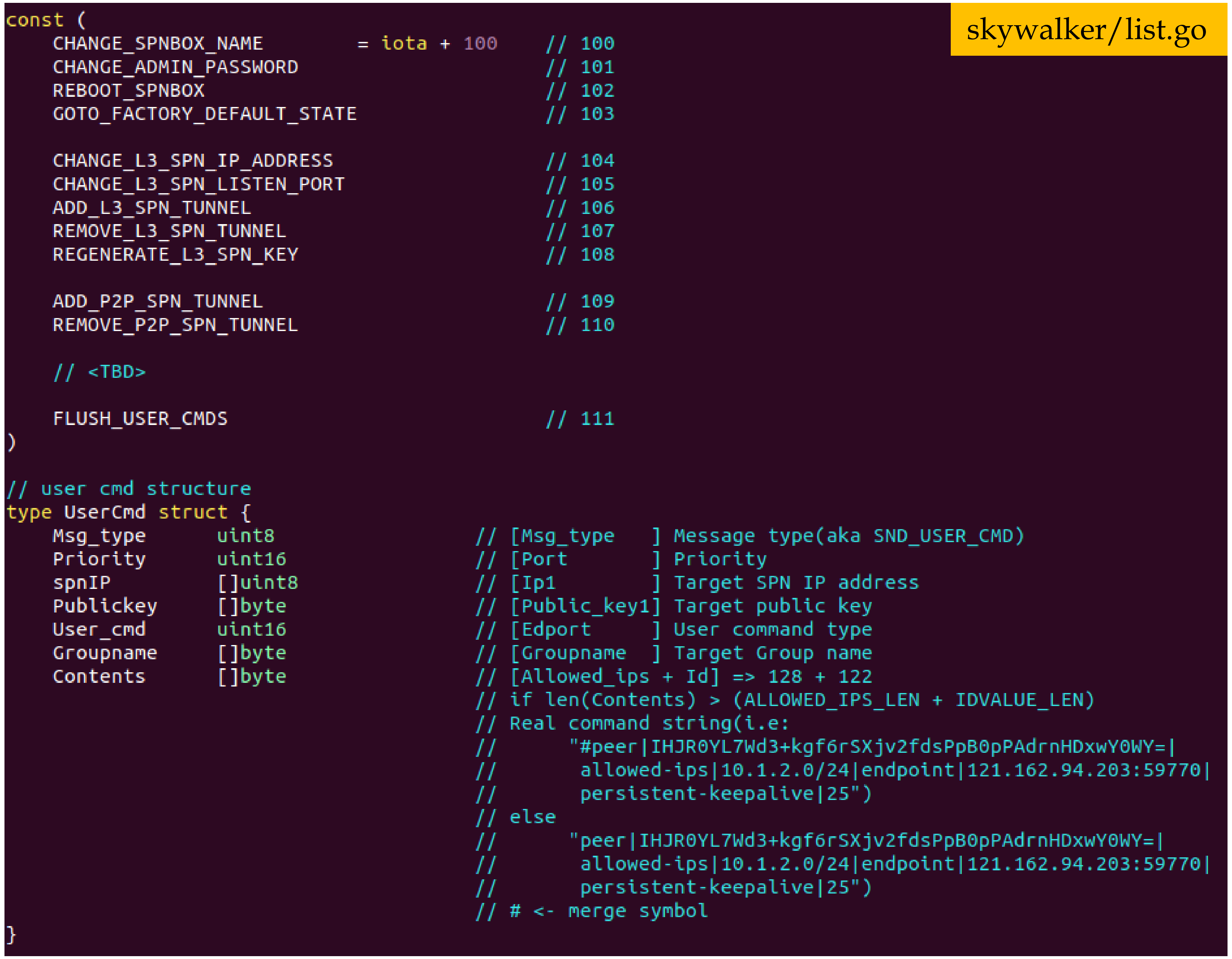
<시나리오>

- [1] swalker <=> dstar | falcon | webserver 간의 통신 message format을 일치시킨다(정확히 말하면 비슷하게 가져간다).
  - ✓ swalker는 UDP 31902 port를 열고, dstar로 부터는 client message를 수신한다. 또한 webserver로 부터는 같은 포트를 통해 user command message를 수신한다.
  - ✓ 한편, falcon과는 보다 안전한 user cmd 전달을 위해 UDP 대신 TCP(31902 port)를 활용한다.
- [2] swalker는 webserver로 부터 UserCmd message를 받아서 list(queue) buffer에 추가 후, list(doubly linked list)에 넣어 준다.
  - ✓ list에 넣을 때는 중복 정보가 있더라도, 신경쓰지 말고 무조건 넣는다(마지막에 추가한다).
  - ✓ 우선 순위가 높은 User Cmd는 list의 맨 앞에 위치시킨다.
- [3] falcon으로 부터의 user cmd 요청 시, list를 검색하여 SPN ip가 일치하는 녀석을 찾아낸 후, falcon에 응답한다.
  - ✓ [TBD] 이때 spnIP가 0.0.0.0(ALL 명령)인 명령도 자신의 것으로 간주한다.
  - ✓ [TBD] 0.0.0.0 ip 명령을 제거하기 위해서는 falcon(SPNBox)의 개수를 관리할 수 있어야 한다.

5. SkyWalker Daemon(4) – FALCON Interface(3)

User Cmd

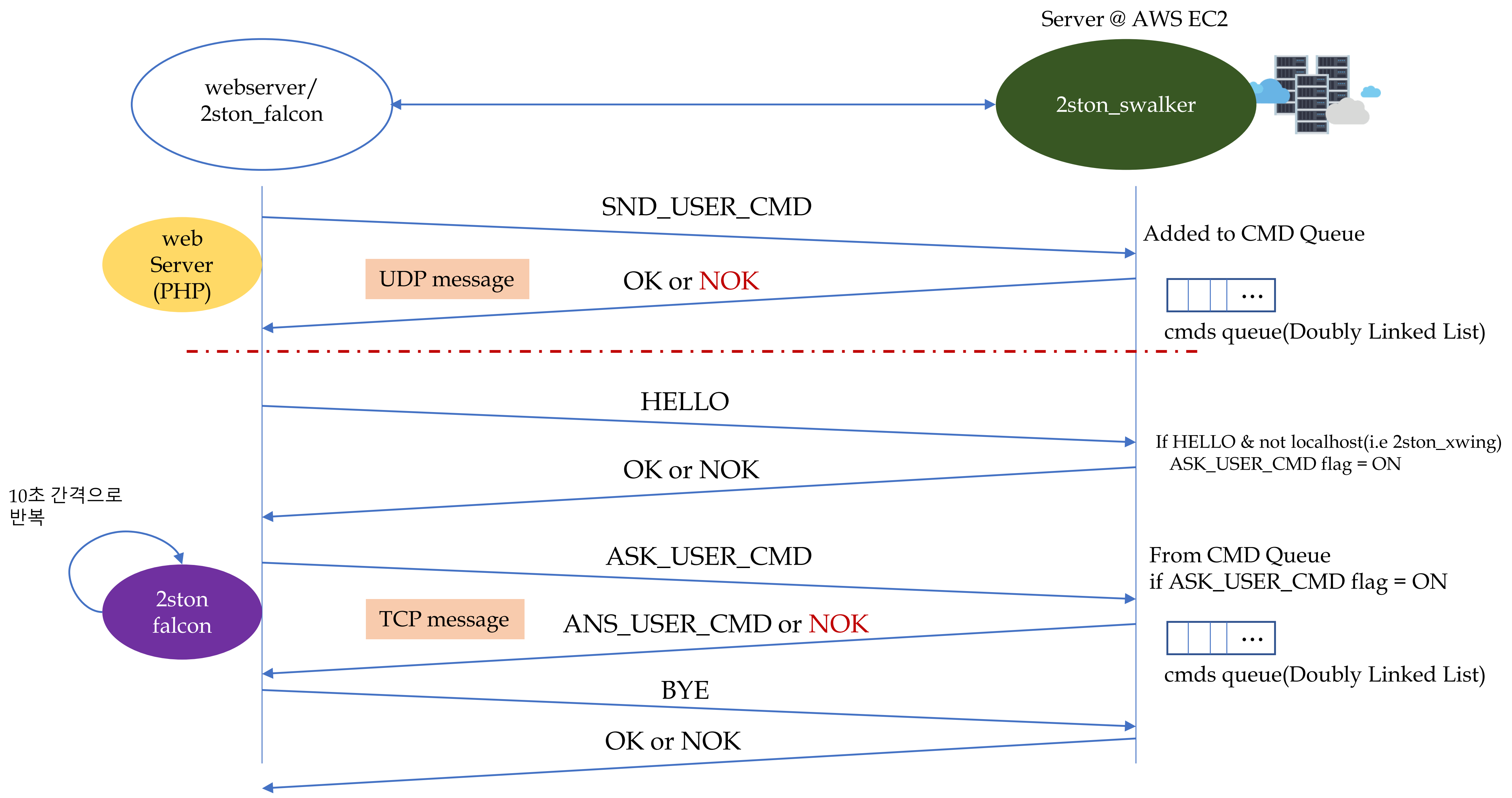
Structure for User Cmd



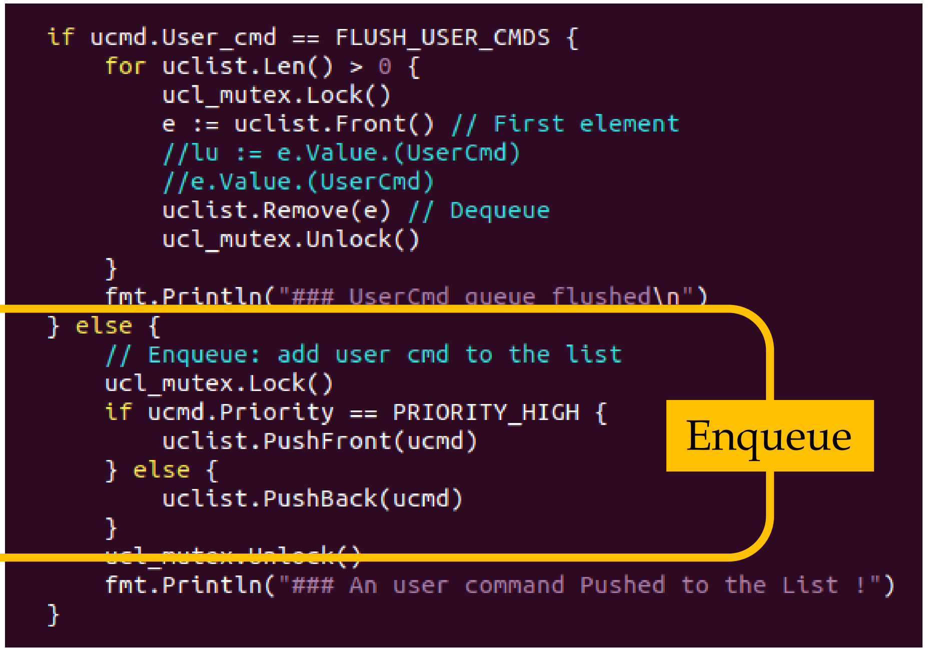
skywalker/list.go

```
const (
    CHANGE_SPNBOX_NAME        = iota + 100    // 100
    CHANGE_ADMIN_PASSWORD                     // 101
    REBOOT_SPNBOX                             // 102
    GOTO_FACTORY_DEFAULT_STATE                // 103

    CHANGE_L3_SPN_IP_ADDRESS                  // 104
    CHANGE_L3_SPN_LISTEN_PORT                 // 105
    ADD_L3_SPN_TUNNEL                         // 106
    REMOVE_L3_SPN_TUNNEL                      // 107
    REGENERATE_L3_SPN_KEY                     // 108

    ADD_P2P_SPN_TUNNEL                        // 109
    REMOVE_P2P_SPN_TUNNEL                     // 110

    // <TBD>

    FLUSH_USER_CMDS                           // 111
)

// user cmd structure
type UserCmd struct {
    Msg_type      uint8                 // [Msg_type    ] Message type(aka SND_USER_CMD)
    Priority      uint16                // [Port        ] Priority
    spnIP         []uint8               // [Ip1         ] Target SPN IP address
    Publickey     []byte                // [Public_key1] Target public key
    User_cmd      uint16                // [Edport      ] User command type
    Groupname     []byte                // [Groupname   ] Target Group name
    Contents      []byte                // [Allowed_ips + Id] => 128 + 122
                                        // if len(Contents) > (ALLOWED_IPS_LEN + IDVALUE_LEN)
                                        // Real command string(i.e:
                                        //      "#peer|IHJR0YL7Wd3+kgf6rSXjv2fdsPpB0pPAdrnHDxwY0WY=|
                                        //       allowed-ips|10.1.2.0/24|endpoint|121.162.94.203:59770|
                                        //       persistent-keepalive|25")
                                        // else
                                        //      "peer|IHJR0YL7Wd3+kgf6rSXjv2fdsPpB0pPAdrnHDxwY0WY=|
                                        //       allowed-ips|10.1.2.0/24|endpoint|121.162.94.203:59770|
                                        //       persistent-keepalive|25")
                                        // # <- merge symbol
}
```

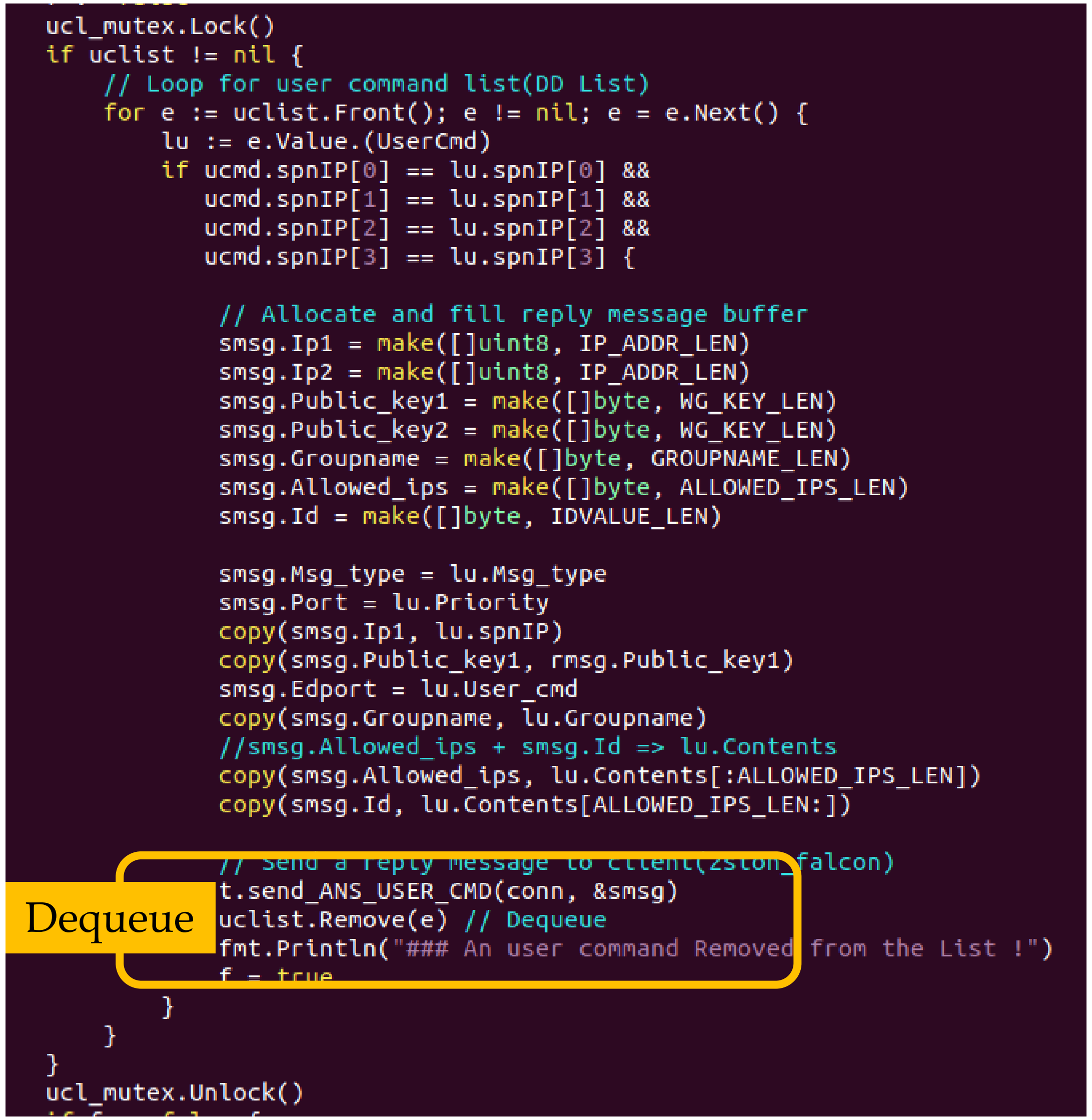
5. SkyWalker Daemon(4) – FALCON Interface(4)



5. SkyWalker Daemon(4) – FALCON Interface(5)

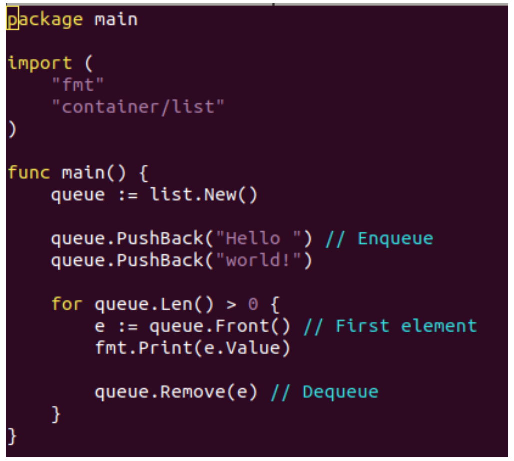


```
if ucmd.User_cmd == FLUSH_USER_CMDS {
    for uclist.Len() > 0 {
        ucl_mutex.Lock()
        e := uclist.Front() // First element
        //lu := e.Value.(UserCmd)
        //e.Value.(UserCmd)
        uclist.Remove(e) // Dequeue
        ucl_mutex.Unlock()
    }
    fmt.Println("### UserCmd queue flushed\n")
} else {
    // Enqueue: add user cmd to the list
    ucl_mutex.Lock()
    if ucmd.Priority == PRIORITY_HIGH {
        uclist.PushFront(ucmd)
    } else {
        uclist.PushBack(ucmd)
    }
    ucl_mutex.Unlock()
    fmt.Println("### An user command Pushed to the List !")
}
```



```
ucl_mutex.Lock()
if uclist != nil {
    // Loop for user command list(DD List)
    for e := uclist.Front(); e != nil; e = e.Next() {
        lu := e.Value.(UserCmd)
        if ucmd.spnIP[0] == lu.spnIP[0] &&
           ucmd.spnIP[1] == lu.spnIP[1] &&
           ucmd.spnIP[2] == lu.spnIP[2] &&
           ucmd.spnIP[3] == lu.spnIP[3] {

            // Allocate and fill reply message buffer
            smsg.Ip1 = make([]uint8, IP_ADDR_LEN)
            smsg.Ip2 = make([]uint8, IP_ADDR_LEN)
            smsg.Public_key1 = make([]byte, WG_KEY_LEN)
            smsg.Public_key2 = make([]byte, WG_KEY_LEN)
            smsg.Groupname = make([]byte, GROUPNAME_LEN)
            smsg.Allowed_ips = make([]byte, ALLOWED_IPS_LEN)
            smsg.Id = make([]byte, IDVALUE_LEN)

            smsg.Msg_type = lu.Msg_type
            smsg.Port = lu.Priority
            copy(smsg.Ip1, lu.spnIP)
            copy(smsg.Public_key1, rmsg.Public_key1)
            smsg.Edport = lu.User_cmd
            copy(smsg.Groupname, lu.Groupname)
            //smsg.Allowed_ips + smsg.Id => lu.Contents
            copy(smsg.Allowed_ips, lu.Contents[:ALLOWED_IPS_LEN])
            copy(smsg.Id, lu.Contents[ALLOWED_IPS_LEN:])

            // Send a reply message to client(2ston_falcon)
            t.send_ANS_USER_CMD(conn, &smsg)
            uclist.Remove(e) // Dequeue
            fmt.Println("### An user command Removed from the List !")
            f = true
        }
    }
}
ucl_mutex.Unlock()
```

Doubly Linked List example =>



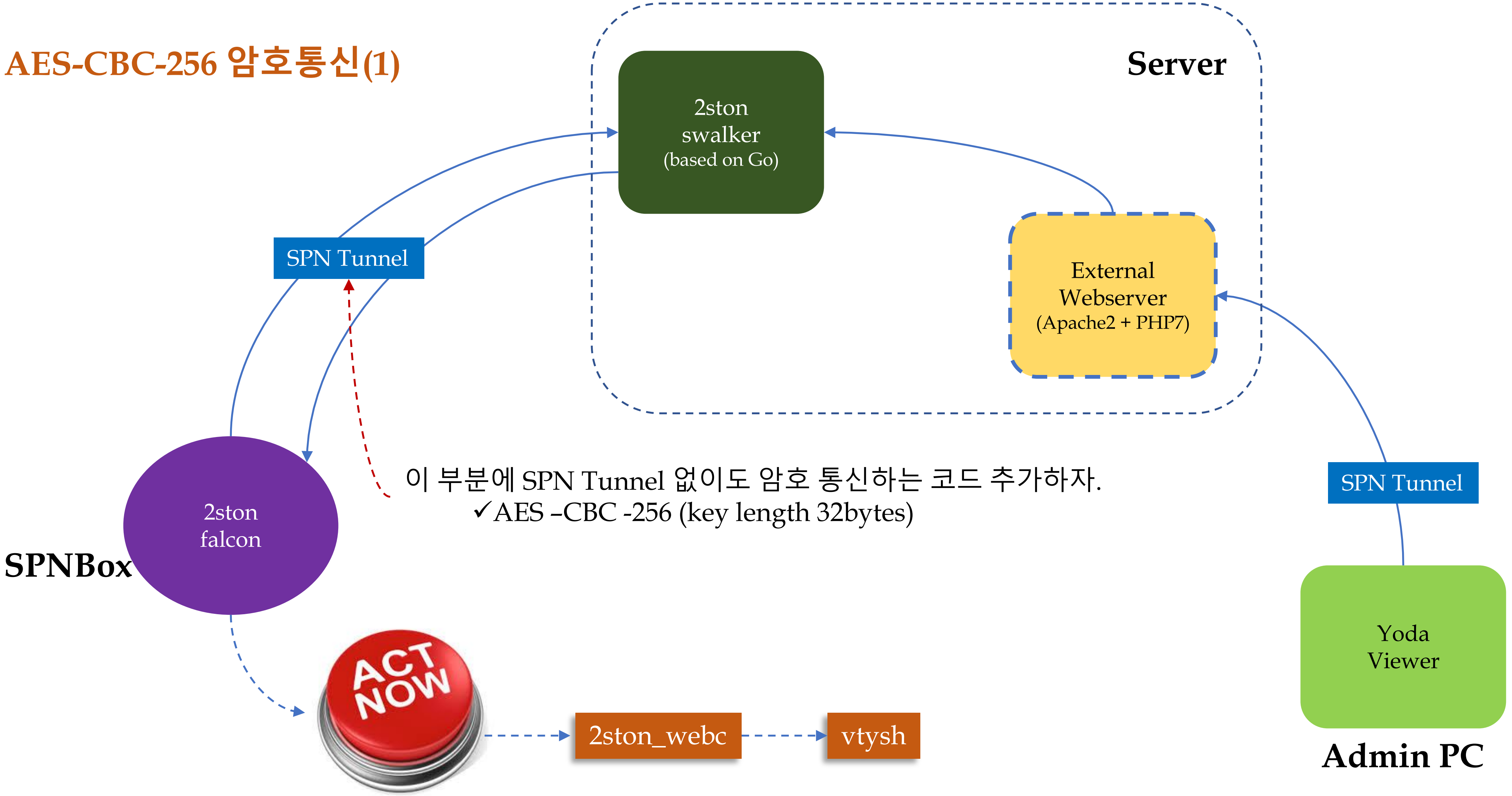
```
package main

import (
    "fmt"
    "container/list"
)

func main() {
    queue := list.New()

    queue.PushBack("Hello ") // Enqueue
    queue.PushBack("world!")

    for queue.Len() > 0 {
        e := queue.Front() // First element
        fmt.Print(e.Value)

        queue.Remove(e) // Dequeue
    }
}
```

User Cmd Queue

- 사용자 명령 저장

5. SkyWalker Daemon(4) – FALCON Interface(6-1)

AES-CBC-256 암호통신(1)

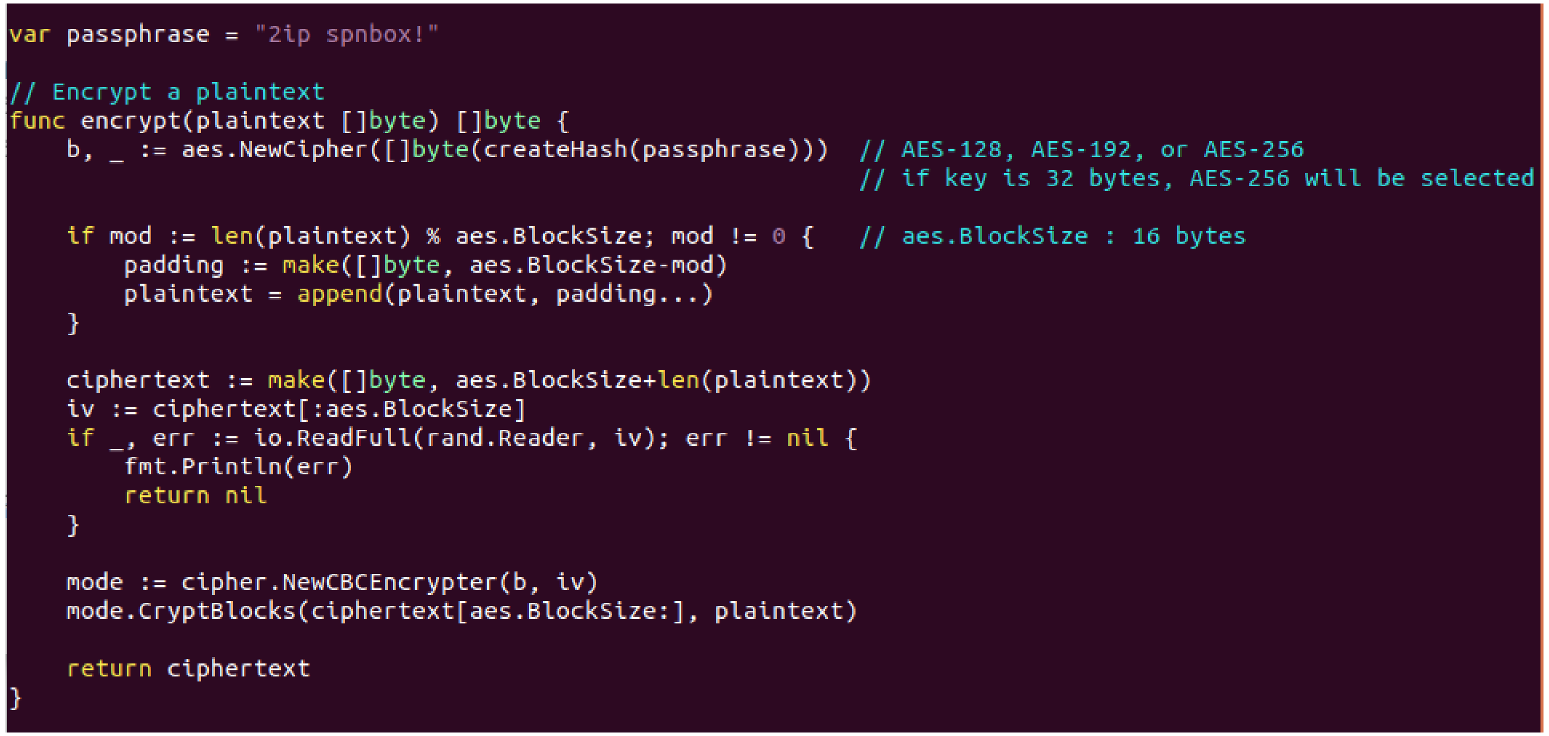


이 부분에 SPN Tunnel 없이도 암호 통신하는 코드 추가하자.

✓AES –CBC -256 (key length 32bytes)

5. SkyWalker Daemon(4) – FALCON Interface(6-2)

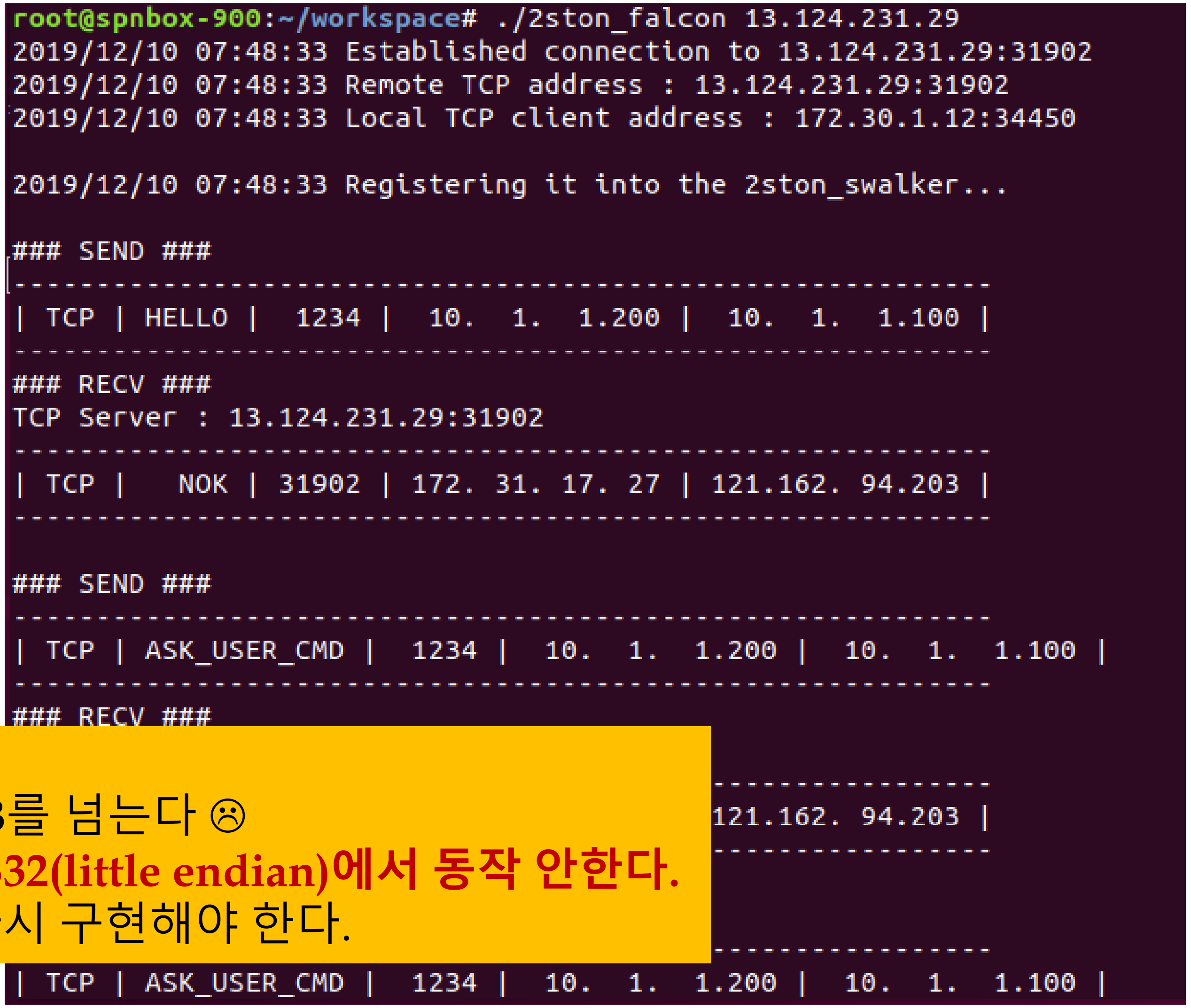
AES-CBC-256 암호통신(2)



```
var passphrase = "2ip spnbox!"

// Encrypt a plaintext
func encrypt(plaintext []byte) []byte {
    b, _ := aes.NewCipher([]byte(createHash(passphrase)))  // AES-128, AES-192, or AES-256
                                                           // if key is 32 bytes, AES-256 will be selected

    if mod := len(plaintext) % aes.BlockSize; mod != 0 {    // aes.BlockSize : 16 bytes
        padding := make([]byte, aes.BlockSize-mod)
        plaintext = append(plaintext, padding...)
    }

    ciphertext := make([]byte, aes.BlockSize+len(plaintext))
    iv := ciphertext[:aes.BlockSize]
    if _, err := io.ReadFull(rand.Reader, iv); err != nil {
        fmt.Println(err)
        return nil
    }

    mode := cipher.NewCBCEncrypter(b, iv)
    mode.CryptBlocks(ciphertext[aes.BlockSize:], plaintext)

    return ciphertext
}
```

5. SkyWalker Daemon(4) – FALCON Interface(7)

실제 동작 모습



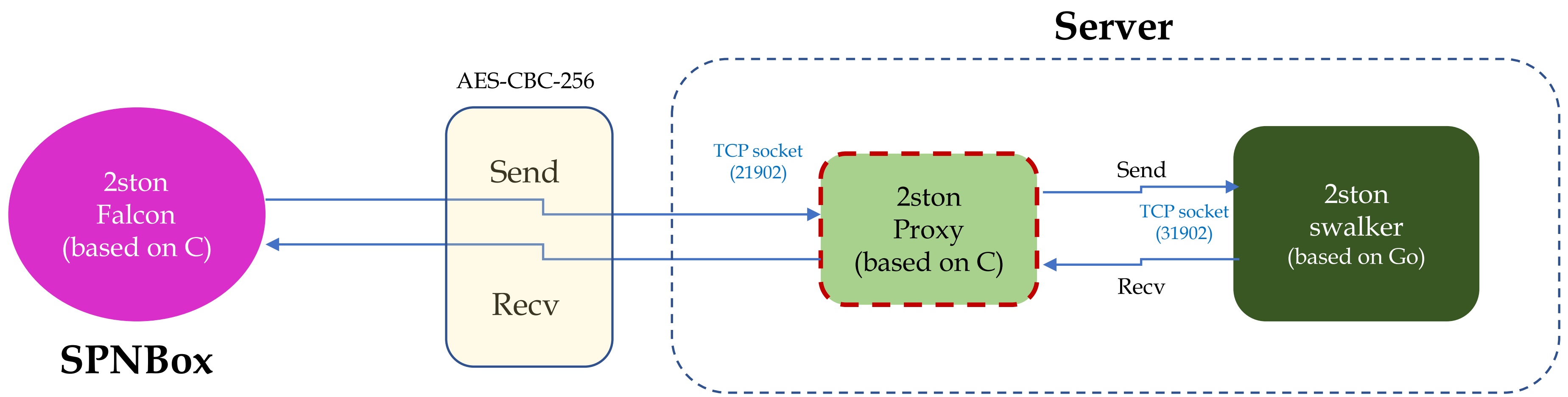
```
root@spnbox-900:~/workspace# ./2ston_falcon 13.124.231.29
2019/12/10 07:48:33 Established connection to 13.124.231.29:31902
2019/12/10 07:48:33 Remote TCP address : 13.124.231.29:31902
2019/12/10 07:48:33 Local TCP client address : 172.30.1.12:34450

2019/12/10 07:48:33 Registering it into the 2ston_swalker...

### SEND ###
-----------------------------------------------------------
| TCP | HELLO |  1234 |  10.  1.  1.200 |  10.  1.  1.100 |
-----------------------------------------------------------
### RECV ###
TCP Server : 13.124.231.29:31902
-----------------------------------------------------------
| TCP |   NOK | 31902 | 172. 31. 17. 27 | 121.162. 94.203 |
-----------------------------------------------------------

### SEND ###
-----------------------------------------------------------
| TCP | ASK_USER_CMD |  1234 |  10.  1.  1.200 |  10.  1.  1.100 |
-----------------------------------------------------------
### RECV ###
                                     ----------------
                                      121.162. 94.203 |
                                     ----------------

                                     ----------------
| TCP | ASK_USER_CMD |  1234 |  10.  1.  1.200 |  10.  1.  1.100 |
```

<TBD>

- ✓ Go binary size가 1MB를 넘는다 ☹
- ✓ **2ston_falcon이 MIPS32(little endian)에서 동작 안한다.**
- ✓ 2ston_falcon - C로 다시 구현해야 한다.

5. SkyWalker Daemon(4) – FALCON Interface(8-1)

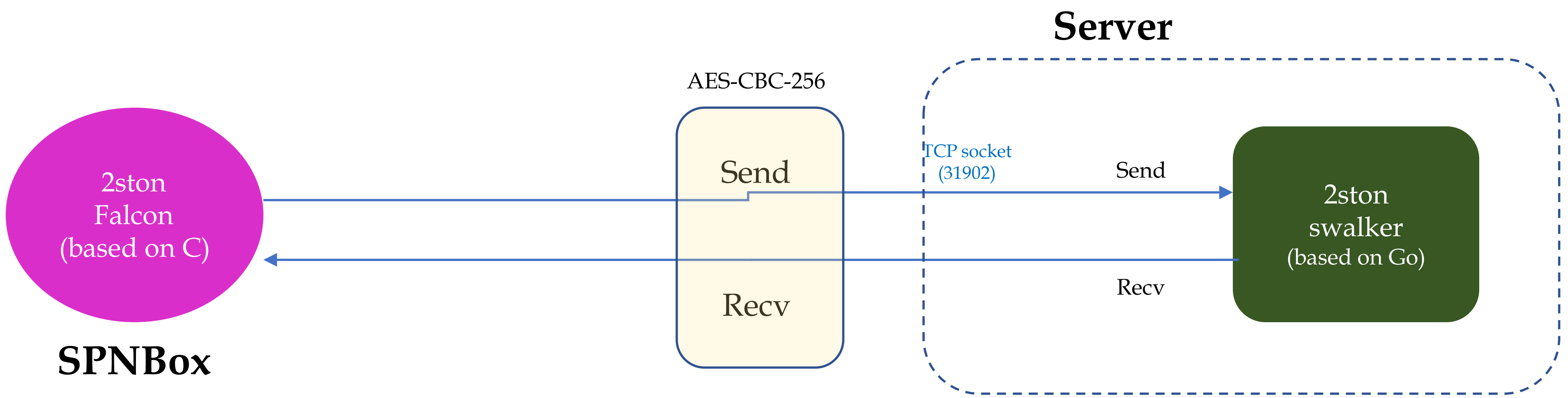
Proxy Interface



- 2ston_falcon - C로 다시 구현하자.
- 중간에 proxy를 하나 두자.
- 왜 ?
  - ✓ *C ⇔ Go routine 간 AES-CBC-256을 맞추는게 쉽지 않아 보여…*
  - ✓ *C로 proxy code를 구현하는 것이 상대적으로 빠른 작업이어서 …*

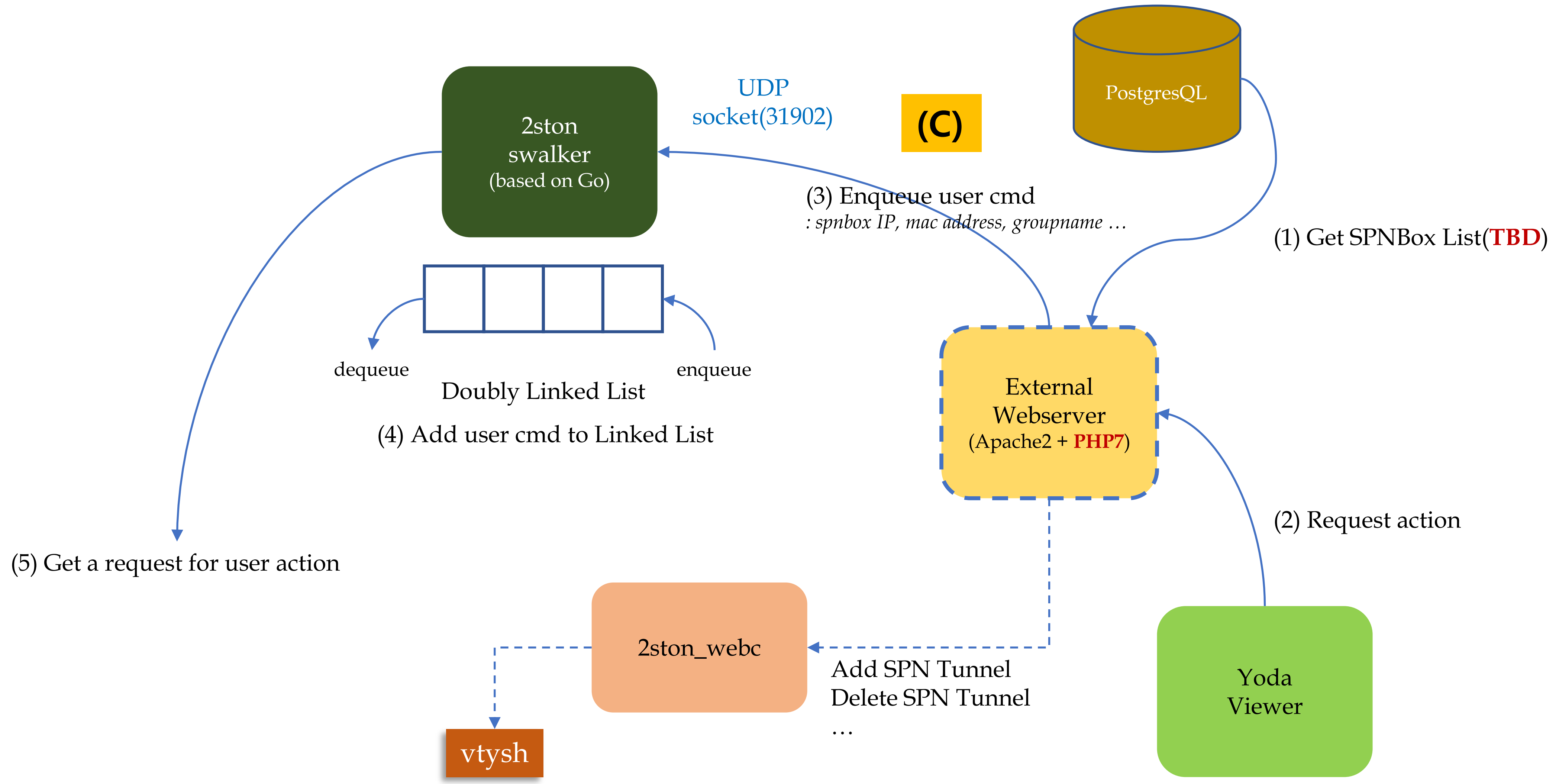
5. SkyWalker Daemon(4) – FALCON Interface(8-2)

Non-Proxy Interface



- 2ston_falcon (C version), no proxy
  - ✓ 중간에 proxy를 두는 방식이, 문제를 너무 복잡하게 만드는 듯 하니 direct로 연결하도록 하자.

5. SkyWalker Daemon(5) – WebServer Interface(1)

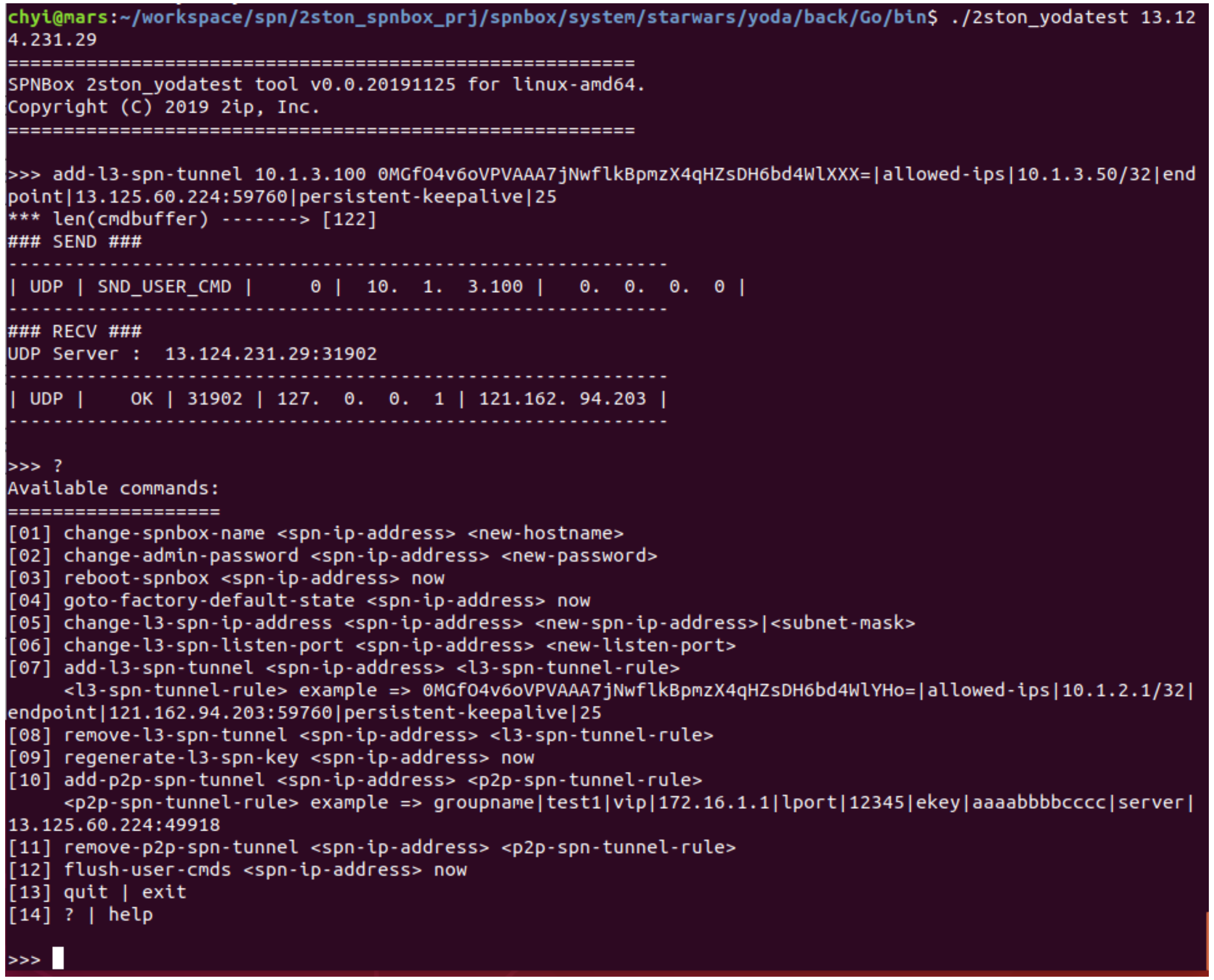


5. SkyWalker Daemon(5) – WebServer Interface(2)

<시나리오>

- [1] [TBD] WebServer backend(이하 PHP)는 주기적으로 PostgresQL DBMS에 연결하여 SPNBox List를 가져온다.
- [1]' 혹은 WebServer backend(이하 PHP)는 주기적으로 2ston_swalker에게 ASK_SPN_INFO 명령을 전달하여 ANS_SPN_INFO를 수신한다. 이 과정을 통해 전체 SPNBox List를 확보한다.
- [2] 사용자는 SPNBox List 중 하나를 선택한 후, 이를 토대로 사용자 명령을 내린다.
  - ✓ 사용자 명령으로는 change_spnbox_name, change_admin_password, reboot_spnbox, goto_factory_default_state, change_l3_spn_ip_address, … 등이 존재한다.
- [3] 사용자 명령을 전달 받은 WebServer PHP는 2ston_swalker에게 관련 명령을 전달한다.
  - Test code: 2ston_yodatest(based on Go)
- [4] 2ston_swalker는 사용자 명령을 Linked List에 추가한다.
- [5] 2ston_falcon은 주기적으로 2ston_swalker로 부터 사용자 명령을 가져와 관련 action을 수행한다.

5. SkyWalker Daemon(5) – WebServer Interface(3)



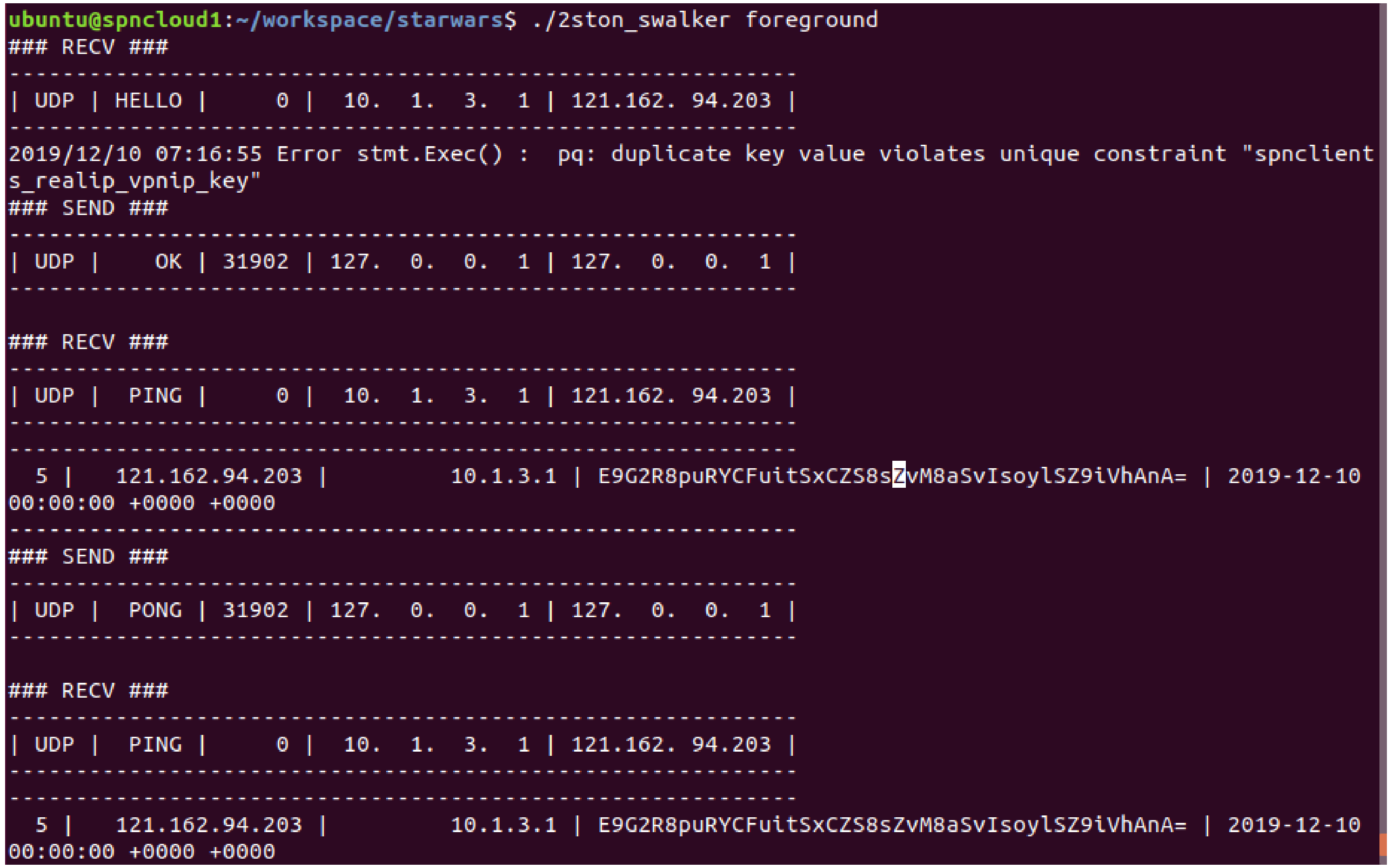
```
chyi@mars:~/workspace/spn/2ston_spnbox_prj/spnbox/system/starwars/yoda/back/Go/bin$ ./2ston_yodatest 13.12
4.231.29
========================================================
SPNBox 2ston_yodatest tool v0.0.20191125 for linux-amd64.
Copyright (C) 2019 2ip, Inc.
========================================================

>>> add-l3-spn-tunnel 10.1.3.100 0MGfO4v6oVPVAAA7jNwflkBpmzX4qHZsDH6bd4WlXXX=|allowed-ips|10.1.3.50/32|end
point|13.125.60.224:59760|persistent-keepalive|25
*** len(cmdbuffer) -------> [122]
### SEND ###
-----------------------------------------------------------
| UDP | SND_USER_CMD |     0 |  10.  1.  3.100 |   0.  0.  0.  0 |
-----------------------------------------------------------
### RECV ###
UDP Server :  13.124.231.29:31902
-----------------------------------------------------------
| UDP |    OK | 31902 | 127.  0.  0.  1 | 121.162. 94.203 |
-----------------------------------------------------------

>>> ?
Available commands:
===================
[01] change-spnbox-name <spn-ip-address> <new-hostname>
[02] change-admin-password <spn-ip-address> <new-password>
[03] reboot-spnbox <spn-ip-address> now
[04] goto-factory-default-state <spn-ip-address> now
[05] change-l3-spn-ip-address <spn-ip-address> <new-spn-ip-address>|<subnet-mask>
[06] change-l3-spn-listen-port <spn-ip-address> <new-listen-port>
[07] add-l3-spn-tunnel <spn-ip-address> <l3-spn-tunnel-rule>
     <l3-spn-tunnel-rule> example => 0MGfO4v6oVPVAAA7jNwflkBpmzX4qHZsDH6bd4WlYHo=|allowed-ips|10.1.2.1/32|
endpoint|121.162.94.203:59760|persistent-keepalive|25
[08] remove-l3-spn-tunnel <spn-ip-address> <l3-spn-tunnel-rule>
[09] regenerate-l3-spn-key <spn-ip-address> now
[10] add-p2p-spn-tunnel <spn-ip-address> <p2p-spn-tunnel-rule>
     <p2p-spn-tunnel-rule> example => groupname|test1|vip|172.16.1.1|lport|12345|ekey|aaaabbbbcccc|server|
13.125.60.224:49918
[11] remove-p2p-spn-tunnel <spn-ip-address> <p2p-spn-tunnel-rule>
[12] flush-user-cmds <spn-ip-address> now
[13] quit | exit
[14] ? | help

>>> 
```

이 코드는 Go 로작성한 것이며,
실제로는 PHP로 다시 작성해야 함.

5. SkyWalker Daemon(5) – WebServer Interface(4)

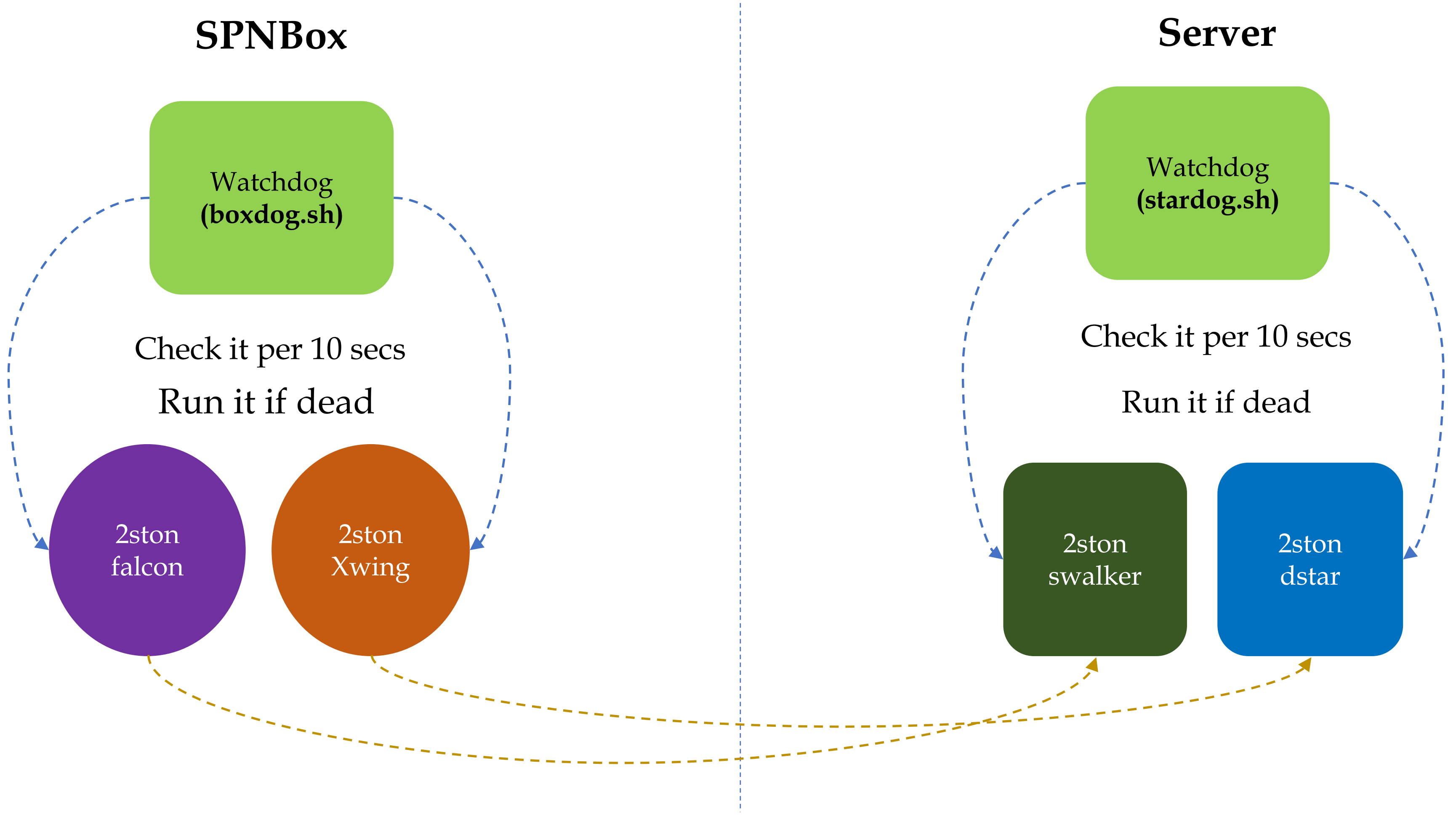
- <TBD> PHP codes(client)

5. SkyWalker Daemon(6) – 실제 동작 모습



```
ubuntu@spncloud1:~/workspace/starwars$ ./2ston_swalker foreground
### RECV ###
-----------------------------------------------------------
| UDP | HELLO |     0 |  10.  1.  3.  1 | 121.162. 94.203 |
-----------------------------------------------------------
2019/12/10 07:16:55 Error stmt.Exec() :  pq: duplicate key value violates unique constraint "spnclient
s_realip_vpnip_key"
### SEND ###
-----------------------------------------------------------
| UDP |    OK | 31902 | 127.  0.  0.  1 | 127.  0.  0.  1 |
-----------------------------------------------------------

### RECV ###
-----------------------------------------------------------
| UDP |  PING |     0 |  10.  1.  3.  1 | 121.162. 94.203 |
-----------------------------------------------------------
-----------------------------------------------------------
  5 |   121.162.94.203 |         10.1.3.1 | E9G2R8puRYCFuitSxCZS8sZvM8aSvIsoylSZ9iVhAnA= | 2019-12-10
00:00:00 +0000 +0000
-----------------------------------------------------------
### SEND ###
-----------------------------------------------------------
| UDP |  PONG | 31902 | 127.  0.  0.  1 | 127.  0.  0.  1 |
-----------------------------------------------------------

### RECV ###
-----------------------------------------------------------
| UDP |  PING |     0 |  10.  1.  3.  1 | 121.162. 94.203 |
-----------------------------------------------------------
-----------------------------------------------------------
  5 |   121.162.94.203 |         10.1.3.1 | E9G2R8puRYCFuitSxCZS8sZvM8aSvIsoylSZ9iVhAnA= | 2019-12-10
00:00:00 +0000 +0000
```

5. SkyWalker Daemon(7) – Watchdog Script



5. SkyWalker Daemon(8) – TODO

- 1) 2ston_falcon(C version)
  - 2ston_falcon(C version) ⇔ 2ston_swalker간 암호 통신
  - User command(원격 명령) 실제 처리 코드(예: reboot)
  - 2ston_falcon code를 2ston_xwing에 통합 할 수도 있음.

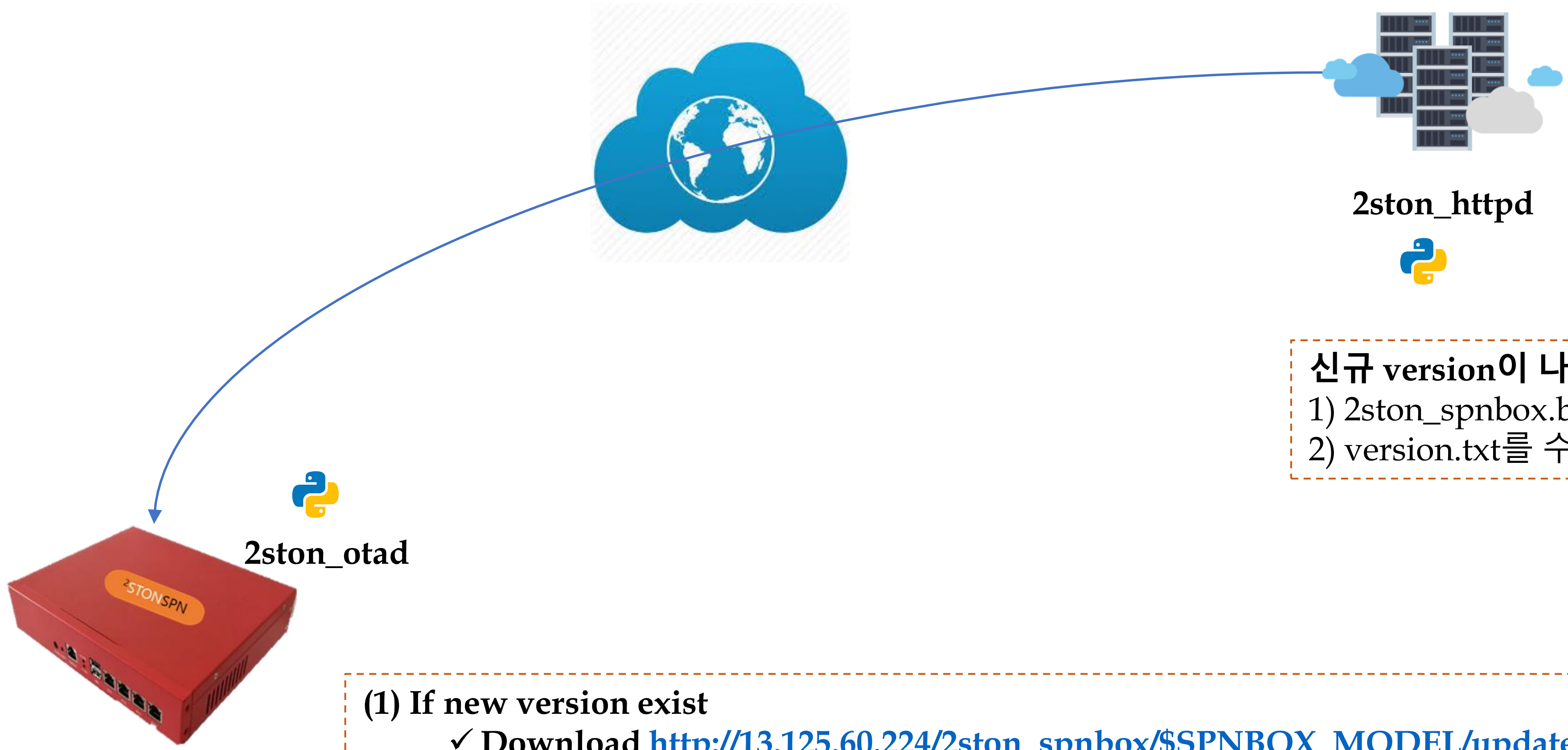
- 2) 2ston_swalker(Go version)
  - Swalker 내에서 DB table 생성하는 코드 추가
  - PostgresQL DB operation(추가 작업이 있을 듯)
  - Doubly Linked List(User command Queue) 관련 추가 작업 있음.
  - …

- 3) 2ston_dstar, 2ston_xwing
  - 추가 debugging(안정화 작업)

- 4) Startup script
  - Start/stop 관련 shell script 보강 작업

OTA Daemon

6. OTA Daemon(1) – S/W Upgrade



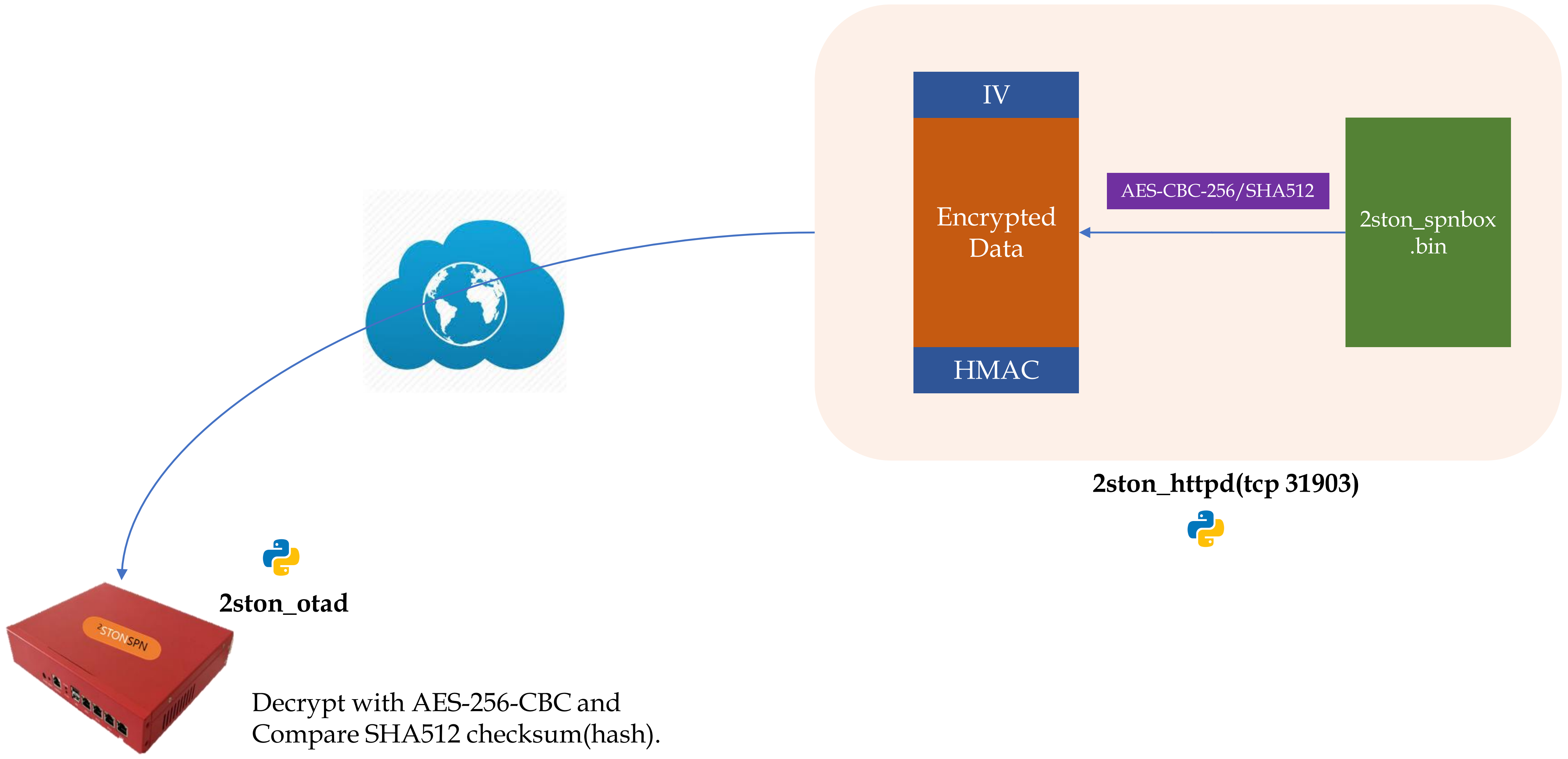
version.txt
update.bin
2ston_spnbox.bin
(*) AES 암호화/Hash

신규 version이 나올 경우
1) 2ston_spnbox.bin 갱신
2) version.txt를 수정(version up)

(1) If new version exist
- ✓ **Download http://13.125.60.224/2ston_spnbox/$SPNBOX_MODEL/update.bin**

(2) Decrypt update.bin and then run ./update.sh
- ✓ **Download 2ston_spnbox.bin and decrypt it.**
- ✓ **Uncompress and untar 2ston_spnbox.tar.gz**
- ✓ **Run AutoInstall.sh**
- ✓ **Reboot**

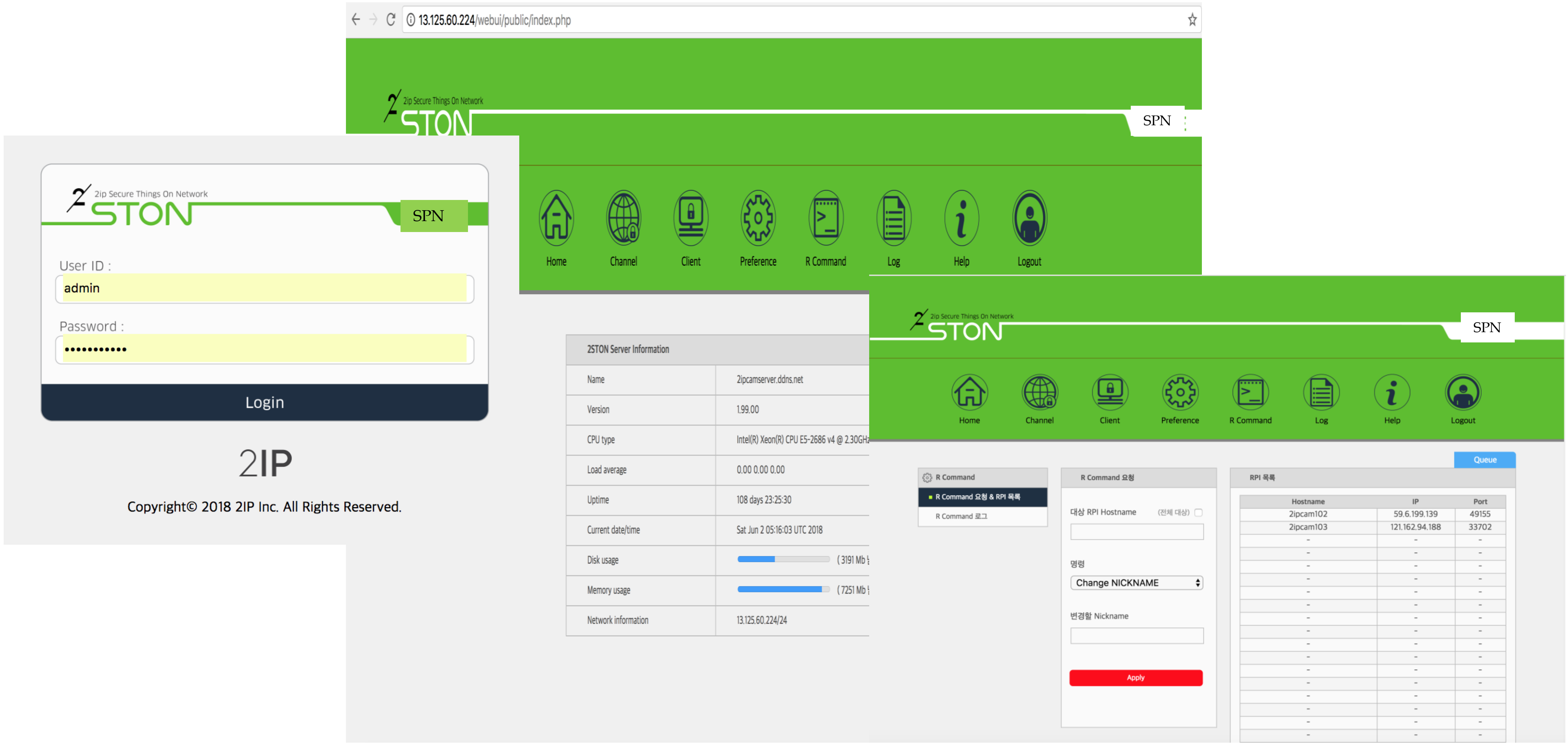
6. OTA Daemon(2) – S/W Upgrade



Decrypt with AES-256-CBC and
Compare SHA512 checksum(hash).

SPNBox Star Console Viewer

7. SPNBox Star Console Viewer – Yoda(1)



User ID : admin

Password : •••••••••••

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2STON Server Information

Name	2ipcamserver.ddns.net
Version	1.99.00
CPU type	Intel(R) Xeon(R) CPU E5-2686 v4 @ 2.30GH
Load average	0.00 0.00 0.00
Uptime	108 days 23:25:30
Current date/time	Sat Jun 2 05:16:03 UTC 2018
Disk usage	(3191 Mb
Memory usage	(7251 Mb
Network information	13.125.60.224/24

R Command
- R Command 요청 & RPI 목록
- R Command 로그

R Command 요청

대상 RPI Hostname (전체 대상) ☐

명령: Change NICKNAME

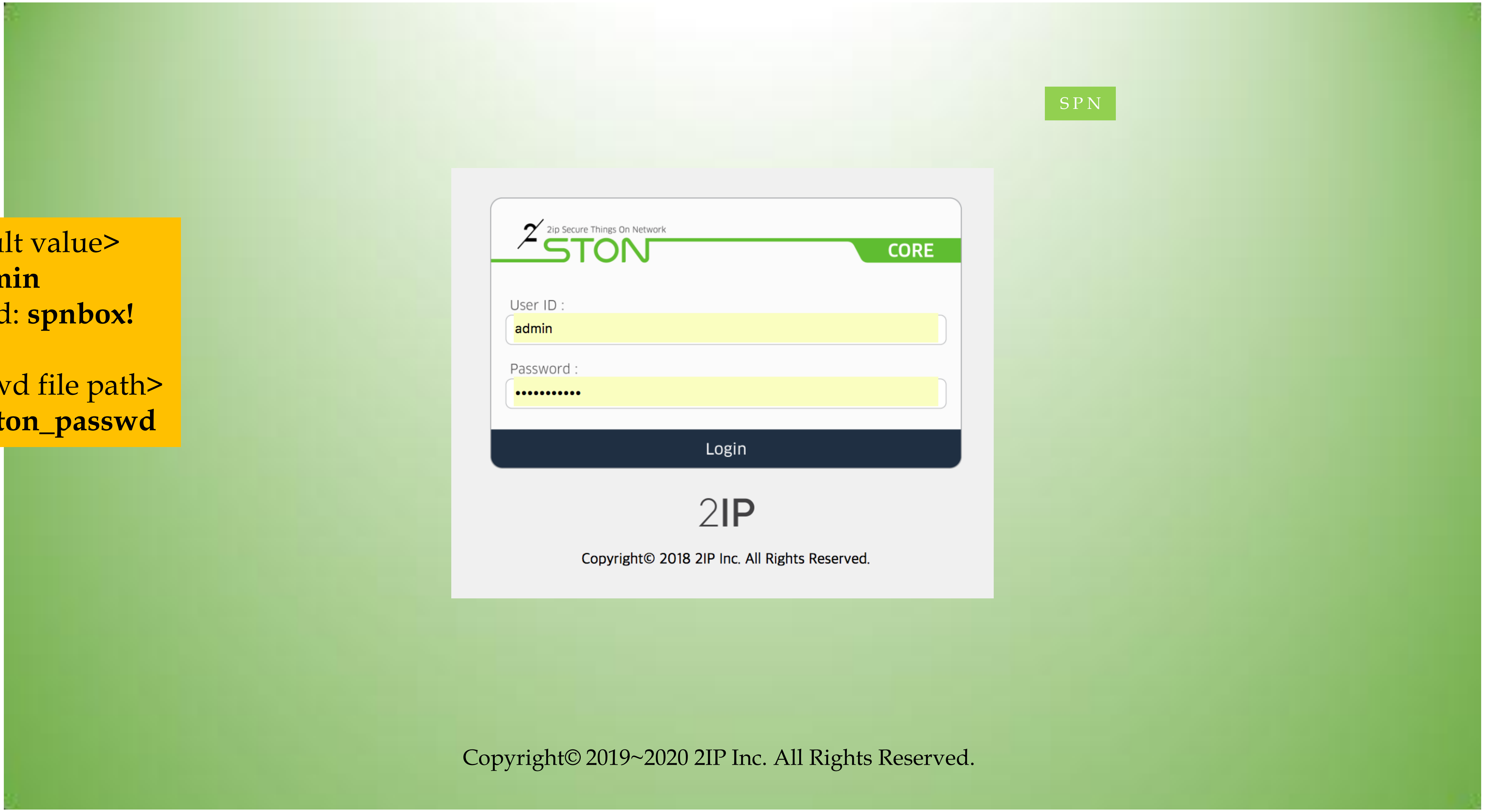
변경할 Nickname

RPI 목록

Hostname	IP	Port
2ipcam102	59.6.199.139	49155
2ipcam103	121.162.94.188	33702
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-
-	-	-

7. SPNBox Star Console Viewer – Yoda(2)

Login Page



User ID :
admin
Password :
•••••••••••

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<default value>
id: **admin**
passwd: **spnbox!**

<passwd file path>
/etc/2ston_passwd

Thank You

2STONSPN

We Secure the Internet of Things with 2STON™