厦門大學

信息学院软件工程系

《计算机网络》实验报告

题　　目　实验五　应用层协议服务配置

班　　级　软件工程 2021 级卓越班

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2023 年 5 月 23 日

填写说明

1、本文件为 Word 模板文件，建议使用 Microsoft Word 2021 打开，在可填写的区域中如实填写；

2、填表时勿改变字体字号，保持排版工整，打印为 PDF 文件提交；

3、文件总大小尽量控制在 1MB 以下，最大勿超过 5MB；

4、应将材料清单上传在代码托管平台上；

5、在实验课结束 14 天内，按原文件发送至课程 FTP 指定位置。

1 实验目的

通过完成实验，掌握基于 RFC 应用层协议规约文档传输的原理，实现符合接口且能和已有知名软件协同运作的软件。

2 实验环境

操作系统：Windows11

编程语言：C++

3 实验结果

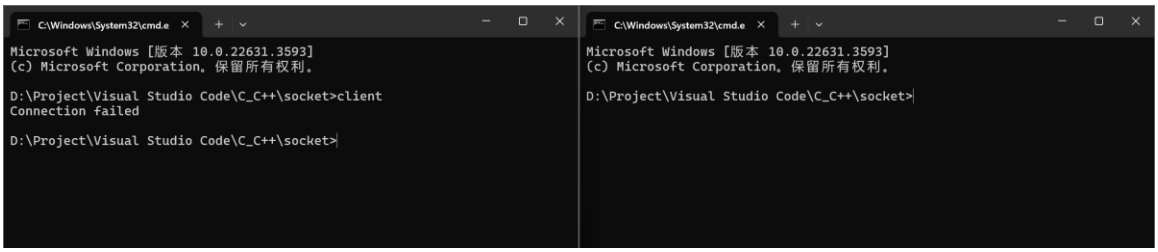
按照 socket api 的方法首先配置好两个可以通信的进程

服务器的配置

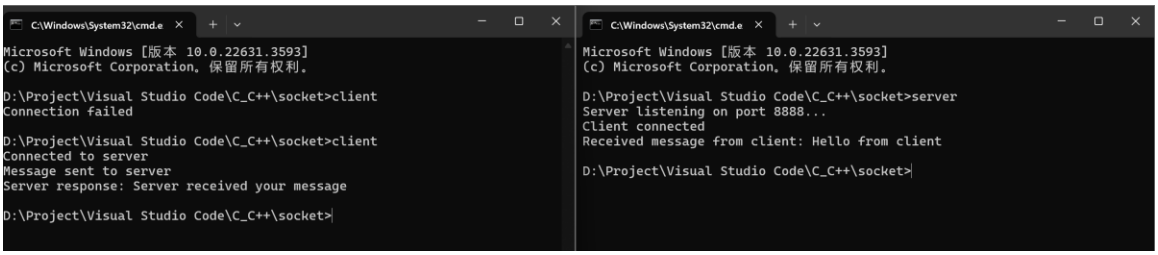
```
// 创建服务器 socket
serverSocket = socket(AF_INET, SOCK_STREAM, 0);
if (serverSocket == INVALID_SOCKET) {
    cerr << "Socket creation failed" << endl;
    WSACleanup();
    return 1;
}

// 设置服务器地址结构
serverAddr.sin_family = AF_INET;
serverAddr.sin_addr.s_addr = INADDR_ANY;
serverAddr.sin_port = htons(PORT);

// 绑定服务器地址到 socket
if (bind(serverSocket, (struct sockaddr *)&serverAddr, sizeof(serverAddr)) == SOCKET_ERROR) {
    cerr << "Bind failed" << endl;
    closesocket(serverSocket);
    WSACleanup();
    return 1;
}

// 监听连接
if (listen(serverSocket, SOMAXCONN) == SOCKET_ERROR) {
    cerr << "Listen failed" << endl;
    closesocket(serverSocket);
    WSACleanup();
    return 1;
}

cout << "Server listening on port " << PORT << "..." << endl;
```

客户端的配置

服务器未启动时，客户端连接失败。



启动服务器后，客户端向服务器发送“Hello”，且服务器接收成功



在使用 g++进行编译时发现有如下问题，在编译时使用-lws2_32 链接 ws2_32.lib 即可正常生成可执行程序

```
 undefined reference to `__imp_WSAStartup'
 undefined reference to `__imp_socket'
 undefined reference to `__imp_WSACleanup'
 undefined reference to `__imp_htons'
): undefined reference to `__imp_bind'
): undefined reference to `__imp_closesocket'
): undefined reference to `__imp_WSACleanup'
): undefined reference to `__imp_listen'
): undefined reference to `__imp_closesocket'
): undefined reference to `__imp_WSACleanup'
): undefined reference to `__imp_accept'
): undefined reference to `__imp_closesocket'
): undefined reference to `__imp_WSACleanup'
): undefined reference to `__imp_recv'
): undefined reference to `__imp_send'
): undefined reference to `__imp_closesocket'
): undefined reference to `__imp_closesocket'
): undefined reference to `__imp_WSACleanup'
```

接下来该代码基础上编写登陆购买连接等逻辑

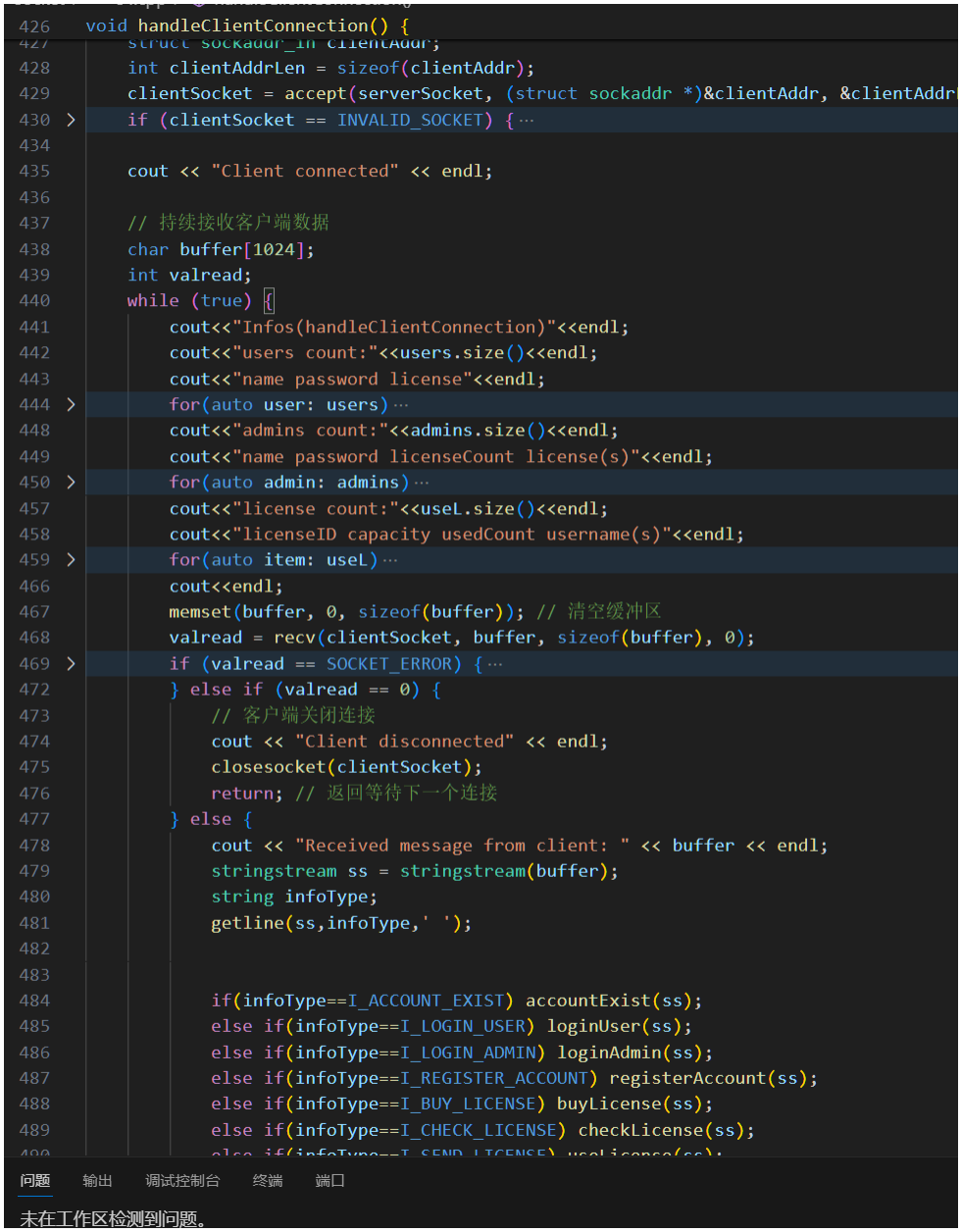
编写头文件，使得服务器与客户端两个代码间使用统一的确认信息

socket > C basic.h > LICENSE_PATH

```cpp
#include <iostream>
#include <fstream>
#include <sstream>
#include <string>
#include <vector>
#include <map>
#include <winsock2.h>
#include <ctime>

using namespace std;

#define IS_A_USER "user"
#define IS_A_ADMIN "admin"
#define ACCOUNT_NOT_EXIST "null"
#define ACCOUNT_ALREADY_EXIST "Account already exist"
#define REGISTER_SUCCESS "Registration successful"
#define PASSWORD_INCORRECT "Password incorrect"
#define LOGIN_SUCCESS "Log in successfully"
#define NO_LICENSE "You have no license now"
#define HAVE_LICENSE "You are using a license"
#define USE_SUCCESS "Use the license successfully"
#define USE_FAILED "License is not existed or full"

#define USER_PATH "resource/server_user.txt"
#define ADMIN_PATH "resource/server_admin.txt"
#define LICENSE_PATH "resource/server_license.txt"

// 统一客户端与进程间的指令代码
#define I_ACCOUNT_EXIST "000"
#define I_LOGIN_USER "001"
#define I_LOGIN_ADMIN "002"
#define I_REGISTER_ACCOUNT "003"
#define I_BUY_LICENSE "004"
#define I_CHECK_LICENSE "005"
#define I_SEND_LICENSE "006"
```

服务器端：

```cpp
// 加载用户信息
void loadUserInfoFromFile() {…
// 加载管理员信息
void loadAdminInfoFromFile() {…
// 加载许可证的使用情况
void loadLicenseInfo() {…
// 保存用户信息到文件
void saveUserInfoToFile() {…
// 保存管理员信息到文件
void saveAdminInfoToFile() {…
// 保存许可证使用情况
void saveLicenseINfoTofile() {…
```



```
426  void handleClientConnection() {
427      struct sockaddr_in clientAddr;
428      int clientAddrLen = sizeof(clientAddr);
429      clientSocket = accept(serverSocket, (struct sockaddr *)&clientAddr, &clientAddr
430      if (clientSocket == INVALID_SOCKET) {…
434
435      cout << "Client connected" << endl;
436
437      // 持续接收客户端数据
438      char buffer[1024];
439      int valread;
440      while (true) {
441          cout<<"Infos(handleClientConnection)"<<endl;
442          cout<<"users count:"<<users.size()<<endl;
443          cout<<"name password license"<<endl;
444          for(auto user: users)…
448          cout<<"admins count:"<<admins.size()<<endl;
449          cout<<"name password licenseCount license(s)"<<endl;
450          for(auto admin: admins)…
457          cout<<"license count:"<<useL.size()<<endl;
458          cout<<"licenseID capacity usedCount username(s)"<<endl;
459          for(auto item: useL)…
466          cout<<endl;
467          memset(buffer, 0, sizeof(buffer)); // 清空缓冲区
468          valread = recv(clientSocket, buffer, sizeof(buffer), 0);
469          if (valread == SOCKET_ERROR) {…
472          } else if (valread == 0) {
473              // 客户端关闭连接
474              cout << "Client disconnected" << endl;
475              closesocket(clientSocket);
476              return; // 返回等待下一个连接
477          } else {
478              cout << "Received message from client: " << buffer << endl;
479              stringstream ss = stringstream(buffer);
480              string infoType;
481              getline(ss,infoType,' ');
482
483
484              if(infoType==I_ACCOUNT_EXIST) accountExist(ss);
485              else if(infoType==I_LOGIN_USER) loginUser(ss);
486              else if(infoType==I_LOGIN_ADMIN) loginAdmin(ss);
487              else if(infoType==I_REGISTER_ACCOUNT) registerAccount(ss);
488              else if(infoType==I_BUY_LICENSE) buyLicense(ss);
489              else if(infoType==I_CHECK_LICENSE) checkLicense(ss);
490              else if(infoType==I_SEND_LICENSE) useLicense(ss);
```

问题　输出　调试控制台　终端　端口

未在工作区检测到问题。

客户端

```
// 登陆的多个流程…
string accountExist(string &name)…
bool loginUser(string username)…
bool loginAdmin(string adminName)…
bool registerAccount(string name)…
bool login(string name)…

// 购买与使用许可证
bool buyLicense()…
bool toUse() {…
int main() {…
```

```
int main() {
    if (!connectToServer()) {…

    while (true) {
        reset();
        // 读取用户输入
        std::cout << "Enter accountname (or 'exit' to quit): ";
        string accountname;
        std::cin >> accountname;

        // 检查用户是否想退出
        if (accountname == "exit") {
            break;
        }

        // 检查消息是否为空
        if (accountname.empty()) {
            cout << "Cannot send empty message" << endl;
            continue;
        }

        if (login(accountname))
        {
            if(isAdmin)
            {
                string confirm;
                cout<<"Buy license?(yes/not):";
                cin>>confirm;
                if(confirm == "yes") {
                    if(buyLicense()) cout<<"Buy license successfully!"<<endl;
                    else cout<<"Buy license failed"<<endl;
                }

            }
            else
            {
                toUse();
            }
        }

    }
```

当输入用户名不存在时，实现注册

客户端↓

```
Connected to server
Enter accountname (or 'exit' to quit): 10005
Account not found. Would you like to register? (yes/no): yes
Enter password: 123
Are you an administrator? (yes/no): no
Enter accountname (or 'exit' to quit):
```

服务器↓

```
Received message from client: 000 10005
Infos(handleClientConnection)
users count:4
name password license
10001 123 null
10002 123 null
10003 123 null
10004 123 null
admins count:4
name password licenseCount license(s)
111 123 0
222 123 0
333 123 0
444 123 0
license count:0
licenseID capacity usedCount username(s)

Received message from client: 003 10005 123 user
Infos(handleClientConnection)
users count:5
name password license
10001 123 null
10002 123 null
10003 123 null
10004 123 null
10005 123 null
admins count:4
name password licenseCount license(s)
111 123 0
222 123 0
333 123 0
444 123 0
license count:0
licenseID capacity usedCount username(s)
```

购买许可证

客户端，购买成功接收到服务器随机生成的 license↓

```
Enter accountname (or 'exit' to quit): 111
Is a admin
Enter password(or 'exit' to quit):123
Buy license?(yes/not):yes
Input count of license could capacity?(50/10/2):2
get license:2439726918
Buy license successfully!
Enter accountname (or 'exit' to quit):
```

服务器随机生成许可证

```
string id;
srand(time(NULL));
for (int i = 0; i < 10;i++)
{
    id.push_back(rand()%10+'0');
}
cout<<"The license is:"<<id<<endl;
```

在本地文件中成功更新该记录

用两个账户使用该许可证（便于演示，该许可证容量只有 2）

```
Enter accountname (or 'exit' to quit): 10001
This account is a user
Enter password(or 'exit' to quit):123
Log in successfully
You have no license now
Enter a license to use the software:2439726918
Use the license successfully
Enter accountname (or 'exit' to quit): 10002
This account is a user
Enter password(or 'exit' to quit):123
Log in successfully
You have no license now
Enter a license to use the software:2439726918
Use the license successfully
Enter accountname (or 'exit' to quit):
```

服务器输出的信息可以看到该许可证的两个用户

```
licenseID capacity usedCount username(s)
2439726918 2 2 10001 10002
```

此时新用户使用该许可证时无法通过

```
Enter accountname (or 'exit' to quit): 10003
This account is a user
Enter password(or 'exit' to quit):123
Log in successfully
You have no license now
Enter a license to use the software:2439726918
License is not existed or full
```

基本实现实验要求功能

4 实验代码

本次实验的代码已上传于以下代码仓库：Codes/ComputerNetwork/exp5 at main · MidiAug/Codes (github.com)

5 实验总结

通过完成实验，我掌握了应用层文件传输的原理，理解了传输过程中应用层协议的重要性，并学会了设计和实现简单的许可证验证机制。