oslab3

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Περιεχόμενα

1. Sockets

1.1 Socket Handling

Τα sockets χειρίζονται από ένα Simple Socket Interface ***SSI*** *(definitions από MARC J.ROCHKIND "Programming in UNIX" Simple Socket Interface αλλά* ***υλοποιημένο ανεξάρτητα από εμάς*** *SSI.c)*

Ο handle για την χρήση του interface

```
typedef struct{
    bool ssi_server;    //server or client
    int ssi_fd;         //the socket fd used in calls
    int port;           //port
    char ssi_name_server[SSI_NAME_SIZE];
} SSI;
```

Οι συναρτήσεις που χρησιμοποιούνται στις υλοποιήσεις των epollserver.c και client.c

```
/**
 * @brief
```

```
 * Opens a socket and either listens as a server or connects to as a
client.
 * @param name the address of the server (Should be NULL for server);
 * @param port the port to listen or to connect to.
 * @param server a boolean to specify the behaviour.
 * @param tcp_backlog the number of connections that can wait in queue only
needed in server
 * @return a pointer to an SSI structure specifying the connection.
 */
SSI* ssi_open(char* name, uint16_t port, bool server, int tcp_backlog);

/**
 * @brief
 * Waits for a client to connect if the ssi given belongs to a server.
 * @param ssip the SSI* to created by ssi_open
 * @return int the fd of the client -1 in case of error
 */
int ssi_server_accept(SSI* ssip);

/**
 * @brief
 * Terminates the connection if one is up and closed the corresponding
socket.
 * @param ssip a pointer to SSI structure given by open
 * @return true if connection closed successfully
 *
 */
bool ssi_close(SSI* ssip);

/**
 * @brief Interface for handling unix sockets
 *
 * @param socketname name of the socket
 * @param server server or client boolean
 * @param client_queue backlog
 * @return SSI* the handle for future calls
 */
SSI* ssi_un_open(char* socketname, bool server, int client_queue);
/**
 * @brief Accepting clients for unix sockets opened using the SSI.
 *
 * @param ssip the SSI handle
 * @return int the fd of the client -1 in case of error
 */
int ssi_un_server_accept(SSI* ssip);
```

1.2 AN Protocol 2.0

Stateless προσέγγιση που απλά ανανεώνει την δυναμική <<βάση δεδομένων>> που υπάρχει στον epollserver.c.

Ένα struct μεταφέρεται μεταξύ client και server που περιέχει κάθε δυνατή ερώτηση του client και απάντηση του server.

Αυτό το struct είναι το ακόλουθο :

```
enum PACKET_TYPE {
    QUESTION, ANSWER
} PACKET_TYPE ;

enum COMMAND_TYPE{
    CREATE_USER, CREATE_CHANNEL, ADD_USER, SEND, READ, SERVER_SUCCESS,
SERVER_FAILURE
} COMMAND_TYPE;

struct {
    uint8_t packet_type;// 1 byte
    uint8_t command;    // 1 byte
    char arg1[8];       // 8 bytes
    char arg2[8];       // 8 bytes
    char arg3[8];       // 8 bytes
    char arg4[8];       // 8 bytes
    int length;         //body length
    int id;             //optional argument in case of read.
    char body[260];     // 260 bytes
} packet;
```

Τα Question αφορούν ερωτήσεις από τον client προς τον server και αυτές μπορεί να είναι CREATE_USER, CREATE_CHANNEL, ADD_USER, SEND, READ οι οποίες έχουν λειτουργίες :

Commmand	**Description**
CREATE_USER	Νέος χρήστης με username, password(arg1, arg2)
ADD_USER	Προστίθεται νέος χρήστης σε ένα κανάλι (arg4, arg3) (validation required (arg1, arg2))
CREATE CHANNEL	Δημιοουργείται νέο κανάλι (no validation required)
SEND	Στέλνεται μήνυμα σε ένα κανάλι (arg3) (validation required (arg1, arg2)) (Msg in Body)
READ	Ζητείται αποστολή του id-οστού μηνύματος από το κανάλι στον client (validation required (arg1, arg2))

Απαντήσεις server :

Command	**Description**
SERVER_SUCCESS	Επιτυχία επεξεργασίας ερωτήματος (log msg in body)
SERVER_FAILURE	Αποτυχία επεξεργασίας ερωτήματος (log msg in body)

1.3 Ο Server

Ο server χρησιμοποιεί την κλήση συστήματος epoll (παρόμοια με την poll μόνο που επιστρέφονται μόνο οι έτοιμοι περιγραφητές) για να μπορεί να διαχειριστεί πολλούς πελάτες. Με την

```
    ev.events = EPOLLIN; //for read operations.
    ev.data.fd = server->ssi_fd; //the fd that is added
    epoll_ctl(epollfd, EPOLL_CTL_ADD, server->ssi_fd, &ev)
```

προσθέτουμε file descriptors στο σύνολο που κάνει handle η epoll και με την

```
    epoll_wait(epollfd, events, MAX_EVENTS, -1); //-1 timeout block
indefinitely.
```

αναμένουμε κάποιο file descriptor να είναι έτοιμο για read ή το server να είναι έτοιμος να δεχθεί νέο client. Στην πρώτη περίπτωση απλά διαβάζουμε fragment του πακέτου που στέλνει ο κάθε πελάτης μέχρι να έρθει ολόκληρο (κρατάμε πόσο έχουμε διαβάσει).
Στην δεύτερη απλά προσθέτουμε με την epoll_ctl τον fd του νέου πελάτη για να τον διαχειριστεί η epoll.

1.4 Ο Client

Ξεκινά σύνδεση με κάποιον server η διεύθυνση του οποίου καθορίζεται από τα *command lines args* για κάθε πακέτο που πρόκειται να στείλει. Δέχεται commands από τον χρήστη και τις μεταφράζει άμεσα σε δομή *packet* την οποία αποστέλλει προς τον server, κρυπτογραφώντας την.

2. Κρυπτογράφηση μηνυμάτων

2.1 Η κρυπτογράφηση στους server και client

Και στον server και στον client χρησιμοποιείται το **/dev/crypto** για την κρυπτογράφηση και αποκρυπτογράφηση των δεδομένων.

Χρησιμοποιούνται οι κλήσεις (οι υλοποιήσεις των οποίων βρίσκονται στο encrypt.c και decrypt.c) :

```
/**
 * @brief encrypts data using AES Algorithm
 *
 * @param input data to be ecrypted
 * @param output encrypted data
 * @param size size of input/output data
 */
void encryption(unsigned char* input, unsigned char* output,int size);


/**
```

```
 * @brief decrypts data using AES Algorithm
 *
 * @param input data to be decrypted
 * @param output decrypted data
 * @param size size of input/output data
 */
void decryption(unsigned char* input, unsigned char* output,int size);


/**
 * @brief encrypts and writes data
 *
 * @param fd the file descriptor to write the buffer to after encrypting
the data
 * @param buf the buffer where the data to be send is
 * @param cnt the number of bytes to write to
 * @return ssize_t number of bytes written or a negative value in case of
error
 */
ssize_t encrypt_insist_write(int fd, void* buf, size_t cnt);


/**
 * @brief reads and decrypts data
 *
 * @param fd the file descriptor to read from
 * @param buf the buffer to read to
 * @param cnt the number of bytes to read
 * @return ssize_t the number of bytes read or a negative value in case of
error
 */
ssize_t decrypt_insist_read(int fd, void *buf, size_t cnt);
```

2.2 Επιβεβαίωση κρυπτογραφημένων μηνυμάτων

Με χρήση του ***tcpdump*** επιβεβαιώθηκαν πως τα μηνύματα ήταν κρυπτογραφημένα. Συγκεκριμένα χρησιμοποιώντας την εντολή

```
tcpdump -i lo -vvv -XXX port <serverport>
```

3. Frontend Driver

3.1 Δομές Δεδομένων Driver:

- Μία λίστα με όλες τις συνδεδεμένες συσκευές (τύπου virtio cryptodev)

```
struct crypto_driver_data
```

- Μία δομή για κάθε συσκευή (τύπου virtio cryptodev) που είναι συνδεδεμένη. Για πολλούς fds άρα θέλει lock. Συγκεκριμένα, για να είμαστε σίγουροι πως δεν μπορεί να γράψει κανένας άλλος ταυτόχρονα στο ίδιο VirtQueue γιατί σε αυτή την περίπτωση ο QEMU θα λάβει trash. Χρησιμοποιούμε spinlock, αφού δεν είμαστε σε interrupt context που απαγορεύεται ο ύπνος.

```
    struct crypto_device {
    //next in the list
    struct list_head list;

    /* The virtio device we are associated with. */
    //this is the structure that is passed when the kernel recognizes a new
virtio device that has the same
    // id as the ones we are handling and
    //passes this struct.
    struct virtio_device *vdev;

    //ουρά επικοινωνίας με QEMU
    struct virtqueue *vq;
    /* Lock */
    struct semaphore sem;
    //this will be used as we wait for QEMU to process data
    //and needs to lock so that noone else can write to vq of the same
device.
    //becuase in that case QEMU will receive trash.
    //needs to be initialized when new device is attched.

    /* The minor number of the device. */
    unsigned int minor;
};
```

- Αναπαράσταση από την πλευρά του driver ενός ανοιχτού fd

```
    struct crypto_open_file {
    /* The crypto device this open file is associated with. */
    struct crypto_device *crdev;
    /* The fd that this device has on the Host. */
    int host_fd;
};
```

3.2 Κατα την εισαγωγή του module:

- Κάνουμε register τον driver να κάνει handle virtio_devices με συγκεκριμένα χαρακτηριστικά (id). Αυτό γίνεται με την κλήση :

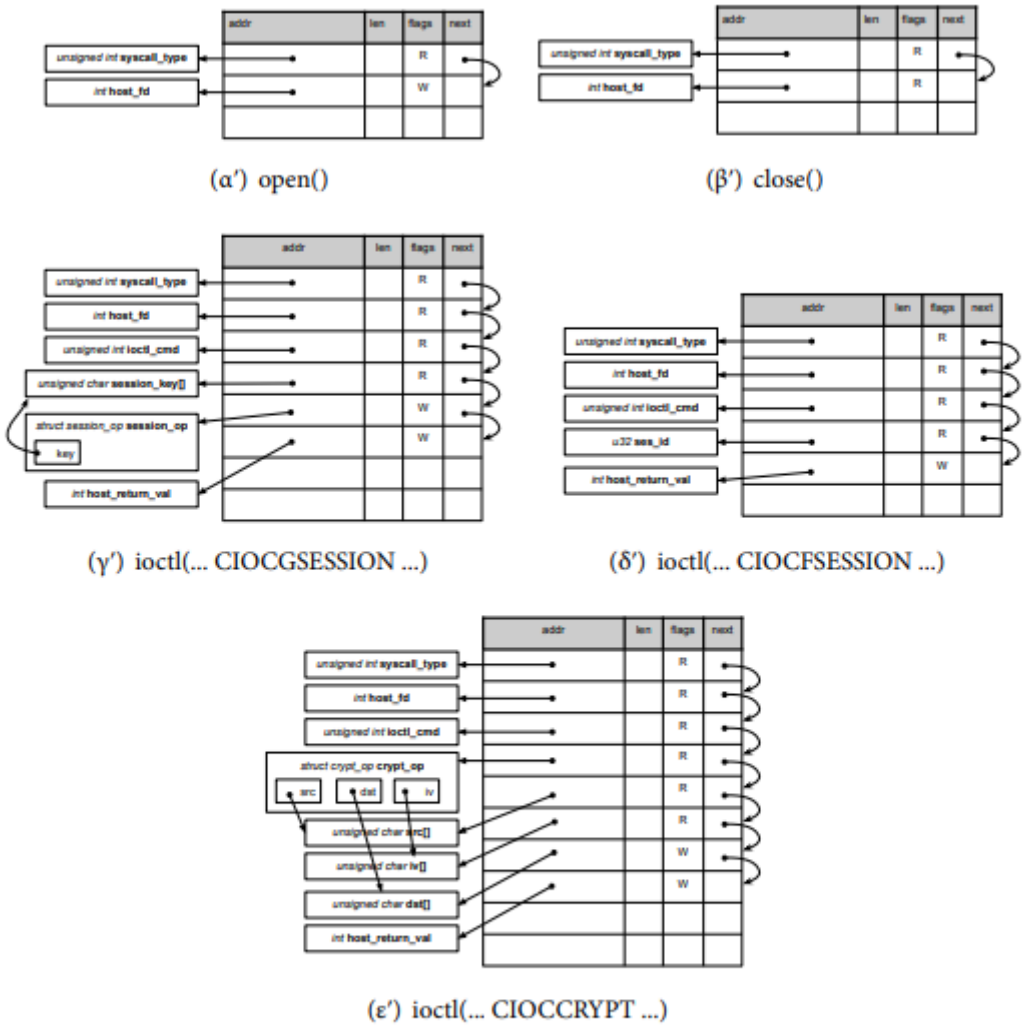
```
    register_virtio_driver(&virtio_crypto);
```

- Βάζουμε ποια συνάρτηση θα κληθεί όταν ο kenrel βρει νέα συσκευή που έχει ίδιο id. Εδώ αυτή η συνάρτηση είναι η

```
static int virtcons_probe(struct virtio_device *vdev);
```

3.3 Πρωτόκολλο μεταφοράς δεδομένων

Χρησιμοποιείται το προτεινόμενο πρωτόκολλο :



Σχήμα 4: Η προτεινόμενη δομή της Virtqueue που χρησιμοποιεί η συσκευή virtio-cryptodev-pci για κάθε κλήση συστήματος.

μόνο που στις περιπτώσεις των buffer οι pointer από structs που μεταβιβάζονται διορθώνονται στην πλευρά του QEMU.

3.4 Περιγραφή συμπεριφοράς system calls στον frontend Driver του VM

- Ανοίγει userspace process του VM κάποιο /dev/cryptodevX το οποίο διαχειρίζεται ο frontend driver.

- Ο frontend driver βρίσκει σε ποια εικονική συσκευή virtio αντιστοιχεί το /dev/cryptodevX (inode) για να βρει με ποια vq θα μιλήσει στον QEMU.

```
    struct crypto_device *crdev;
    ...
    crdev = get_crypto_dev_by_minor(iminor(inode));
    ...
    vq = crdev->vq;
```

- Ο driver στέλνει πληροφορίες στον QEMU μέσω του virtio protocol (virtio_ring), καλεί μέσω VirtualQueues.

  Π.χ. για την open η ετοιμασία της δομής προς αποστολή :

```
    struct scatterlist syscall_type_sg, host_fd_sg, *sgs[2];
    sg_init_one(&syscall_type_sg ,syscall_type, sizeof(*syscall_type)
* 1);
    sgs[num_out++ + num_in] = &syscall_type_sg;

    sg_init_one(&host_fd_sg ,host_fd, sizeof(*host_fd) * 1);
    sgs[num_out + num_in++] = &host_fd_sg;
```

- Καλεί την virtqueue_kick() (hypercall) και κάνει VM_exit (σαν trap) αφού έχει πάρει το lock για το συγκεκριμένο VirtQueue.

```
    if(down_interruptible(&(crdev->sem))){
        ...
    }
    err = virtqueue_add_sgs(vq, sgs, num_out, num_in,
                        &syscall_type_sg, GFP_ATOMIC);  //the
syscall_type_sg is given as primary key.
    virtqueue_kick(vq);
```

- Ο KVM παρεμβαίνει και μεταφέρει τα δεδομένα των virtQueues στον QEMU.

- Ο QEMU ανοίγει file descriptor στον host μηχάνημα που αφορά τον cryptodev driver που διαχειρίζεται πραγματική συσκευή και το διατηρεί ανοιχτό για τις μελλοντικές κλήσεις του frontend driver.

- Ο QEMU απαντά στον frontend driver μέσω των VirtualQueues (βάζοντας τον KVM να αποστείλει). Καλείται σε interrupt context η *vq_has_data* η οποία δεν κάνει τίποτα και απλά επιστρέφει. Ο frontend driver βρίσκεται σε ένα busy wait state όπου περιμένει σύγχρονα τα δεδομένα από το VirtQueue. Αφού τα λάβει διαβάζει τα δεδομένα και αφήνει το lock.

```

```

```
while (virtqueue_get_buf(vq, &len) == NULL)
/* do nothing */;

//now qemu has written everything it was suppossed to.

// read returned data
...
up(&(crdev->sem));
```

4. Backend Driver

4.1 Περιγραφή λειτουργίας του backend driver

- Αρχικά ορίζεται νέα συσκευή η ***virtio-cryptodev-pci*** στο QEMU σύμφωνα με το μοντέλο συσκευών του η οποία κληρονομεί τον τύπο *TYPE_VIRTIO_PCI*.
- Σε αυτήν ορίζεται η συνάρτηση που καλείται *vq_handle_output* όταν υπάρχει έτοιμο virtQueue και έχει κληθεί η *virtqueue_kick* από τον frontend οδηγό οπότε ο έλεγχος μεταβιβάζεται στον QEMU από τον KVM.
- Ο QEMU μπορεί πλέον να διαβάσει το virtQueue και να προσομοιώσει την συμπεριφορά που ζητείται από τον frontend οδηγό ανοίγοντας έναν file descriptor στην πραγματική συσκευή ***/dev/crypto*** στο host μηχάνημα. Ο host_fd και ο τύπος της κλήσης μεταβιβάζεται στις μελλοντικές κλήσεις από τον frontend driver.

```
syscall_type = elem->out_sg[0].iov_base;
switch (*syscall_type) {
case VIRTIO_CRYPTODEV_SYSCALL_TYPE_OPEN:
    ...
    int fd = open("/dev/crypto", O_RDWR);
    ...
    break;
case VIRTIO_CRYPTODEV_SYSCALL_TYPE_CLOSE:
    ...
    host_fd = elem->out_sg[1].iov_base;
    close(*host_fd);
    ...
    break;

case VIRTIO_CRYPTODEV_SYSCALL_TYPE_IOCTL:
    ...
        switch (*ioctl_cmd){
        case CIOCGSESSION:
            ...
            if((ret = ioctl(*host_fd, CIOCGSESSION, &sess))){
                ...
            }
            ...
            break;
```

```
            case CIOCFSESSION:
                if((ret = ioctl(*host_fd, CIOCFSESSION, ses_id))){
                    ...
                }
                ...
                break;
            case CIOCCRYPT:
                ...
                if((ret = ioctl(*host_fd, CIOCCRYPT, &cryp))){
                    ...
                }
                ...
                break;
            }
     break;
     }
```

5. Socket Source Code

SSI.c

```
#include "SSI.h"
#include <stdbool.h>
#include <stdio.h>
#include <errno.h>
#include <ctype.h>
#include <string.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <netdb.h>
#include <sys/time.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include "SafeCalls.h"
#include <sys/un.h>
#include "linkedlist.h"
SSI* ssi_open(char* name, uint16_t port, bool server, int tcp_backlog)
{
    if(server) {
        int sd;
        struct sockaddr_in sa;

        if ((sd = socket(PF_INET, SOCK_STREAM, 0)) < 0) {
            perror("socket");
            exit(1);
        }
```

```
        fprintf(stderr, "Created TCP socket\n");

        /* Bind to a port */
        memset(&sa, 0, sizeof(sa));
        sa.sin_family = AF_INET;
        sa.sin_port = htons(port);
        sa.sin_addr.s_addr = htonl(INADDR_ANY);

        if (bind(sd, (struct sockaddr *)&sa, sizeof(sa)) < 0) {
            perror("bind");
            exit(1);
        }
        fprintf(stderr, "Bound TCP socket to port %d\n", port);

        if (listen(sd, tcp_backlog) < 0) {
            perror("listen");
            exit(1);
        }

        SSI* ssi = sfmalloc(sizeof(SSI));
        ssi->ssi_fd = sd;
        memset(ssi->ssi_name_server, 0, sizeof(ssi->ssi_name_server));

        ssi->port = port;
        ssi->ssi_server = true;
        return ssi;
    }
    //client
    else{
        int sd;
        char *hostname = name;
        struct hostent *hp;
        struct sockaddr_in sa;

        if ((sd = socket(PF_INET, SOCK_STREAM, 0)) < 0) {
            perror("socket");
            exit(1);
        }
        fprintf(stderr, "Created TCP socket\n");

        /* Look up remote hostname on DNS */
        if ( !(hp = gethostbyname(hostname))) {
            printf("DNS lookup failed for host %s\n", hostname);
            exit(1);
        }

        /* Connect to remote TCP port */
        sa.sin_family = AF_INET;
        sa.sin_port = htons(port);
        memcpy(&sa.sin_addr.s_addr, hp->h_addr, sizeof(struct in_addr));
        fprintf(stderr, "Connecting to remote host... "); fflush(stderr);
        if (connect(sd, (struct sockaddr *) &sa, sizeof(sa)) < 0) {
            perror("connect");
            exit(1);
```

```
        }
        fprintf(stderr, "Connected.\n");
        SSI* ssi = sfmalloc(sizeof(SSI));
        ssi->port = port;
        ssi->ssi_fd = sd;
        strcpy(ssi->ssi_name_server, hostname);
        ssi->ssi_server = false;
        return ssi;
    }
}


int ssi_server_accept(SSI* ssip)
{
    if(!ssip->ssi_server){
        fprintf(stderr, "You gave me a client to accpet a server ...\n");
        return -1;
    }
    struct sockaddr_in sa;
    socklen_t len;
    int newsd;
    char addrstr[INET_ADDRSTRLEN];
    int sd = ssip->ssi_fd;

    if ((newsd = accept(sd, (struct sockaddr *)&sa, &len)) < 0) {
        perror("accept");
        return -1;
    }
    if (!inet_ntop(AF_INET, &sa.sin_addr, addrstr, sizeof(addrstr))) {
        perror("could not format IP address");
        return -1;
    }
    fprintf(stderr, "Incoming connection from %s:%d\n", addrstr,
ntohs(sa.sin_port));

    return newsd;
}


bool ssi_close(SSI* ssip)
{
    //  i leave space for future edits to it.
    if(ssip->ssi_server)
    {
        close(ssip->ssi_fd);
        free(ssip);
        return true;
    }
    else
    {
        close(ssip->ssi_fd);
        free(ssip);
        return true;
    }
```

```
}


SSI* ssi_un_open(char* socketname, bool server, int client_queue)
{
    if(!server){
        struct sockaddr_un addr;
        int directorSock;
        directorSock = errorcheck(socket(AF_UNIX, SOCK_STREAM, 0), -1,
"create unix socket as a child\n");
        memset(&addr, 0, sizeof(addr));
        addr.sun_family=AF_UNIX;
        strncpy(addr.sun_path, socketname, sizeof(addr.sun_path)-1);
        printf("trying to connect to %s\n", socketname);
        errorcheck(connect(directorSock, (struct sockaddr*)&addr,
sizeof(addr)), -1, "failed to connect to unix socket");
        SSI* s = sfmalloc(sizeof(SSI));
        s->ssi_fd = directorSock;
        s->ssi_server = false;
        memcpy(s->ssi_name_server, socketname, strlen(socketname));
        return s;
    }else{
        struct sockaddr_un addr;
        int sock = errorcheck(socket(AF_UNIX, SOCK_STREAM, 0), -1, "error
creating unix socket");
        memset(&addr, 0, sizeof(addr));
        addr.sun_family = AF_UNIX;
        memcpy(addr.sun_path, socketname, sizeof(addr.sun_path)-1);
        // errorcheck(unlink(socketname), -1, "[director] failed to unlink
socket");
        errorcheck(bind(sock, (struct sockaddr*)&addr, sizeof(addr)), -1, "
failed to bind to unix socket");
        errorcheck(listen(sock, client_queue), -1, "unixsock listen
failed");
        SSI* s = sfmalloc(sizeof(SSI));
        s->ssi_fd = sock;
        s->ssi_server = true;
        memcpy(s->ssi_name_server, socketname, strlen(socketname));
        return s;
    }
}

int ssi_un_server_accept(SSI* ssip)
{
    if(ssip->ssi_server != true)
    {
        fprintf(stderr, "you gave me a clent to accept conn un sock\n");
        return -1;
    }
    int client = accept(ssip->ssi_fd, NULL, NULL);
    return client;
}
```

part of packet.h and packet.c

```
packet format_wrapper(PACKET_TYPE t, COMMAND_TYPE cmd, char* arg1,
char* arg2, char* arg3, char* arg4, int length, int id,
char* body);

#define packetCU(username, password) format_wrapper(QUESTION, CREATE_USER,
username, password, NULL, NULL, 0, 0, NULL)

#define packetC(username, channelname) format_wrapper(QUESTION,
CREATE_CHANNEL, username, NULL, channelname, NULL, 0, 0, NULL)

#define packetA(username, password, channelname, secondusername)
format_wrapper(QUESTION, ADD_USER, username, password, channelname,
secondusername, 0, 0, NULL)

#define packetR(username, password, channelname, id)
format_wrapper(QUESTION, READ, username, password, channelname, NULL, 0,
id, NULL)

#define packetS(username, password, channelname, msg)
format_wrapper(QUESTION, SEND, username, password, channelname, NULL,
strlen(msg),0, msg)

#define packetServerS(msg) format_wrapper(ANSWER, SERVER_SUCCESS, NULL,
NULL, NULL, NULL, strlen(msg), 0, msg)

#define packetServerF(msg) format_wrapper(ANSWER, SERVER_FAILURE, NULL,
NULL, NULL, NULL, strlen(msg), 0, msg)

packet format_wrapper(PACKET_TYPE t, COMMAND_TYPE cmd, char* arg1,
char* arg2, char* arg3, char* arg4, int length, int id,
char* body)
{
    packet p;
    memset(&p, 0, sizeof(p));
    p.packet_type = t;
    p.command = cmd;
    if(arg1 != NULL){
        memcpy(p.arg1, arg1, strlen(arg1));
    }
    if(arg2 != NULL){
        memcpy(p.arg2, arg2, strlen(arg2));
    }
    if(arg3 != NULL){
        memcpy(p.arg3, arg3, strlen(arg3));
    }
    if(arg4 != NULL){
        memcpy(p.arg4, arg4, strlen(arg4));
    }
    p.length = length;
    p.id = id;
```

```
    if(body != NULL){
        memcpy(p.body, body, length);
    }

    return p;
}
```

epollserver.c

```
#include <fcntl.h>
#include <sys/epoll.h>
#include <errno.h>
#include "SafeCalls.h"
#include <errno.h>
#include <stdio.h>
#include <ctype.h>
#include <string.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <netdb.h>
#include <sys/time.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <stdbool.h>
#include "socket-common.h"
#include "linkedlist.h"
#include "channel.h"
#include "user.h"
#include "message.h"
#include "anutil.h"
#include "Astring.h"
#include "SSI.h"
#include "packet.h"
#include "packet_parser.h"
#include "cryptops.h"


#define MAX_EVENTS 1024
//i want to specify a data type to hold for each handler at any given point
typedef struct {
    packet input;  // the input packet
    size_t offset; // how much of the packet is read.
    int fd;        // the file descriptor that associates the received
packet and client.
} serve_data;
```

```
int set_non_blocking(int sockfd);
int handle_connection(serve_data* req);


list* userlist;
list* channellist;
void AN_protocol_setup()
{
    userlist = emptyList;
    channellist = emptyList;
}


bool validateUser(char* usrname, char* pwd)
{
    printf("@validate with %s and %s\n", usrname, pwd);
    forEachList(userlist, i)
    {
        user* curruser = getData(i);
        if((strcmp(curruser->username, usrname) == 0) && (strcmp(curruser-
>password, pwd) == 0))
        {
            return true;
        }
    }
    return false;
}

channel* checkChannelExistance(char *name)
{
    channel* req = NULL;
    forEachList(channellist, i)
    {
        channel* ch = getData(i);
        if(strcmp(ch->name, name) == 0)
            req = ch;
    }
    return req;
}

bool checkAccessToChannel(channel* req, char* usrname)
{
    bool flag = false;
    forEachList(req->userlist, i)
    {
        user* u = getData(i);
        if(strcmp(u->username, usrname) == 0)
            flag = true;
    }
    return flag;
}

bool checkUserExistance(char* usrname)
{
```

```
    user* u;
    forEachList(userlist, i)
    {
        u = getData(i);
        if(strcmp(usrname, u->username)==0)
            return true;
    }
    return false;
}

#define USERNAME 0
#define COMMAND 1
#define ARGUMENT 2
#define EXTRAUSERNAME 4
#define CHANNELPARAM 3
#define PASSWORD 2
#define MSGNUM 4
packet AN_protocol_execute(packet* p)
{
    char buf[BUFSIZ];
    memset(buf, 0, sizeof(buf));
    if(p->command == CREATE_USER)
    {
        //add user to user list
        if(checkUserExistance(p->arg1)){
            return packetServerS("User already exists");
        }
        userlist = cons(user_constructor(p->arg1, p->arg2), userlist);
        printf("[director] Created user with username : %s, password :
%s\n", ((user*)head(userlist))->username, ((user*)head(userlist))-
>password);
        printf("list length %d\n", listlength(userlist));
        return packetServerS("User created sucessfully.");
    }
    else if(p->command == CREATE_CHANNEL)
    {
        forEachList(channellist, ch)
        {
            if(strcmp(p->arg3,((channel*)getData(ch))->name) == 0)
            {
                printf("[director] channel already exists\n");
                return packetServerF("Channel already exists.");
            }
        }

        channellist = cons(channel_costructor(p->arg3,
cons(user_constructor(p->arg1, "") ,emptyList), emptyList), channellist);
        printf("[director] Created channel with channelname : %s username :
%s, password %s\n", ((channel*)head(channellist))->name,
((user*)head(((channel*)head(channellist))->userlist))->username,
((user*)head(((channel*)head(channellist))->userlist))->password);
        printf("[director] Channellist length %d\n",
listlength(channellist));
        sprintf(buf, "Created channel %s", p->arg3);
```

```
        return packetServerS(buf);

    }
    else if(p->command == ADD_USER)
    {
        // //user
        // //add channel user |
        //validate user.
        if(!validateUser(p->arg1, p->arg2))
        {
            printf("[director] failed to validate user\n");
            return packetServerS("Failed to validate user");
        }
        //check that the channel exists.

        channel* req = checkChannelExistance(p->arg3);
        if(req == NULL){
            printf("[director] channel not found requested = %s\n", p-
>arg3);
            return packetServerF("Channel requested not found");
        }
        if(!checkUserExistance(p->arg4))
        {

            printf("[director] no such user exists %s\n", p->arg4);
            return packetServerF("No such user exists");
        }

        //check that he has access to the channel.
        bool flag = checkAccessToChannel(req, p->arg1);
        if(!flag){
            printf("[director] user %s does not have access to %s\n", p-
>arg1, req->name);
            return packetServerF("Access denied for that channel");
        }
        //add user to the channel.
        req->userlist = cons(user_constructor(p->arg4, ""), req->userlist);
        printf("[director] added user %s to %s\n", p->arg4, req->name);
        sprintf(buf, "added user %s to %s\n", p->arg4, req->name);
        return packetServerS(buf);
    }
    else if(p->command == SEND)
    {
        //as a server we receive the message here.
        //validateUser
        if(!validateUser(p->arg1, p->arg2))
        {
            printf("[director] failed to validate user\n");
            return packetServerS("Failed to validate user");
        }
        //checkChannelExistance
        channel* req = checkChannelExistance(p->arg3);
        if(req == NULL)
        {
```

```
            printf("[director] channel not found requested = %s\n", p->arg3);
            return packetServerF("Channel requested not found");

        }
        //check user access to the channel.
        if(!checkAccessToChannel(req, p->arg1))
        {
            printf("[director] user %s does not have access to %s\n", p->arg1, req->name);
            return packetServerF("Access denied for that channel");
        }
        // memcpy(buf, p->body, p->length);
        snprintf(buf,5+strlen(p->arg1)+p->length ,"[%s]\t %s", p->arg1, p->body);
        int previousId = (req->messagelist == emptyList) ? -1 : (((message*)head(req->messagelist))->id);
        req->messagelist = cons( message_constructor(++previousId, buf , user_constructor(p->arg1, "")) , req->messagelist);
        printf("[director] msg = %s to %s\n", (((message*)(head(req->messagelist)))->text), req->name);
        return packetServerS("Sent packet successfully");

    }
    else if(p->command == READ)
    {

        //validateUser
        if(!validateUser(p->arg1, p->arg2))
        {
            printf("[director] failed to validate user\n");
            return packetServerS("Failed to validate user");
        }
        //checkChannelExistance
        channel* req = checkChannelExistance(p->arg3);
        if(req == NULL)
        {
            printf("[director] channel not found requested = %s\n", p->arg3);
            return packetServerF("Channel requested not found");

        }
        //check user access to the channel.
        if(!checkAccessToChannel(req, p->arg1))
        {
            printf("[director] user %s does not have access to %s\n", p->arg1, req->name);
            return packetServerF("Access denied for that channel");
        }
        //no we have to give all the messages that are greater or equal to the requested one.
        //might fix to recursion in another lifetime
        int maxid = ((message*)head(req->messagelist))->id;
        int id = p->id;
```

```
        forEachList(req->messagelist, i)
        {
            message* msg = getData(i);
            if(msg->id == id)
            {
                packet temp =  packetServerS(msg->text);
                temp.id = maxid;
                return temp;
            }
        }
        return packetServerF("No such packet");
    }
    else
    {
        printf("[director] failed command\n");
        return packetServerF("Failed Question");
    }

}




int main()
{
    struct epoll_event ev, events[MAX_EVENTS];
    int epollfd, nfds, client_sock;
    serve_data *newdata;
    SSI* server = ssi_open(NULL, TCP_PORT, true, TCP_BACKLOG);
    //epoll file descriptor.
    errorcheck(epollfd = epoll_create1(0), -1, "failed @ epoll_create1()");
// you can add cloexec to close on execve

    //Add the server listening socket to epoll
    ev.events = EPOLLIN; //read operations.
    ev.data.fd = server->ssi_fd;
    errorcheck(epoll_ctl(epollfd, EPOLL_CTL_ADD, server->ssi_fd, &ev), -1,
"failed to add server socket to epoll");
    AN_protocol_setup();

    while(1)
    {
        nfds = epoll_wait(epollfd, events, MAX_EVENTS, -1); //-1 timeout
block indefinitely.
        errorcheck(nfds, -1, "failed @epoll_wait inside event loop");

        //cycle through ready fds.
        for(int i = 0; i < nfds; i++)
        {
            if(events[i].data.fd == server->ssi_fd)
            {
                //handle new connection.
                client_sock = ssi_server_accept(server);
                if(set_non_blocking(client_sock) < 0){
```

```
                    fprintf(stderr, "failed to set_non_block\n");
                    close(client_sock);
                    continue;
                };
                ev.events = EPOLLIN | EPOLLET; //set the client for read
and make it edge triggered.
                //this means that non consumed data will not trigger
epoll_wait to return.

                //allocate the new data for each fd.
                newdata = sfmalloc(sizeof(serve_data));
                memset(newdata, 0, sizeof(serve_data));
                newdata->fd = client_sock;
                newdata->offset = 0;   //it is already zero it is here for
sanity check.

                ev.data.ptr = newdata;
                //Put client in the set of clients we are handling.
                if(epoll_ctl(epollfd, EPOLL_CTL_ADD, client_sock, &ev) < 0)
{
                    fprintf(stderr, "failed to add a client to epoll
struct\n");
                    close(client_sock);
                    continue;
                }
            }
            else{
                if(handle_connection(events[i].data.ptr) == -1){
                    //remove him from the epoll list.
                    int closingfd = ((serve_data *)events[i].data.ptr)->fd;
                    serve_data* data = events[i].data.ptr;
                    errorcheck(epoll_ctl(epollfd, EPOLL_CTL_DEL, closingfd,
&ev), -1,
                     "failed to remove finished @ connection for epoll");
                    close(closingfd);
                    free(data);
                    fprintf(stderr, "closed one!!\n");


                };
            }
        }



    }
    return 0;
}


int set_non_blocking(int sockfd)
{
    int flags, s;
    //get previous state
```

```
    flags = fcntl(sockfd, F_GETFL, 0);
    errorcheck(flags, -1, "fnctl getfl failed");
    //set new state with nonblock on
    flags |= O_NONBLOCK;
    s = fcntl(sockfd, F_SETFL, flags);
    errorcheck(s, -1, "fnctl setfl failed");
    return 0;
}


int handle_connection(serve_data* req)
{
    int fd = req->fd;
    packet response;
    int nread = read(fd, ((unsigned char* )&(req->input)) + req->offset,
sizeof(req->input) - req->offset);
    //non_blocking and if it would block a flag is returned.
    if(nread == -1 && errno == EWOULDBLOCK){
        return 1;
    }if(nread == 0){
        return -1;
    }
    //renew what percentage of a full packet we have read.
    req->offset += nread;
    if(req->offset == sizeof(req->input))
    {
        fprintf(stderr, "full packet of size %ld", req->offset);
        //decrypt before executing.
        packet result;
        decryption(&req->input ,&result, sizeof(result));
        response = AN_protocol_execute(&result);
        //encrypt before sending response
        encryption(&response, &result, sizeof(result));
        memcpy(&response, &result, sizeof(result));
        insist_write(fd, &response, sizeof(response));
        return -1;
    }

    // write(fd, buf, nread);
    return 1;
}
```

client.c

```
#include <stdio.h>
#include <errno.h>
#include <ctype.h>
#include <string.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
```

```c
#include <netdb.h>
#include <sys/time.h>
#include <sys/types.h>
#include <sys/socket.h>
#include <fcntl.h>
#include <arpa/inet.h>
#include <netinet/in.h>
#include <stdbool.h>
#include "socket-common.h"
#include <sys/wait.h>
#include <sys/un.h>
#include "linkedlist.h"
#include "anutil.h"
#include "Astring.h"
#include "packet.h"
#include "packet_parser.h"
#include "SSI.h"
#include "cryptops.h"

#define Black "\033[0;30m"
#define Red "\033[0;31m"
#define Green "\033[0;32m"
#define Yellow "\033[0;33m"
#define Blue "\033[0;34m"
#define Purple "\033[0;35m"
#define Cyan "\033[0;36m"
#define White "\033[0;37m"
#define RESET_COLOR "\e[m"

char input[BUFSIZ];
char username[BUFSIZ];
char password[BUFSIZ];
int port;
char servername[256];
SSI* s;
//commands will be
void handle_create();
void handle_login();
int read_response();
void handle_help();
void handle_send();
void handle_follow();
void handle_add();

ssize_t encrypt_insist_write_wrapper(const void *buf, size_t cnt)
{
    s = ssi_open(servername, port, false, 0);
    int fd = s->ssi_fd;
    return encrypt_insist_write(fd, buf, cnt);
}

int main(int argc, char** argv)
{
```

```
    if(argc != 3){
        printf("Usage ./client <address> <port>\n");
        exit(1);
    }
    port = atoi(argv[2]);
    memset(servername, 0, sizeof(servername));
    memcpy(servername, argv[1], strlen(argv[1]));

    memset(input, 0, sizeof(input));
    handle_login();
    while(1)
    {
        printf("> ");
        scanf("%s", input);
        if(!strcmp(input, "exit")){
            goto exit;
        }
        else if(!strcmp(input, "create")){
            handle_create();
        }
        else if(!strcmp(input, "send")){
            handle_send();
        }
        else if(!strcmp(input, "follow")){
            handle_follow();
        }
        else if(!strcmp(input, "help")){
            handle_help();
        }
        else if(!strcmp(input, "add")){
            handle_add();
        }
        else{
            printf(Red"-"RESET_COLOR" Uknown command (try help)\n");
        }
        memset(input, 0, sizeof(input));

    }

exit:
    return 0;
}


int read_response()
{
    packet p, q;
    insist_read(s->ssi_fd, &q, sizeof(packet));
    decryption(&q, &p, sizeof(packet));

    ssi_close(s);
    //here we need to decrypt it.
    if(p.command == SERVER_SUCCESS){
        printf(Green"- "RESET_COLOR"%s\n", p.body);
```

```
        return p.id;
    }
    else if(p.command == SERVER_FAILURE){
        printf(Red"- "RESET_COLOR"%s\n", p.body);
    }
    return 0;
}

void handle_login()
{
    memset(username, 0, sizeof(username));
    memset(password, 0, sizeof(password));
    printf("Enter a username [only 8 chars will be accepted] : ");
    scanf("%s", username);
    printf("Enter a password : [only 8 chars will be accepted] : ");
    scanf("%s", password);
    packet p = packetCU(username, password);
    int read = encrypt_insist_write_wrapper(&p, sizeof(p));
    read_response();
}

void handle_create()
{
    memset(input, 0, sizeof(input));
    printf("channel name to be created : ");
    scanf("%s", input);
    packet p = packetC(username, input);
    int read = encrypt_insist_write_wrapper(&p, sizeof(p));
    read_response();

}

void handle_help(){
    printf("Available Commands Are :\n"Blue"create\t"RESET_COLOR"to create
newchannel\n");
    printf(Blue"follow\t"RESET_COLOR"read contents of a channel\n");
    printf(Blue"send\t"RESET_COLOR"send msg to a channel\n");
    printf(Blue"add\t"RESET_COLOR"add user to a channel\n");
    printf(Blue"exit\t"RESET_COLOR"terminate connection\n");

}

void handle_send()
{
    memset(input, 0, sizeof(input));
    char channelname[BUFSIZ];
    printf("channel : ");
    scanf("%s", channelname);
    printf("Enter message >");
    scanf("\n");
    memset(input, 0, sizeof(input));
    int nread = 0, n;
    fgets(input, PACKET_MAX_BODY_LENGTH, stdin);
    char* cp = strchr(input, '\n');
```

```
    *cp = 0;
    packet p;
    p = packetS(username, password, channelname, input);
    int read = encrypt_insist_write_wrapper(&p, sizeof(p));
    read_response();
    memset(input, 0, sizeof(input));
}


void handle_follow()
{
    memset(input, 0, sizeof(input));
    char channelname[BUFSIZ];
    printf("channel : ");
    scanf("%s", channelname);
    //now get all msges from that channel.
    int id = 0;
    packet p = packetR(username, password, channelname, id);
    int maxid = id+1;

    while(id <= maxid)
    {
        int read = encrypt_insist_write_wrapper(&p, sizeof(p));
        maxid = read_response();
        p.id++;id++;
    }

}


void handle_add()
{
    memset(input, 0, sizeof(input));
    char channelname[BUFSIZ];
    printf("channel : ");
    scanf("%s", channelname);
    char extrauser[BUFSIZ];
    memset(extrauser, 0, sizeof(extrauser));
    printf("user : ");
    scanf("%s", extrauser);

    packet p = packetA(username, password, channelname, extrauser);
    int read = encrypt_insist_write_wrapper(&p, sizeof(p));
    read_response();

}
```

encrypt.c

```
```

```c
#include "socket-common.h"
#include "crypto/cryptodev.h"
#include <sys/ioctl.h>
#include <stdio.h>
#include <unistd.h>
#include <fcntl.h>
#include <string.h>
#include "linkedlist.h"
#include "cryptops.h"
#include "SafeCalls.h"
#include "anutil.h"

/**
 * @brief encrypts data
 *
 * @param input data to be ecrypted
 * @param output encrypted data
 * @param size size of input/output data
 */
void encryption(unsigned char* input, unsigned char* output,int size){

    int fd = open(CRYPTODEV_NODE, O_RDWR);
    errorcheck(fd,-1,"open(/dev/crypto) {encrypt}");

    unsigned char key[] = KEY;
    unsigned char iv[] = IV;

    struct session_op sess;
    struct crypt_op cryp;

    memset(&sess, 0, sizeof(sess));
    memset(&cryp, 0, sizeof(cryp));

    /*
     * Get crypto session for AES128
     */
    sess.cipher = CRYPTO_AES_CBC;
    sess.keylen = KEY_SIZE;
    sess.key = key;

    errorcheck(!ioctl(fd, CIOCGSESSION, &sess),0, "ioctl(CIOCGSESSION)
{encrypt}" );

    /*
     * Encrypt input to output
     */
    cryp.ses = sess.ses;
    cryp.len = size;
    cryp.src = input;
    cryp.dst = output;
    cryp.iv = iv;
    cryp.op = COP_ENCRYPT;
```

```
    errorcheck(!ioctl(fd, CIOCCRYPT, &cryp),0, "ioctl(CIOCCRYPT) {encrypt}"
);

    /*Finish crypto session*/
    errorcheck(!ioctl(fd, CIOCFSESSION, &sess.ses),0,"ioctl(CIOCFSESSION)
{encrypt}");

    errorcheck(close(fd),-1,"close(/dev/crypto) {encrypt}");

}


ssize_t encrypt_insist_write(int fd, void* buf, size_t cnt){
    unsigned char* bufout = sfmalloc(cnt);
    memset(bufout, 0, cnt);
    encryption(buf,bufout,cnt);
    return insist_write(fd,bufout,cnt);
}
```

decrypt.c

```
#include "socket-common.h"
#include "crypto/cryptodev.h"
#include <sys/ioctl.h>
#include <stdio.h>
#include <unistd.h>
#include <fcntl.h>
#include <string.h>
#include "linkedlist.h"
#include "cryptops.h"
#include "SafeCalls.h"
#include "anutil.h"

/**
 * @brief encrypts data
 *
 * @param input data to be ecrypted
 * @param output encrypted data
 * @param size size of input/output data
 */
void encryption(unsigned char* input, unsigned char* output,int size){

    int fd = open(CRYPTODEV_NODE, O_RDWR);
    errorcheck(fd,-1,"open(/dev/crypto) {encrypt}");

    unsigned char key[] = KEY;
    unsigned char iv[] = IV;

    struct session_op sess;
    struct crypt_op cryp;
```

```
    memset(&sess, 0, sizeof(sess));
    memset(&cryp, 0, sizeof(cryp));

    /*
     * Get crypto session for AES128
     */
    sess.cipher = CRYPTO_AES_CBC;
    sess.keylen = KEY_SIZE;
    sess.key = key;

    errorcheck(!ioctl(fd, CIOCGSESSION, &sess),0, "ioctl(CIOCGSESSION)
{encrypt}" );

    /*
     * Encrypt input to output
     */
    cryp.ses = sess.ses;
    cryp.len = size;
    cryp.src = input;
    cryp.dst = output;
    cryp.iv = iv;
    cryp.op = COP_ENCRYPT;

    errorcheck(!ioctl(fd, CIOCCRYPT, &cryp),0, "ioctl(CIOCCRYPT) {encrypt}"
);

    /*Finish crypto session*/
    errorcheck(!ioctl(fd, CIOCFSESSION, &sess.ses),0,"ioctl(CIOCFSESSION)
{encrypt}");

    errorcheck(close(fd),-1,"close(/dev/crypto) {encrypt}");

}


ssize_t encrypt_insist_write(int fd, void* buf, size_t cnt){
    unsigned char* bufout = sfmalloc(cnt);
    memset(bufout, 0, cnt);
    encryption(buf,bufout,cnt);
    return insist_write(fd,bufout,cnt);
}
```