



计算机网络实验报告

实验四：应用层实验

数据科学与计算机学院 17大数据与人工智能

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一、实验目的

掌握应用层的基本工作原理和实现方法。

二、实验工具

Telnet或SecureCRT

三、实验环境

本机为Ubuntu 18.04 (LTS) + gcc 7.3.0

四、注意事项

- 截屏时注意遮盖掉自己的邮箱密码
- QQ邮箱需要在Web访问方式下开启POP3和SMTP服务才允许在客户端访问(设置/账号/开启POP3/SMTP)，否则会出现错误“454 Authentication failed, please open smtp flag first!”
- QQ邮箱的接收邮件服务器：pop.qq.com，端口号为995
- QQ邮箱的发送邮件服务器：smtp.qq.com，端口号为465
- 客户端登录的用户名为QQ号的base64编码
- 客户端登录的密码也采用base64编码

五、实验内容

先认真阅读课件Chapter2-application-layer.pdf，再完成下面内容。注意：协议标准可以查阅RFC；选取的内容不要与课件相同；响应内容太长时自己选取截取前后部分以及其中重点部分。

参考视频：<http://172.18.187.9/video/>

（选做）使用自己编写的TcpClient运行步骤一~步骤四，具体见步骤六。

如果不自己编写TcpClient，可以尝试使用老师给的TcpClient.exe完成步骤一~步骤四，如果不愿意尝试，可以使用telnet来完成实验。

1. HTTP协议

看完HTTP协议的课件后完成以下实验。

1. 从学院网站 (sdcs.sysu.edu.cn) 找一网页下载。

http请求:

```
1 GET /content/3822 HTTP/1.1
2 Connection:close
3 Host:sdcs.sysu.edu.cn
```

http响应:

```
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
$ ./client sdcs.sysu.edu.cn 80
Host: sdcs.sysu.edu.cn 80
Connecting to server...
Connected!

GET /content/3822 HTTP/1.1
Connection:keep-alive
Host:sdcs.sysu.edu.cn

Sending...
Finish sending.
HTTP/1.1 202 Accepted
Server: *****
Date: Wed, 03 Apr 2019 02:11:04 GMT
Content-Type: text/html; charset=utf-8
Transfer-Encoding: chunked
Connection: keep-alive
Pragma: no-cache
Cache-Control: no-cache
Expires: Wed, 03 Apr 2019 02:11:04 GMT
Set-Cookie: FSSBB11UgzbN7N80T=43k_Sip2VP6vjAZmgVNaUK0hbtY9Q50U, zR5ewQRo.16.X0bJ6EYVgmHnK91WkGXCeF8c6A1bkft00qJpw2Vqxm
eTisy.kyZ2R3QaC8Z5C0doelkc_vUJOnxfhbclikA8iXWQbrrJgUxGnZrabbMV43qf_QndouUX_ie62a8Adz7514zCH4edTFvHmAtmEz3E, Path=/; exp
ires=Sat, 31 Mar 2029 02:11:04 GMT
Set-Cookie: FSSBB11UgzbN7N80S=nF85PfiWEdeP_V5R0Rrm_7w4JA9meFm4v3uRXYImlx4H6yvr6xrRuIqHk7WnQsrxX; Path=/; expires=Sat, 31
Mar 2029 02:11:04 GMT; HttpOnly

637b
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=utf-8">
<meta content="LIQC7w57WD?Hh?H27Hj?Jx7wR7N-7NH7K, 9Q)8amp.Q2\beehVffboV5VVZVghYabc:e,nj`M@_&gt;7f~iLOAK)H81t,CGm.?=>FE/(
XLID (-pN6WIdk)J9,loU+P [+Zqsrt 1#3#uvwxvz0356QSTVhVYl_bVtV1b_i[VvedWjVw)P)l)z&amp;.&gt;Jo6tPtfzfridT[qrrRr5umudpErEmedSh9
tIglVvYkVdUe4omF02edUyVWuegS#sqxpsdI7u7v66o0 (fRe1lvkIr3m8kdwVps3rkuU- [JQv&gt;UyWfm)WfRO&gt;.(QzcFgI&gt;Ge15QyHl
Q1I5&gt;3-OrGQm8&gt;ml_k/hPi&gt;5n(C)g&gt;F026+wy(4h&gt;.*20-v2V/N&gt;.(QkIFLXm31&gt;.(O)k+hKTh0v&gt;.)7P-4JEJqg24)2&gt;Q.v
W0ne&gt;.)22h)K2+4gUv&gt;.(xK[hv&gt;NMKrf)Xr:W&gt;QS1PGnX1Q&gt;Ux2j(3w&gt;3
-hWf1xUUEW)A1f7&gt;USv&gt;UT1j(klCm7&gt;f2PN/nPz&gt;./@7n&gt;./fgSmkeX/2/c/k1&gt;./T5cmkOHU1i/.16mQ4x5)Di+, xFMV?`MKL(-5
&gt;4n&gt;4n&gt;v7,(f7,+)7P7Q&gt;.+vY2_3Dx5IK/RT2EU-PEUxOxFT715JKE5V+53v7m0&gt;.N70z7L1N7eD7)4N&gt;QJ7k&gt;.*k(1 N7&gt;.TDN(y
7)G(f MK-NIU2F2x)lOTdnK0&gt;.)fXJ4J24gVv3v&gt;.[4&gt;.&gt;Onz&gt;hA1X5Qv&gt;.iND4nK0&gt;.3QPPFIUF0I87&gt;.FgX/+v&gt;.I5&gt;.mLU
8m0&gt;.&gt;.H2FfEc.PJUQO)7.Wj/L2VRME&gt;.5&gt;+ln_h2Xg(x*&gt;N40&gt;.UMU-/&gt;.mI7kUmzem3V2[1&gt;.UMV7RKCEm0&gt;.(gKNz27mdx7
eN0K.77&gt;.5y,00g1T0v&gt;.7-OF(4/B(ePy**Qx0.7toz7,=#s9_gJE_MfLlO.Ju8Ng)Or=Q09PN(B.,d)4nC)tG GGt)Gooq)uxds\oCOI( (vEI
ja) +yq0Vf=KFgA-*x(dD(v)0wM+-.:??+).@q&gt;.9Q&gt;.s-/adN,7@eD?9NqvdM(dGNaDC=QJ.8J'O+0+&gt;.eSF-QG GbK_uqagxAOC(+v
M(J.y0i1F_v0.&gt;.:QD(qQ9) Cy-[aID*00OH9+0PE(rG&gt;.l.MPyxDC(9D0a+0H8)8bx:&gt;.z?P(WVzoQW0_070g020)0a0o0-000+U)U40m)003
A0043A0u0.OCUazyUd0D0&gt;.UyU/OKz[23DUQW]OrUTU0U ?o0bU(YHU1UuUgU)Ux4TU+UHU.24Y:2r2/2?Kz[Uk2x?][042&gt;.U_Uz7A2(2U)U32W@P
ggYU,ATU,.;?EUu3+2uT0z1Um:A7.&gt;.l[2q2H2Q2T2PU ?P?mY7UKK(22?#2[4J2(AEZork2.2J2&amp;.C3zo7[2a@yzE0220?af_2_zK20Y.AmY[2o23
72.P4 H9D2Y7Lu9C7&amp;.7327zVzb2km4a7/zP u?J7T2?z(z3?(&gt;.s@Dz-4L@C7V7BY.g[ akarr[3z0L7ND-&gt;.DT3--o[ WY3kYzA?g?P-P-&
lt;@zz:q7C4Z7z@SY0uz)xP.493@A:C3uKJ&lt;.d&lt;.72, CY)7g? zV&lt;.Z7-43zH3&lt;.zBzYk[A&amp;.r2z/zD7K? 4rZ-AkY2_L|HA#K#3&amp;.H#
YF&lt;.LxUh.4[AgY 40kg d* K:gIzW0z4-gDx]3bz;@3L &amp;.z04b-D0#x0z @ 00;)zk ]@_zuY(3dA.Y&amp;.A:4 AbYH7-Y7 J0Y4(D&lt;.03r @/
H(VQ)to:4.,d&amp;.p&amp;.YLK -OR&amp;.-Yk4 3[ /KU|x&lt;.F0).#ra0VA-D)*m0 @K0W3W-LP].4#rV4UZq A#dAHP.:Q31.b bA -gd-).$-or140.gK
z+3x3k.TP ZYr.E0_74N43J4&amp;.3# T&lt;.l.#p4Y3C#0E3y#(&lt;.y x0(#442J4Vg0)q4lr&amp;.s4s.rL3Q0?gJogmK-(,J+Y4Tx[Bb#Za#7Zyx
QqV.,oW3rJ:U7#q0c,*#H: OJp0K3(A mx P2D.)-kgA4-a&lt;C.Zme@A.gbKL2a0kxg4.[3r47 zmZ 7 *Kx:OP L Ax r.Gu7&lt;.EBKroUDWu
r74m3x#Hb:q(Cy ?gsmkoA27P.C4DuD:7d#k*eg 3 V0K#VY &amp;.#l:8Pz:P-EA&gt;#xmi:l:l0-B0&amp;.40xImD-kB)54P.[fPm?;.s
kkoEDk0D W_./22m34T.0m0&lt;.m*2H0m3E/D.#2&lt;.VeExL.[2o]-qWrx:4D ZE#uC/rul,-P-#m1z:c*2K4gH #7 (EZd)(.KCE&lt;W (kgs.EDP
#0oA&lt;D&lt;.r:1&lt;.kdu? Z0H7Y.gZACU70 *x m&lt;.P:5 Um#;D0..s2#&lt;.lUlPJ./AQmLxWg.&lt;.0rAx#xmi)mz?YTDJZuk2.&lt;.C22K6_Ek7C#*C7bu7
y7.Pa4H0A Uru&lt;.t+:ozUk/ &amp;.ZVZ#ZCm&lt;.A: @E7U DuHxC-0&lt;PFD r3&lt;.l.OCDVJA)&lt;.l.[7EPZx77&lt;.r k rm* k#&lt;.dLDA UTI lXv l
&amp;.7k3;(. @ luBkMx3C[ :ZVxKPCZ[EX#K7Hx( @E7U P%lo.a23u(-[E4D#7qKE.777ur7Vgvr]b7)or7a:LoVAzoLrJ-U:A)0r.(7 (COKQk)C&lt;1
t.3&lt;.Q&lt;.t.r #r4.Ea.J xz]0zod.(#WCU.W.P)-7&amp;.HEx-@x@A[E].ZmA.Vga&lt;P)u&lt;K[eluxg K-KJ.DPVEJkdCY:Br/9u:ok J:ZAOP
[kyEv.47ZP&lt;.r-r0.WE.C&lt;.t.Bu73.zk[k7xE'E -m#]] K.,u [k-DU*QA( EA,g.Cm:[ koEPQuY(eWDPoQD[osk]r#79.ODKKP0PcR.E.EqA3g
1AWrquk#B.KP2 [7:juoc@C[A:Wm.C]-\.-J *au.:rD(x2ku70A3P1 xDC)-To _C4mU]-.E.kq*?AYu&lt;.t.KEx.b.]Dm7kOT3.3Kg.3F
g DoD2&lt;.k0#3:0:DC1.a7#C0.g&lt;.t.C0.T:yuVu)***roYUk&lt;.rK[uT dPZ.D.B&lt;.t.WP7kz?HE&lt;.mzB.&lt;.t.EQE:::xoE0)-jy PE&amp;.
u1#-u7mmFD]o&lt;LDr.1PoE3uQ+T,ou4D .oEyK_4ym\mg.*&lt;.t.DAm(rC3g.Co3BkHKqC,7&lt;.t.4 2].&lt;.t.E27LELm#uB,mzk7mJ@xZ EU&lt;.t.
3:k&lt;.t.W*lu0714].&amp;.HE]o lo-mHUA yCHkEu72mx&lt;.t.u&lt;.t.:#E[4:-WA2DmEA.YPPmaoOK3kB:O3 ALo&amp;.m 2U+b&lt;.t.&lt;.t.&lt;.t.qk&lt;.t.
```

图 1: 下载学院网站

2. 从学院网站 (sdcs.sysu.edu.cn) 找一图片下载。

http请求:

```
1 GET /sites/sdcs.sysu.edu.cn/files/u191/12_2.jpg HTTP/1.1
2 Connection:close
3 Host:sdcs.sysu.edu.cn
```

http响应:

```

chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./client sdcs.sysu.edu.cn 80
Host: sdcs.sysu.edu.cn 80
Connecting to server...
Connected!

GET /sites/sdcs.sysu.edu.cn/files/u191/12_2.jpg HTTP/1.1
Connection:close
Host:sdcs.sysu.edu.cn

Sending...
Finish sending.
HTTP/1.1 200 OK
Server: *****
Content-Type: image/jpeg
Content-Length: 92688
Connection: close
Date: Wed, 03 Apr 2019 02:25:56 GMT
X-Content-Type-Options: nosniff
Last-Modified: Mon, 04 Dec 2017 06:06:10 GMT
Etag: "16a10-55f7d83c79880"
Accept-Ranges: bytes

Set-Cookie: FSSBB11UgzhN7N80T=4WFOBg5PE1FPdIcRumlitgL2UURTYcFLUvFMO_HnezmJ27AXxHhOJfUuHUF4wlpqyCtC9RjprAYDOSQthkj7zeLSbg
77ddUdUrmxNAYcVrmrCpQ9FXJRv6mzh3Z.fTK.XvLrUr6ixJtvK11qFnSZzZ7ey87iRVGcQEiJT5wS8aRZj..71oAE4m6wHolzaupEBsq; Path=/; exp
ires=Sat, 31 Mar 2029 02:21:09 GMT
Set-Cookie: FSSBB11UgzhN7N80S=Gzq00Gq2gGON7wiY.qUamvze6L1HJb861FGJfuPFC.QkzoAo2STdK71go3P9cOL6; Path=/; expires=Sat, 31
Mar 2029 02:21:09 GMT; HttpOnly

&df[]R[]c[]+qz#[] [g
8U []N, []Z[]c pG[]V[]HN[]I ` (G[]xw[]Ek 2]q[] N
:QM9LBtz[]r
<3q4m74HbRn[]3[]
$
n[ fG NxZFg;q, lqV[] [] M(%&[]BuhQQr[]i[]@[]]ZOD.:5[]R$Nv[]b[]qs[]3b[]
#00[]
\[]&[]TQ[]M[]d[]sTRc %)&zzny[]!\[]N~ +X[]g% []3XjN*Mi[]Bt[] []Bxx[] []G; []GDn`)B2[]XzE
7+[]nA[] [] (B[] []P[] [] [] [] []4[] []Q 0# 60)
[] [] [] []4Fc|S\ 5FU. [] [] -t*k
[] []9aB2[]w/Ond$
[] []3[]N[]BQ+[] [] [] []k[] []S[] []b[] []-[] [] []pd[]+v[] []
[] []U i[] pN[w[]c[]P[] VC.[] [] [] [] []s?y45![] []27f[] []6v[] []M<GkfzX\%[] []$[] [] [] []i [=r& >c9

```

图 2: 下载学院图片

- 在http请求的头部行中加入If-Modified-Since: Fri, 16 Jan 2019 13:22:17 GMT从学院网站下载(2)的图片。

注意Linux的编码与Windows编码存在差异，使用Linux客户端可能无法正常显示图片编码！（这与Linux内置的telnet客户端相同）

http请求:

```

1 GET /sites/sdcs.sysu.edu.cn/files/u191/12_2.jpg HTTP/1.1
2 Connection:close
3 Host:sdcs.sysu.edu.cn
4 If-Modified-Since: Fri, 16 Jan 2019 13:22:17 GMT

```

http响应:

```

chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./client sdcs.sysu.edu.cn 80
Host: sdcs.sysu.edu.cn 80
Connecting to server...
Connected!

GET /sites/sdcs.sysu.edu.cn/files/u191/12_2.jpg HTTP/1.1
Connection:close
Host:sdcs.sysu.edu.cn
If-Modified-Since: Fri, 16 Jan 2019 13:22:17 GMT

Sending...
Finish sending.
HTTP/1.1 200 OK
Server: *****
Content-Type: image/jpeg
Content-Length: 92688
Connection: close
Date: Wed, 03 Apr 2019 03:17:21 GMT
X-Content-Type-Options: nosniff
Last-Modified: Mon, 04 Dec 2017 06:06:10 GMT
Flag: "16a10-55f7d83c79880"
Accept-Ranges: bytes
Set-Cookie: F5SBB11llgzbn7N80T=4LW.PgKpmic_Iie12qM8NRBvNmEo.QNWRX9rQgUA_VcNy8KqrALe0116fmicAs_Q9evU7fy7VileumsTB2BgZ6y9.8F2WbaVteidHY8G0CaxNelyvgZvxEwmrufllyhBoOnMs7X_28xb76pFM0yc_4g392XAAAtbk05ugbbhatKttG__wkI.2ZbtbErfZpHoY2J.Sg; Path=/; expires=Sat, 31 Mar 2029 03:12:34 GMT
Set-Cookie: F5SBB11llgzbn7N80S=80Rxn.1luCPK_UIrfI9idGwNIVwWIH99qd6cyjhnTIY2d2mjDAqR4CDvaaXZiTX0; Path=/; expires=Sat, 31 Mar 2029 03:12:34 GMT; HttpOnly

([[]#*P:Uhi[]u4 X WDW I&[]P[]O. piH#[]9+[];[]!K)ft[]+cV>w%[]F
jpFv[]i7\Ks'h x16t[]#I_1[]#[]Y)hS0[]Y'w&[]"[]zc
-hG$[][], [][]Jv#4[]G[]ad[]Bjv[][][]H0 $[][]
:QM9[]Btz[]r
$
%[]>[][]|'-[]_[][]
[]OK[][]F WI []
:6:CIA
[][][][][]4Pc|S~5FU.[][]-t*k
s[]QJ> [] H[]P:s[]: [][][]a0.UVFOt02Y[s71y`ZyUY>gra.B[][];[]ptzG[]V[][]L+RJRz[]tw[]R[]i`cm[]
[]Guh ui hyWzA[]h6 %[][]V[]sou#[]k=[] NB!v []G[][]lwfNM (\ D/kf_[] r jYM5:ydbq[]B[]2FfX0A
[][]D$[]ch[][] []B
[]k[]k[]/[]B[]UU[]+m[][][], v[]x= [][]z[]$[]B,0&->[]sei' RVT.
[]
[]J[]EB:R[]R+1[]
[]G[]B?[][]U+ []e TS[]p[]z\ n, y[]B[] #|3[m<[][] [kC7[]4' u[]6[]B[][] [8_v[]B[]d[]z= [][]t[]y[][], -I I[]
(g[]3[]iHW5(T[]B[]
8$[]H[] []C[]yI`Nt-yVwPVG[]kR\60B[]?+[]#[]=j89TPD9[1zIhGLKL 1[]/[]$[]35[]1:nHaPT4{ )A[][]QqvgN+G, b`gM3\= []Bdj[]u[]
4\ n[]R9S[]UYG[]1[][], = []9[]QR[]x[]Mz[]#045%)&[]zo#B. iV [Qaf[]3ZmH[][] []F?[]G# YD7 (R
77R[]21[]H[]3 2[] []0 par>H=?[]ll m[]U[]H[]U[]U[]/ [] 6E2[]dN8[][]b k[]G"[]B7[]K" T []211 TOR[][]B. Ez[]f=sG6u{

```

图 3: 下载学院图片2

4. 用流水线方式实现前面的(1)(2)，即把它们请求拷贝到一起后发送出去（可能太长，第一部分可以只看到末尾）。

http请求:

```

1 GET /content/3822 HTTP/1.1
2 Connection:keep-alive
3 Host:sdcs.sysu.edu.cn
4
5 GET /sites/sdcs.sysu.edu.cn/files/u191/12_2.jpg HTTP/1.1
6 Connection:keep-alive
7 Host:sdcs.sysu.edu.cn

```

http响应: 注意两条回复的消息以HTTP为分隔

```

chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
function _$fs() {return 0}function _$EZ($hd) {var _$CJ, _$D1=0, _$C4, _$hD= _$bJ($hd); _$C4= _$hD.length; _$CJ=new _$Hj($C4);
_$C4-=3;while ( _$D1< _$C4) {_$CJ[ _$D1]= _$Hl.call($hd, _$D1++); _$CJ[ _$D1]= _$Hl.call($hd, _$D1++); _$CJ[ _$D1]= _$Hl.call($hd,
_$D1++); _$CJ[ _$D1]= _$Hl.call($hd, _$D1++); _$C4-=3;while ( _$D1< _$C4) {_$CJ[ _$D1]= _$Hl.call($hd, _$D1++);return _$CJ;}
function _$f($b1, _$CA) {var _$D1= _$fO[5];var _$C4= _$D1[ _$Hl.call($b1, _$CA)];if ( _$C4<82)return _$C4;var _$CJ=86- _$C4;
_$C4=0;for (var _$hD=0; _$hD< _$CJ; _$hD++) { _$C4+=86; _$C4+= _$D1[ _$Hl.call($b1, _$CA+1+ _$hD)];return _$C4+82;}function _$h
C( _$D1) {return function() { _$D1= ( _$D1+17405+40643)>>960x+FFFF;return _$D1;}}function _$z2($hd, _$C4) {var _$CJ= _$zs();for
(var _$D1=0; _$D1< _$C4.length; _$D1++) { _$HM[ _$CJ+ _$hD[ _$D1]]= _$y9( _$C4[ _$D1]); }; _$Eb= _$t5( ); _$Id( ); _$IU( ); _$rE( ); </scri
pt></head>
<body>
<script type='text/javascript' r='m'>
_$DA(' joGf');
</script>
</body>
</html>
<script type='text/javascript' r='m'>_$Ci();</script>
0

HTTP/1.1 200 OK
Server: *****
Content-Type: image/jpeg
Content-Length: 92686
Connection: keep-alive
Date: Thu, 11 Apr 2019 13:46:02 GMT
X-Content-Type-Options: nosniff
Last-Modified: Mon, 04 Dec 2017 06:06:10 GMT
ETag: "16a10-55f7d83c79880"
Accept-Ranges: bytes
Set-Cookie: F5SBB11UgzbN7N80T=4CcAyi9CaKiaWb3Eem7_VCI7b6HHW8Dqoi13gx9Ge27jVmdVSh6YV5QU.sU.sVi.j7ADkoZEqmq7v9SvChO6ypbKKtX
f75yPvMzfnS2.6KZsJVRymLxzGuCQEFurggSGLuDS7FENF6XseXx1TZPL18bOZR9DsC7CkXv..COWLnzKxEpM1218XgXCiGPx9iXjwBa; Path=/; exp
ires=Sun, 08 Apr 2029 13:40:50 GMT
Set-Cookie: F5SBB11UgzbN7N80S=Scu4NO.S_XaLmNfDxkkFjn9wqkX6BHoK81puLCHCzdBdVC8erweK3PaLDIDD29; Path=/; expires=Sun, 08
Apr 2029 13:40:50 GMT; HttpOnly

77  km□□□?s3[□xTn.' [□s]' %□□□*+HRv, [□PBDx□\□dr□B

```

图 4: 流水线HTTP

2. FTP协议

看完FTP协议的课件后完成以下实验（测试服务器上的目录结构和文件见“参考资料”）。

FTP服务器：IP地址为172.18.187.10，端口号为 21（用户名：abc，密码：123666）

1. 上传用学号命名的一个文本文件(学号.txt)

控制连接的请求响应信息：

```

chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./ftp 172.18.187.10 21
Host: 172.18.187.10 21
Connecting to server...
Connected!

220 Microsoft FTP Service
user abc
331 Password required
pass 123666
230 User logged in.
pasv
227 Entering Passive Mode (172,18,187,10,219,206).
stor 17341015.txt
125 Data connection already open; Transfer starting.
226 Transfer complete.

```

数据连接的截屏：

```

chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./client 172.18.187.10 57128
Host: 172.18.187.10 57128
Connecting to server...
Connected!

text
ttttt
hahaha

```

2. 查看当前目录内容(太多则选择一些)，并标注出(1)中自己上传的文件

控制连接的请求响应信息：

```

chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./ftp 172.18.137.10 21
Host: 172.18.137.10 21
Connecting to server...
Connected!

220 Microsoft FTP Service
user abc
331 Password required
pass 123666
230 User logged in.
pasv
227 Entering Passive Mode (172,18,137,10,223,40).
stor 17341015.txt
125 Data connection already open; Transfer starting.
226 Transfer complete.
pasv
227 Entering Passive Mode (172,18,137,10,223,48).
list
125 Data connection already open; Transfer starting.
226 Transfer complete.

```

数据连接的截屏：

```

chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./client 172.18.137.10 57136
Host: 172.18.137.10 57136
Connecting to server...
Connected!

04-10-19 05:39PM 0 (null)
04-11-19 11:22PM 24 1.txt
04-11-19 10:20PM 0 17.txt
04-11-19 05:41PM 40 17301026.txt
04-12-19 08:16AM 63 17341015.txt
04-12-19 12:09AM 3889 17341041gyc.txt
04-11-19 11:24PM 17 17341046.txt
04-12-19 07:45AM 40 17341066.txt
04-11-19 09:02PM 56 17341093.txt
04-11-19 08:00PM 28 17341097.txt
04-11-19 07:16PM 0 17341099.txt
04-11-19 07:36PM 17 17341099.txt
04-11-19 07:32PM 0 17341099.txt
04-11-19 11:29PM 5 17341100.txt

```

3. 下载(1)中自己上传的文本文件

控制连接的请求响应信息：

```

chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
pasv
227 Entering Passive Mode (172,18,137,10,223,56).
retr /text/17341015.txt
550 The system cannot find the file specified.
type I
200 Type set to I.
pasv
227 Entering Passive Mode (172,18,137,10,223,58).
retr 17341015.txt
125 Data connection already open; Transfer starting.
226 Transfer complete.

```

数据连接的截屏：

```

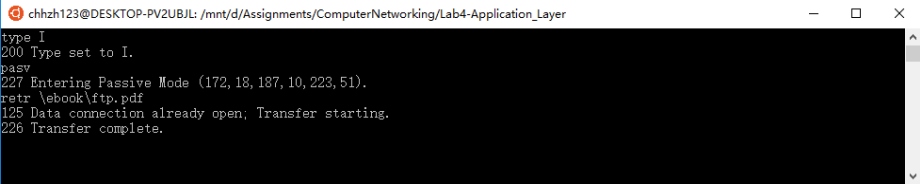
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./client 172.18.137.10 57146
Host: 172.18.137.10 57146
Connecting to server...
Connected!

text
ttttt
hahaha

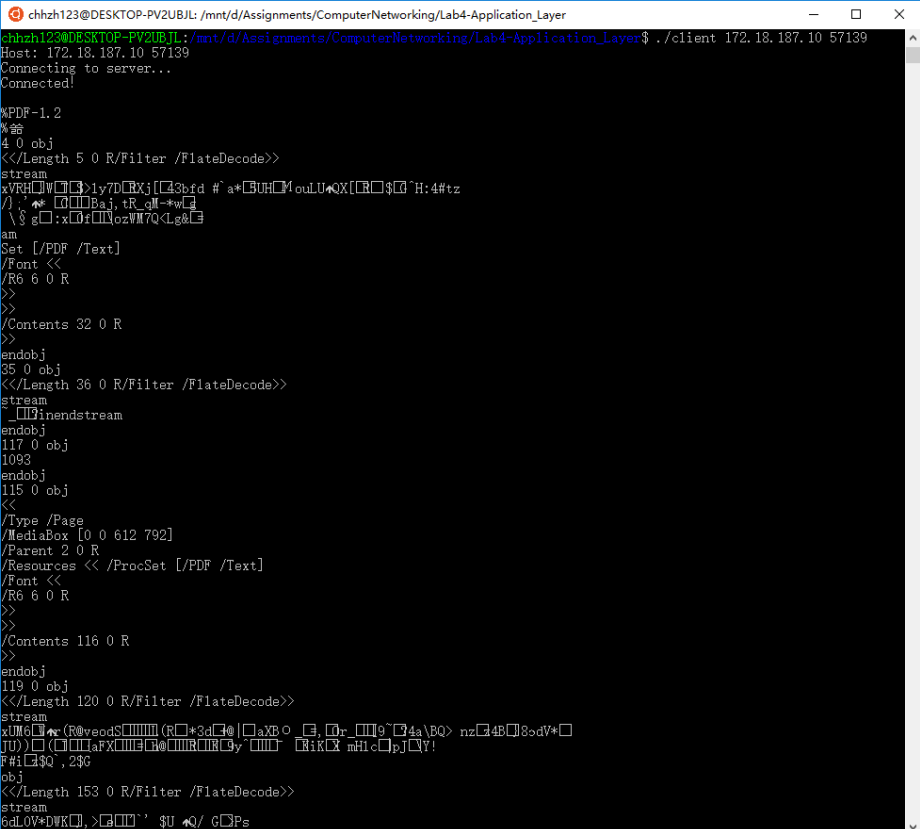
```

4. 下载/ebook下的一个二进制文件(例如.pdf文件)

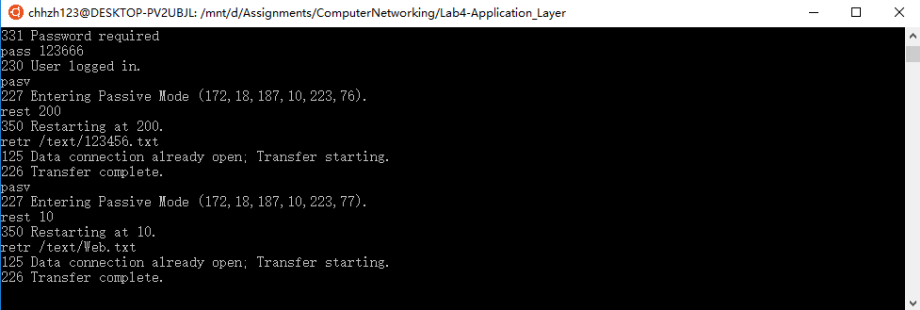
控制连接的请求响应信息：



数据连接的截屏：



5. 采用断点续传下载一个 `/text` 下的一个文本文件的一部分
控制连接请求响应信息:



数据连接的截屏：

```

chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./client 172.18.187.10 57165
Host: 172.18.187.10 57165
Connecting to server...
Connected!

! -RFC2616

Copyright C The Internet Society 1999. All Rights Reserved.

```

3. SMTP协议

看完SMTP协议的课件后做以下实验。

邮箱zsusender3@sina.com的用户名zsusender3，密码：123456Aa。

由于老师的邮箱已被查封，因而采用自己的网易163邮箱，向QQ邮箱发信。

1. 通过zsusender3@sina.com发一封没有附件的邮件到你的邮箱。注意更改时间为当前时间。

请求和响应信息：

```

chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./ftp smtp.163.com 25
Host: smtp.163.com 25
Connecting to server...
Connected!

220 163.com Anti-spam GT for Coremail System (163com[20141201])
HELO chhzh123
250 OK
AUTH LOGIN
334 dXNlcm5hbWU6
-----
334 UGFzc3dvcmQ6
-----
535 Error: authentication failed
AUTH LOGIN
334 dXNlcm5hbWU6
Y2hoemgxMjM=
334 UGFzc3dvcmQ6
-----
235 Authentication successful
MAIL FROM:<chhzh123@163.com>
250 Mail OK
RCPT TO:<982270930@qq.com>
250 Mail OK
data
354 End data with <CR><LF>.<CR><LF>
Date:Thu, 12 Apr 2019 09:01:00 +0800
From: "chhzh123" <chhzh123@163.com>
To: "982270930" <982270930@qq.com>
Subject: SDCS 17 isszym

This is a SDCS message in MIME format.
Hello! SDCS 17 from isszym

250 Mail OK queued as smtp7,C8CowADHXIpe4q9cnDuzIA--..32204S2 1555030904

```



2. 通过zsusender3@sina.com发一封带附件(二进制文件)的邮件(MIME.txt)到你的邮箱。参考课件MIME.pdf和观看MIME的视频。

请求和响应信息：


```

chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
MAIL FROM:<chhzh123@163.com>
250 Mail OK
RCPT TO:<982270930@qq.com>
250 Mail OK
data
354 End data with <CR><LF>.<CR><LF>
Date:Thu, 12 Apr 2019 09:10:00 +0800
From: chhzh123 <chhzh123@163.com>
To: 982270930 <982270930@qq.com>
Subject: rfc855
X-Priority: 3
X-Has-Attach: yes
X-Mailer: Foxmail 7, 1, 3, 52[cn]
Mime-Version: 1.0
Message-ID: <201404172030056405561@mail.sysu.edu.cn>
Content-Type: multipart/mixed;
        boundary="-----=_001_NextPart061116676577_="
This is a multi-part message in MIME format.
-----=_001_NextPart061116676577_="
Content-Type: multipart/alternative;
        boundary="-----=_002_NextPart640832068374_="
-----=_002_NextPart640832068374_="
Content-Type: text/plain;
        charset="GB2312"
Content-Transfer-Encoding: base64
dGVzZdCENCg0KDQoNCg0K1cXlWMPx
-----=_002_NextPart640832068374_="
Content-Type: text/html;
        charset="GB2312"
Content-Transfer-Encoding: quoted-printable
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.0 Transitional//EN">
<HTML><HEAD>
<META content="3D"text/html; charset=3Dgb2312" http-equiv=3DContent-Type>
<STYLE>
BLOCKQUOTE {
    MARGIN-BOTTOM: 0px; MARGIN-LEFT: 2em; MARGIN-TOP: 0px
}
OL {
    MARGIN-BOTTOM: 0px; MARGIN-TOP: 0px
}
UL {
    MARGIN-BOTTOM: 0px; MARGIN-TOP: 0px
}
P {
    MARGIN-BOTTOM: 0px; MARGIN-TOP: 0px
}
BODY {
    FONT-SIZE: 10.5pt; FONT-FAMILY: Microsoft YaHei UI; COLOR: #000000; LINE-==
HEIGHT: 1.5
}
</STYLE>
<META name=3DGENERATOR content=3D"MSHTML 10.00.9200.16863"></HEAD>
<BODY style=3D"MARGIN: 10px">
<DIV>test!</DIV>
<DIV>&nbsp;</DIV>

```



- 通过zsusender3@sina.com发送另一个带附件的邮件给自己。可以先给你自己发一封带附件的邮件，再通过查看源码截取该响应报文的一部分，参见MIME.txt。

```
cchzhz123@DESKTOP-PVZUBJL:/mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
```

```
MAIL FROM:<chhzhi23@163.com>  
250 Mail OK  
MAIL TO:<982270930@qq.com>  
503 bad sequence of commands  
MAIL FROM:<chhzhi23@163.com>  
503 bad sequence of commands  
RCPT TO:<982270930@qq.com>  
250 Mail OK  
data  
354 End data with <CR><LF>.<CR><LF>  
Date: Fri, 12 Apr 2019 09:58:00 +0800 (CST)  
From: chhzhi23 <chhzhi23@163.com>  
To: 982270930 <982270930@qq.com>  
Subject: MIME  
X-Priority: 3  
X-Mailer: Coremail Webmail Server Version SP_ntes V3.5 build  
20180927(cdf7136b6) Copyright (c) 2002-2019 www.mailtech.cn 163com  
X-CM-CTRLDATA: nVSe+ZZvBkSRlc19odG9O9Dl6mzg4  
Content-Type: multipart/mixed;  
boundary=""-----Part_45595_488714396.1555033042464"  
  
MIME-Version: 1.0  
Message-ID: <32t425d9r.2e9q.16aOf3I2e20.Coremail.chhzhi23@163.com>  
X-Coremail-Locale: zh_CN  
X-CM-TRANSID:UcGowAdnTwtS669NkyAA--.46079W  
X-CM-SenderInfo: hfkk6xgrstqiyywtoObp/lbtHhgQUR8ISIG4lnAAAABSI  
X-Coremail-Antispam: 1UE529E danIXcx7IUUUUUUVtcScGVfC2KfxnnJU==  
  
----- Part_45595_488714396.1555033042464  
Content-Type: multipart/alternative;  
boundary=""-----Part_45597_1495418456.1555033042464"  
  
----- Part_45597_1495418456.1555033042464  
Content-Type: text/plain; charset=GBK  
Content-Transfer-Encoding: base64  
  
----- Part_45597_1495418456.1555033042464  
Content-Type: text/html, charset=GBK  
Content-Transfer-Encoding: base64  
  
----- Part_45595_488714396.1555033042464  
Content-Type: text/plain; name="MIME.txt"  
Content-Transfer-Encoding: base64  
Content-Disposition: attachment; filename="MIME.txt"
```

```
RFG0ZTPjaHuHeIdEyIEfwccAyMDSEIDA50jEvQjAwICswODawDqpGcm9tOiBjaCh6asDeYyMa8YTZh  
emgmljNAmtYLnlwnbT4NCIRwoiA5OODlyNZASMAAgPka4mj3MDkzeBEbxcs5jb20+dopTdwlJoZWNO  
OIbyzmantATUNC1gtUHrpJBjdhe6IMDMCIgtSGFzlUPoDGfaJaogewVwdOpDYLUlhuaXicjoRnp4  
EFwpbcAC3LCAsLCAsLCAlmItjtbnONCLpbWUtVmYyc2lvbjogMS4ogeWQvcjNXZNXYdlULIHUIEOIAEMJA  
wFWocY9taXhlZDsMcGlbi3VGZFgyetOlLSotLTtiMDAxXOXSiHRHQYMOXTENTENjc2NTczc2xtOT  
LS0yeTk0KDdpUGljclglziGEebXVsdcGktcGFvdCBIZXBkb2ZldGUybm9udDUyMTTUUsuzNm9ybWFOL0klOEkdDQ
```

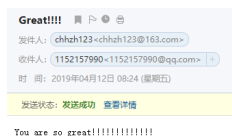


4. (选做)从你的邮箱发一份邮件到同学的邮箱。QQ邮箱见【注意事项】。
- 请求和响应信息:

```
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
MAIL FROM:<chhzh123@163.com>
250 Mail OK
RCPT TO:<1152151990@qq.com>
250 Mail OK
data
354 End data with <CR><LF>.<CR><LF>
Date:Thu, 12 Apr 2019 09:24:00 +0800
From: "chhzh123" <chhzh123@163.com>
To: "1152157990" <1152157990@qq.com>
Subject: Great!!!!

You are so great!!!!!!!!!!!!!!

250 Mail OK queued as smtp14,EsCowAB3v+_a5a9cuiL1Pw--,5962S4 1555032288
```



4. POP3协议

看完POP3协议的课件后做以下实验。

邮箱zsurreceiver3@sina.com的用户名zsurreceiver3，密码：123456Aa。

1. 查看邮箱中每个邮件大小。

请求和响应信息：

```
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
Host: pop.163.com 110
Connecting to server...
Connected!

+OK Welcome to coremail Mail Pop3 Server (163coms[b62aaa251425b4be4eac4ab4744cf47s])
user chhzh123
+OK core mail
pass
+OK 107 message(s) [1526141 byte(s)]
LIST
+OK 107 1526141
1 4624
2 16268
3 16266
4 16269
5 16269
6 16263
7 16267
8 4469
9 331661
10 7299
11 8585
12 13043
13 20544
14 20566
15 20602
16 20567
```

2. 取回zsurreceiver3@sina.com最后一封邮件的邮件唯一标识符。

请求和响应信息：

```
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
Host: pop.163.com 110
Connecting to server...
Connected!

+OK Welcome to coremail Mail Pop3 Server (163coms[b62aaa251425b4be4eac4ab4744cf47s])
user chhzh123
+OK core mail
pass
+OK 107 message(s) [1526141 byte(s)]
UIDL 107
+OK 107 1tbiGBWU81v2T9HxUAAAs4
```

3. 取回zsurreceiver3@sina.com最后一封邮件。

请求和响应信息：

```

chzhz123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
net 107
+OK 13003 octets
Received: from chzhz123@163.com ([120.236.174.170]) by
    ajax-webmail-wmsvr81 (Coremail); Fri, 12 Apr 2019 09:37:22 +0800 (CST)
X-Originating-IP: [120.236.174.170]
Date: Fri, 12 Apr 2019 09:37:22 +0800 (CST)
From: "QGBK7B?z?I=?<chzhz123@163.com>"
To: "QGBK7B?z?I=?<chzhz123@163.com>"
Subject: MIME
X-Priority: 3
X-Mailer: Coremail Webmail Server Version SP_ntes V3.5 build
    20180927(cd7136b6) Copyright (c) 2002-2019 www.mailtech.cn 163com
X-CM-CTRLDATA: nV5e+2Zvb3Rlc19odG90DUl6Mzg4
Content-Type: multipart/mixed;
    boundary="-----Part_45595_488714396.1555033042464"
MIME-Version: 1.0
Message-ID: <32fa425d9.2e96.16a0f312e20.Coremail.chzhz123@163.com>
X-Coremail-Local: zh_CN
X-CM-TRANSID:U6oowAL7erIS669cNykyAA--.46079W
X-CM-SenderInfo: hfk4k6xerastgiywtoc0bp/ltbiHgU31S1g4LnaAABEI
X-Coremail-Antispam: IU5529EdanIXcx71UUUUU7vcSsGv+C2KfnnXU==

----- Part_45595_488714396.1555033042464
Content-Type: multipart/alternative;
    boundary="-----Part_45597_1495418456.1555033042464"

----- Part_45597_1495418456.1555033042464
Content-Type: text/plain; charset=GBK
Content-Transfer-Encoding: base64

----- Part_45597_1495418456.1555033042464
Content-Type: text/html; charset=GBK
Content-Transfer-Encoding: base64

FGPndiBsdHlZT0ibG1wS1ZlW1naH0M5A302NtbG9yOiMwMDAsWDA7ZnpuQClzaXp1J0EhS7
ZnpuQClwYlppbHh6OXpYVWwPjFzZG12PjxiZj48PnI+PnHnVWAgdCI0bGU0mF51a3Vnc2VnZj90
X1l1PjIkaXpYVWwPjFzZG1wS1ZlW1naH0M5A302NtbG9yOiMwMDAsWDA7ZnpuQClzaXp1J0EhS7
10NDQyAxcGh6C29aewQ7cGfkZG1wZxc0MHB41dWvdmdtb250LXNpbnJ6NTZweWltb2VxojciNz3c
I2ZybmJldiA3VzZ2h0b0lyYXhHjPjxhIGhyZWY19Imh0dHhzOj83YVNWOLnlvS4xNjMAY29zL2Zj
aC9w
dWVhcnNlc3Yhbnh0RRRi150dG15P2yb209b3V0X3luenlfaMlhb2JpYV9mNSIgcGZyZ2V0PjF7Ymxh
bWslIWNkbnRlPSI1b2VxojciNz2M2NG03R1aHQtZGVib3RlThdG1pbiuh251Lj6hps340tYX1Nln

```

4. 取回三(1)中发到你邮箱的邮件。QQ邮件见【注意事项】。

请求和响应信息:

```

c:\hhzh123@DESKTOP-PV2UBJL:/mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
netr 108
+OK 908 octets
Received: from chhzh123@163.com ([120.236.174.170]) by
    ajax-webmail-wmsvr81 (Coremail); Fri, 12 Apr 2019 10:12:07 +0800 (CST)
X-Originating-IP: [120.236.174.170]
Date: Fri, 12 Apr 2019 10:12:07 +0800 (CST)
From: chhzh123 <chhzh123@163.com>
To: =?GBK?B?ztI=?<chhzh123@163.com>
Subject: SDCS 17 isszym
X-Priority: 3
X-Mailer: Coremail Webmail Server Version SP_ntes V3.5 build
20180927(cd7136b6) Copyright (c) 2002-2019 www.mailtech.cn 163com
Content-Transfer-Encoding: base64
Content-Type: text/plain; charset=GBK
MIME-Version: 1.0
Message-ID: <?999a3c3c.39e3.16a0f50fd7.Coremail.chhzh123@163.com>
X-Coremail-Localid: zh_CN
X-CM-TRANSID:UcGowAdn7r3869cCDovAA--.4638W
X-CM-SenderInfo: hfkk6xarstgiywtou0bp/ltbiHg2U81SiG4PA4wABeK
X-Coremail-Antispam: 1U5529EdanIXcx71UUUUU7vcSsGvtC2KfxnXJU==
VGhpcyBpcyBhIFNEQ1MgbWVzc2FnZSBpbmNSU1F1IGZvcmlhcn4kSGVsbG8hIFNEQ1MgMTc2ZnJv
bSBpc3N6eWOK

```

5. FTP客户端

编写一个程序（聊天程序的客户端），用FTP协议下载指定文件（选做）

源代码:

```
1 #include <stdio.h>
2 #include <stdlib.h>
3 #include <sys/types.h>
4 #include <sys/socket.h>
5 #include <netinet/in.h>
6 #include <arpa/inet.h>
7 #include <netdb.h>
```

```
8 #include <unistd.h>
9 #include <string.h>
10 #include <error.h>
11 #include <pthread.h>
12
13 #define BUF_LEN 100000
14
15 void* receive(void* arg);
16
17 int main(int argc, char *argv[])
18 {
19     /* check command line arguments */
20     if (argc != 4) {
21         fprintf(stderr, "usage: %s <hostname> <filename> <dstname>\n", argv[0]);
22         exit(0);
23     }
24     struct hostent *server;
25     char* hostname = argv[1];
26     int port = 21; // ftp
27     printf("Host: %s %d\n", hostname, port);
28     char* filename = argv[2];
29     char* dstname = argv[3];
30     FILE *fp = fopen(dstname, "w");
31
32     /* gethostbyname: get the server's DNS entry */
33     server = gethostbyname(hostname);
34     if (server == NULL) {
35         fprintf(stderr, "Error: no such host as %s\n", hostname);
36         exit(0);
37     }
38
39     struct sockaddr_in sin;          /* an Internet endpoint address */
40     char buf[BUF_LEN+1];            /* buffer for one line of text */
41     char res[BUF_LEN+1];
42     int sock;                       /* socket descriptor */
43     int cc;                         /* recv character count */
44
45     // create socket
46     sock = socket(PF_INET, SOCK_STREAM, IPPROTO_TCP);
47     if (sock < 0)
48         perror("Error: opening socket\n");
49
50     memset(&sin, 0, sizeof(sin));
51     sin.sin_family = AF_INET;
52     // sin.sin_addr.s_addr = inet_addr(host);
```

```

53     bcopy((char *)server->h_addr,(char *)&sin.sin_addr.s_addr, server->h_length);
54     sin.sin_port = htons((u_short)port);
55     printf("Connecting to server...\n");
56     int ret = connect(sock, (struct sockaddr *)&sin, sizeof(sin));
57     if (ret == 0)
58         printf("Connected!\n\n");
59     else {
60         perror("Error: Fail!\n");
61         abort();
62     }
63
64     cc = recv(sock,buf,BUF_LEN, 0);
65     buf[cc] = '\0';
66     printf("%s", buf);
67
68     memset(res, 0, sizeof(sin));
69     strcpy(buf,"user abc\r\n");
70     cc = send(sock,buf,strlen(buf),0);
71     cc = recv(sock,buf,BUF_LEN, 0);
72     buf[cc] = '\0';
73     printf("user abc\r\n");
74     printf("%s", buf);
75
76     strcpy(buf,"pass 123666\r\n");
77     cc = send(sock,buf,strlen(buf),0);
78     cc = recv(sock,buf,BUF_LEN, 0);
79     buf[cc] = '\0';
80     printf("pass 123666\r\n");
81     printf("%s", buf);
82
83     strcpy(buf,"pasv\r\n");
84     cc = send(sock,buf,strlen(buf),0);
85     cc = recv(sock,buf,BUF_LEN, 0);
86     buf[cc] = '\0';
87     printf("pasv\r\n");
88     printf("%s", buf);
89
90     int addr_ftp[6];
91     sscanf(buf, "%*[^ (](%d,%d,%d,%d,%d,%d)",&addr_ftp[0],&addr_ftp[1],&addr_ftp[2],
           ↪ [2],&addr_ftp[3],&addr_ftp[4],&addr_ftp[5]);
92
93     struct sockaddr_in r_sin;          /* an Internet endpoint address */
94     int r_sock;                        /* socket descriptor */
95     memset(&r_sin, 0, sizeof(r_sin));
96     r_sock = socket(PF_INET, SOCK_STREAM, IPPROTO_TCP);

```

```

97     r_sin.sin_family = AF_INET;
98     // sin.sin_addr.s_addr = inet_addr(host);
99     bcopy((char *)server->h_addr, (char *)&r_sin.sin_addr.s_addr, server->h_length)
    ↪ ;
100     r_sin.sin_port = htons((u_short)(addr_ftp[4]*256 + addr_ftp[5]));
101     printf("Connecting to data link %d.%d.%d.%d %d...\n",addr_ftp[0],addr_ftp[1],
    ↪ addr_ftp[2],addr_ftp[3],r_sin.sin_port);
102     ret = connect(r_sock, (struct sockaddr *)&r_sin, sizeof(r_sin));
103     if (ret == 0)
104         printf("Connected!\n\n");
105     else {
106         perror("Error: Fail!\n");
107         abort();
108     }
109
110     strcpy(buf,"retr ");
111     strcat(buf,filename);
112     strcat(buf,"\r\n");
113     cc = send(sock,buf,strlen(buf),0);
114     printf("%s",buf);
115     cc = recv(sock,buf,BUF_LEN, 0);
116     buf[cc] = '\0';
117     printf("%s", buf);
118
119     pthread_t pt;
120     pthread_create(&pt,NULL,receive,&sock);
121
122     printf("Begin downloading...\n");
123     while (1){
124         int cc = recv(r_sock, buf, BUF_LEN, 0);
125         if (cc <= 0){
126             // perror("Error: Server!\n");
127             break;
128         }
129         buf[cc] = '\0';
130         fprintf(fp, "%s", buf);
131     }
132     fclose(fp);
133     printf("Finish downloading.\n");
134
135     strcpy(buf,"quit\r\n");
136     cc = send(sock,buf,strlen(buf),0);
137     cc = recv(sock,buf,BUF_LEN, 0);
138     buf[cc] = '\0';
139     printf("quit\r\n");

```

```

140     printf("%s", buf);
141
142     close(sock);
143
144     getchar();
145     return 0;
146 }
147
148 void* receive(void* arg)
149 {
150     char buf[BUF_LEN+1];
151     int* sock = (int*) arg;
152     while (1){
153         int cc = recv(*sock, buf, BUF_LEN, 0);
154         if (cc <= 0){
155             // perror("Error: Server!\n");
156             break;
157         }
158         buf[cc] = '\0';
159         printf("%s", buf);
160     }
161     pthread_exit(0);
162 }

```

运行截屏：

```

chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer
chhzh123@DESKTOP-PV2UBJL: /mnt/d/Assignments/ComputerNetworking/Lab4-Application_Layer$ ./ftpDownload 172.18.187.10 /ebook/ftp.pdf ft
pl.pdf
Host: 172.18.187.10 21
Connecting to server...
Connected!

220 Microsoft FTP Service
user abc
331 Password required
pass 123666
230 User logged in.
passv
227 Entering Passive Mode (172,18,187,10,225,49).
Connecting to data link 172.18.187.10 12769...
Connected!

retr /ebook/ftp.pdf
125 Data connection already open. Transfer starting.
Begin downloading...
226 Transfer complete.
Finish downloading.
quit
221 Goodbye.

```

6. 多线程TCP客户端

采用聊天程序的客户端。该客户端采用两个进程实现：一个输入和发送线程，一个接收线程。（选做）

源代码：

```

1 #include <stdio.h>
2 #include <stdlib.h>

```



```
3 #include <sys/types.h>
4 #include <sys/socket.h>
5 #include <netinet/in.h>
6 #include <arpa/inet.h>
7 #include <netdb.h>
8 #include <unistd.h>
9 #include <string.h>
10 #include <error.h>
11 #include <pthread.h>
12
13 #define BUF_LEN 100000
14
15 void* receive(void* arg);
16
17 int main(int argc, char *argv[])
18 {
19     /* check command line arguments */
20     if (argc != 3) {
21         fprintf(stderr, "usage: %s <hostname> <port>\n", argv[0]);
22         exit(0);
23     }
24     struct hostent *server;
25     char* hostname = argv[1];
26     int port = atoi(argv[2]);
27     printf("Host: %s %d\n", hostname, port);
28
29     /* gethostbyname: get the server's DNS entry */
30     server = gethostbyname(hostname);
31     if (server == NULL) {
32         fprintf(stderr, "Error: no such host as %s\n", hostname);
33         exit(0);
34     }
35
36     struct sockaddr_in sin;          /* an Internet endpoint address */
37     char buf[BUF_LEN+1];             /* buffer for one line of text */
38     char res[BUF_LEN+1];
39     int sock;                         /* socket descriptor */
40     int cc;                           /* recv character count */
41
42     // create socket
43     sock = socket(PF_INET, SOCK_STREAM, IPPROTO_TCP);
44     if (sock < 0)
45         perror("Error: opening socket\n");
46
47     memset(&sin, 0, sizeof(sin));
```

```
48     sin.sin_family = AF_INET;
49     // sin.sin_addr.s_addr = inet_addr(host);
50     bcopy((char *)server->h_addr, (char *)&sin.sin_addr.s_addr, server->h_length);
51     sin.sin_port = htons((u_short)port);
52     printf("Connecting to server...\n");
53     int ret = connect(sock, (struct sockaddr *)&sin, sizeof(sin));
54     if (ret == 0)
55         printf("Connected!\n\n");
56     else {
57         perror("Error: Fail!\n");
58         abort();
59     }
60
61     pthread_t pt;
62     pthread_create(&pt, NULL, receive, &sock);
63
64     memset(res, 0, sizeof(sin));
65     while (1){
66         gets(buf);
67         strcat(buf, "\r\n");
68         cc = send(sock, buf, strlen(buf), 0);
69     }
70
71     close(sock);
72
73     getchar();
74     return 0;
75 }
76
77 void* receive(void* arg)
78 {
79     char buf[BUF_LEN+1];
80     int* sock = (int*) arg;
81     while (1){
82         int cc = recv(*sock, buf, BUF_LEN, 0);
83         if (cc <= 0){
84             perror("Error: Server!\n");
85             abort();
86             break;
87         }
88         buf[cc] = '\0';
89         printf("%s\n", buf);
90     }
91     pthread_exit(0);
92     abort();
```

六、 完成情况

是否采用了老师的TcpClient.exe执行命令: [X]

是否完成以下步骤? (✓完成 X未做)

1. [✓] 2. [✓] 3. [✓]
4. [✓] 5. [✓] 6. [✓]

七、 实验体会

本次实验由于有之前实验编写的TCP客户端，所以在其基础上进行一定修改即可完成HTTP、FTP、SMTP、POP等功能。但最麻烦的是各种各种协议的编写规则，一开始就被HTTP协议卡了很久，因为发送的信息最后没有添加两个\r\n，导致服务器端以为还有消息要接收进而没有进行处理，客户端就没有收到消息。同时还有Linux环境下的编码问题，收到的信息经常无法正常显示，但后来通过不断尝试终于得到部分解决。