ifm_nettle + libevhtp

安装libhv

```
cd ~
git clone https://github.com/ithewei/libhv.git
cd libhv
mkdir build
cd build
cmake ..
cmake --build .
cmake --install .
```

安装ifm_nettle

```
cd ~
// 注意，由于代码尚未合入，这里的git链接是我个人fork的仓库链接
git clone git@gitee.com:ptbxzrt/ifm_nettle.git ifm_nettle
cd ifm_nettle
mkdir build
cd build
cmake ..
make -j
sudo make install
```

我在VMware（openEuler-22.03-LTS-SP1-x86_64）上测试时，会出现找不到libhv.so的情况，因此还需要执行以下命令才能确保后面不会出错

```
export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:/usr/local/lib
```

调整libevhtp仓库相关文件

cd ~

git clone –b 1.2.18 https://github.com/Yellow-Camper/libevhtp.git

修改libevhtp/CMakeLists.txt，使其不再链接到libevent.so，而是链接到libifm_libhv2ev.so

```
find_package(LibEvent REQUIRED)
list(APPEND LIBEVHTP_EXTERNAL_LIBS ${LIBEVENT_LIBRARIES})
list(APPEND LIBEVHTP_EXTERNAL_INCLUDES ${LIBEVENT_INCLUDE_DIRS})
list(APPEND package_deps LibEvent)
```

```
# find_package(LibEvent REQUIRED)
# list(APPEND LIBEVHTP_EXTERNAL_LIBS ${LIBEVENT_LIBRARIES})
# list(APPEND LIBEVHTP_EXTERNAL_INCLUDES ${LIBEVENT_INCLUDE_DIRS})
# list(APPEND package_deps LibEvent)

list(APPEND LIBEVHTP_EXTERNAL_INCLUDES /usr/local/include/)
list(APPEND LIBEVHTP_EXTERNAL_INCLUDES /usr/local/include/hv)
list(APPEND LIBEVHTP_EXTERNAL_LIBS /usr/local/lib/libifm_libhv2ev.so)
```

删除libevhtp/evhtp.c中libevent相关的头文件

```
#include <limits.h>
#include <event2/dns.h>
```

```
#include <limits.h>
```

删除libevhtp/thread.c中libevent相关的头文件

```
#include <pthread.h>

#include <event2/event.h>
#include <event2/thread.h>
```

```
#include <pthread.h>
```

删除libevhtp/evhtp.h中libevent相关的头文件，并添加ifm_nettle中的头文件hv2ev.h

```
#include <sys/queue.h>
#include <event2/event.h>
#include <event2/listener.h>
#include <event2/buffer.h>
#include <event2/bufferevent.h>

#ifndef EVHTP_DISABLE_SSL
#include <event2/bufferevent_ssl.h>
#include <openssl/dh.h>
```

```
#include <sys/queue.h>

#include "hv2ev.h"

#ifndef EVHTP_DISABLE_SSL
#include <openssl/dh.h>
```

删除libevhtp/thread.h中libevent相关的头文件，并添加ifm_nettle中的头文件hv2ev.h

```
#include <pthread.h>
#include <event2/event.h>
#include <evhtp/config.h>
```

```
#include <pthread.h>
#include "hv2ev.h"
#include <evhtp/config.h>
```

将libevhtp/examples/test.c中的libevent相关头文件替换为ifm_nettle中的头文件hv2ev.h

```
#include <inttypes.h>
#include <event2/event.h>
```

```
#include <inttypes.h>
#include "hv2ev.h"
```

编译

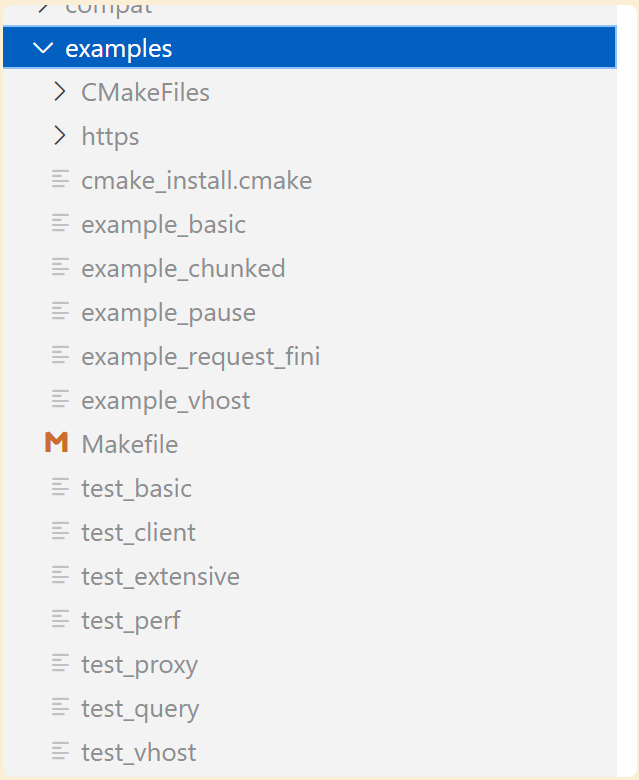
mkdir build

cd build

cmake ..

cmake --build . 该命令编译得到静态库libevhtp/build/libevhtp.a

make examples 该命令编译得到libevhtp/build/examples文件夹下若干二进制测试程序



测试结果概述

- 我用libevhtp提供的示例程序来进行集成测试，同时，我也使用最原始的libevhtp（没有任何改动，底层网络库为libevent）来运行相同的测试程序，以作对比
- 从对比测试的结果来看，基于libhv的libevhtp和基于libevent的libevhtp在测试程序上的行为是一致的。即使有少部分测试程序的运行情况比较奇怪，但两种libevhtp在这些测试下的运行情况是一样的

运行测试程序

1. example_basic

注意，此时是在build目录下。启动example_basic。该程序会启动一个http服务端，响应http客户端的get请求

examples/example_basic

```
[ptbxzrt@localhost build]$ ./examples/example_basic
[INFO]  example_basic.c:44       Basic server, run: curl http://127.0.0.1:9999/
```

开启另外一个会话窗口，运行以下命令

curl http://127.0.0.1:9999/

curl http://127.0.0.1:9999/

curl http://127.0.0.1:9999/

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:9999/
[ptbxzrt@localhost build]$ curl http://127.0.0.1:9999/
[ptbxzrt@localhost build]$ curl http://127.0.0.1:9999/
[ptbxzrt@localhost build]$
```

可以看到，3次httpget指令正常运行并返回

```
[ptbxzrt@localhost build]$ ./examples/example_basic
[INFO]  example_basic.c:44       Basic server, run: curl http://127.0.0.1:9999/
127.0.0.1 127.0.0.1:9999 'curl/7.79.1' [23/Oct/2023:01:56:27 +0800] 'GET / HTTP/1.1' 0
127.0.0.1 127.0.0.1:9999 'curl/7.79.1' [23/Oct/2023:01:56:27 +0800] 'GET / HTTP/1.1' 0
127.0.0.1 127.0.0.1:9999 'curl/7.79.1' [23/Oct/2023:01:56:28 +0800] 'GET / HTTP/1.1' 0
```

2. example_chunked

启动example_chunked。该程序会启动一个http服务端，且注意启动该程序需要一个参数，这个参数是一个文件名，当收到http客户端请求时，该程序会将参数指代的文件发送给http客户端。这里我直接用的是build目录下的Makefile文件

./examples/example_chunked Makefile

```
[ptbxzrt@localhost build]$ ./examples/example_chunked Makefile
[INFO]  example_chunked.c:158       curl http://127.0.0.1:9999/
```

开启另外一个会话窗口，运行以下命令

curl http://127.0.0.1:9999/

可以看到，example_chunked程序成功将Makefile文件发送给了http客户端

```
        @echo "... log.o"
        @echo "... log.i"
        @echo "... log.s"
        @echo "... numtoa.o"
        @echo "... numtoa.i"
        @echo "... numtoa.s"
        @echo "... parser.o"
        @echo "... parser.i"
        @echo "... parser.s"
        @echo "... thread.o"
        @echo "... thread.i"
        @echo "... thread.s"
.PHONY : help



#=============================================================================
# Special targets to cleanup operation of make.

# Special rule to run CMake to check the build system integrity.
# No rule that depends on this can have commands that come from listfiles
# because they might be regenerated.
cmake_check_build_system:
        $(CMAKE_COMMAND) -S$(CMAKE_SOURCE_DIR) -B$(CMAKE_BINARY_DIR) --check-build-system CMakeFiles/Makefile.c
make 0
.PHONY : cmake_check_build_system

[ptbxzrt@localhost build]$
```

```
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 128 bytes
[INFO]   example_chunked.c:35        Sending 50 bytes
[INFO]   example_chunked.c:52        Sending last chunk
[INFO]   example_chunked.c:76        hi
```

3. example_pause.c

启动example_pause。该程序会启动一个http服务端，在响应http客户端的请求时，会延迟10s再返回

./examples/example_pause

```
[ptbxzrt@localhost build]$ ./examples/example_pause
[INFO]   example_pause.c:106      response delayed for 10s: curl http://127.0.0.1:9999/
```

开启另外一个会话窗口，运行以下命令

curl http://127.0.0.1:9999/

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:9999/
time start 1697999691
time end 1697999701
[ptbxzrt@localhost build]$
```

4. example_request_fini

启动example_request_fini。该程序会启动一个http服务端，响应http客户端时，向客户端发送"Hello, world"

./examples/example_request_fini

```
[ptbxzrt@localhost build]$ ./examples/example_request_fini
[INFO]  example_request_fini.c:56       Simple usage of using request_fini hooks, run: curl http://127.0.0.1:9999/x/v/o
```

开启另外一个会话窗口，运行以下命令

curl http://127.0.0.1:9999/i/q/z

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:9999/i/q/z
Hello, world
[ptbxzrt@localhost build]$
```

5. example_vhost

启动example_vhost

./examples/example_vhost

```
[ptbxzrt@localhost build]$ ./examples/example_vhost
[INFO]  example_vhost.c:100      [[ try the following commands and you should see 'evhtp.io domains' ]]
[INFO]  example_vhost.c:101      ======================================================================
[INFO]  example_vhost.c:102      curl -H'Host: evhtp.io' http://127.0.0.1:9999/vhost
[INFO]  example_vhost.c:103      curl -H'Host: www.evhtp.io' http://127.0.0.1:9999/vhost
[INFO]  example_vhost.c:104      curl -H'Host: web.evhtp.io' http://127.0.0.1:9999/vhost
[INFO]  example_vhost.c:105      ======================================================================
[INFO]  example_vhost.c:106      [[ try the following commands and you should see 'google.com domains' ]]
[INFO]  example_vhost.c:107      ======================================================================
[INFO]  example_vhost.c:108      curl -H'Host: google.com' http://127.0.0.1:9999/vhost
[INFO]  example_vhost.c:109      curl -H'Host: www.google.com' http://127.0.0.1:9999/vhost
[INFO]  example_vhost.c:110      curl -H'Host: web.google.com' http://127.0.0.1:9999/vhost
[INFO]  example_vhost.c:111      curl -H'Host: inbox.google.com' http://127.0.0.1:9999/vhost
[INFO]  example_vhost.c:112      curl -H'Host: gmail.google.com' http://127.0.0.1:9999/vhost
```

开启另外一个会话窗口，运行以下命令

curl –H'Host: evhtp.io' http://127.0.0.1:9999/vhost

curl –H'Host: www.evhtp.io' http://127.0.0.1:9999/vhost

curl –H'Host: web.evhtp.io' http://127.0.0.1:9999/vhost

curl –H'Host: google.com' http://127.0.0.1:9999/vhost

curl –H'Host: www.google.com' http://127.0.0.1:9999/vhost

curl –H'Host: web.google.com' http://127.0.0.1:9999/vhost

curl –H'Host: inbox.google.com' http://127.0.0.1:9999/vhost

curl –H'Host: gmail.google.com' http://127.0.0.1:9999/vhost

```
[ptbxzrt@localhost build]$ curl -H'Host: evhtp.io' http://127.0.0.1:9999/vhost
vhost_1__callback_ = host:evhtp.io, arg:evhtp.io domains
[ptbxzrt@localhost build]$ curl -H'Host: www.evhtp.io' http://127.0.0.1:9999/vhost
vhost_1__callback_ = host:www.evhtp.io, arg:evhtp.io domains
[ptbxzrt@localhost build]$ curl -H'Host: web.evhtp.io' http://127.0.0.1:9999/vhost
vhost_1__callback_ = host:web.evhtp.io, arg:evhtp.io domains
[ptbxzrt@localhost build]$ curl -H'Host: google.com' http://127.0.0.1:9999/vhost
vhost_2__callback_ = host:google.com, arg:google.com domains
[ptbxzrt@localhost build]$ curl -H'Host: www.google.com' http://127.0.0.1:9999/vhost
vhost_2__callback_ = host:www.google.com, arg:google.com domains
[ptbxzrt@localhost build]$ curl -H'Host: web.google.com' http://127.0.0.1:9999/vhost
vhost_2__callback_ = host:web.google.com, arg:google.com domains
[ptbxzrt@localhost build]$ curl -H'Host: inbox.google.com' http://127.0.0.1:9999/vhost
vhost_2__callback_ = host:inbox.google.com, arg:google.com domains
[ptbxzrt@localhost build]$ curl -H'Host: gmail.google.com' http://127.0.0.1:9999/vhost
vhost_2__callback_ = host:gmail.google.com, arg:google.com domains
[ptbxzrt@localhost build]$
```

6. test_basic

启动test_basic

```
[ptbxzrt@localhost build]$ ./examples/test_basic
```

开启另外一个会话窗口，运行以下命令

curl http://127.0.0.1:8081/simple/

curl http://127.0.0.1:8081/1/ping

curl http://127.0.0.1:8081/1/ping.json

curl http://127.0.0.1:8081/issue161

客户端得到的结果似乎有点奇怪，因此我还使用了最原始的、链接到libevent.so的libevhtp来进行测试。对比二者的结果，发现是一致的

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/simple/
simple[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/1/ping
one[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/1/ping.json
one[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/issue161
[ptbxzrt@localhost build]$
```

7. test_client

这里需要修改一下test_client.c中的源码。test_client程序会启动1个http客户端，向指定IP地址发送http请求。test_client.c中原本给出的ip地址无法使用，因此我通过Windows上的nslookup命令获取了www.bilibili.com的IP地址121.194.11.73，并将test_client.c中指定的IP地址替换为该地址

```
    evbase  = event_base_new();
    conn    = evhtp_connection_new(evbase, "121.194.11.73", 80);
    request = evhtp_request_new(request_cb, evbase);

```

重新编译测试文件

make examples

启动test_client，它会立即返回

./examples/test_client

```
[ptbxzrt@localhost build]$ ./examples/test_client
Got 9 bytes
hi 9
[ptbxzrt@localhost build]$
```

8. test_extensive

test_extensive程序是由test.c编译生成的。启动test_extensive

./examples/test_extensive

```
[ptbxzrt@localhost build]$ ./examples/test_extensive
```

开启另外一个会话窗口，运行以下命令

curl http://127.0.0.1:8081/ref

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/ref
print_path() full        = '/ref'
             path        = '/'
             file        = 'ref'
             match start = '/ref'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
test_default_cb
```

curl http://127.0.0.1:8081/foo

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/foo
print_path() full        = '/foo'
             path        = '/'
             file        = 'foo'
             match start = '/foo'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
test_foo_cb
```

curl http://127.0.0.1:8081/foo/

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/foo/
print_path() full        = '/foo/'
             path        = '/foo/'
             file        = '(null)'
             match start = '/foo/'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
test_foo_cb
```

curl http://127.0.0.1:8081/bar

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/bar
print_path() full        = '/bar'
             path        = '/'
             file        = 'bar'
             match start = '/bar'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
```

curl http://127.0.0.1:8081/500

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/500
print_path() full        = '/500'
             path        = '/'
             file        = '500'
             match start = '/500'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
test_500_cb
```

curl http://127.0.0.1:8081/pause

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/pause
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
```

curl http://127.0.0.1:8081/glob/

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/glob/
print_path() full        = '/glob/'
             path        = '/glob/'
             file        = '(null)'
             match start = '/glob/'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
test_glob_cb
```

curl http://127.0.0.1:8081/max_body_size

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/max_body_size
print_path() full        = '/max_body_size'
             path        = '/'
             file        = 'max_body_size'
             match start = '/max_body_size'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
test_max_body
```

curl http://127.0.0.1:8081/chunkme

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/chunkme
print_path() full        = '/chunkme'
             path        = '/'
             file        = 'chunkme'
             match start = '/chunkme'
             match_end   = ''
             methno      = '0'
print_kv() key = 'Host', val = '127.0.0.1:8081'
print_kv() key = 'User-Agent', val = 'curl/7.79.1'
print_kv() key = 'Accept', val = '*/*'
print_kvs() key = 'Host', val = '127.0.0.1:8081'
print_kvs() key = 'User-Agent', val = 'curl/7.79.1'
print_kvs() key = 'Accept', val = '*/*'
I give you the light of Eärendil,
our most beloved star.
May it be a light for you in dark places,
when all other lights go out.
```

curl http://127.0.0.1:8081/ownme

这条curl命令会一直卡住，不会返回，看起来很奇怪。因此我又使用最原始的libevhtp做了实验，发现的现象也是一直卡住，也就是说，在该命令下，二者的表现情况是一样的

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/ownme
```

9. test_perf

test_perf程序有一段复杂的处理命令行参数的代码，为了方便测试，我将该段代码直接注释掉，这样test_perf程序在启动时会使用默认的参数设置

```
    // while ((c = getopt(argc, argv, "t:a:p:b:ndrs:")) != -1)
    // {
    //     switch (c) {
    //         case 't':
    //             num_threads  = atoi(optarg);
    //             break;
    //         case 'a':
    //             baddr        = strdup(optarg);
    //             break;
    //         case 'p':
    //             bport        = atoi(optarg);
    //             break;
    //         case 'b':
    //             backlog      = atoll(optarg);
    //             break;
    //         case 'n':
    //             nodelay      = 1;
    //             break;
    //         case 'd':
    //             defer_accept = 1;
    //             break;
    //         case 'r':
    //             reuse_port   = 1;
    //             break;
    //         case 's':
    //             payload_sz   = atoll(optarg);
    //             break;
    //         default:
    //             fprintf(stdout, "Usage: %s [flags]\n", argv[0]);
    //             fprintf(stdout, "  -t <n> : number of worker thre
    //             fprintf(stdout, "  -a <s> : bind address
    //             fprintf(stdout, "  -p <n> : bind port
    //             fprintf(stdout, "  -b <b> : listen backlog
    //             fprintf(stdout, "  -s <n> : size of the response
    //             fprintf(stdout, "  -n     : disable nagle (nodela
    //             fprintf(stdout, "  -d     : enable deferred accep
    //             fprintf(stdout, "  -r     : enable linux reusepor
    //             exit(EXIT_FAILURE);
    //     } /* switch */
    // }
```

启动test_perf

./examples/test_perf

```
[ptbxzrt@localhost build]$ ./examples/test_perf
|
```

开启另外一个会话窗口，运行以下命令

curl http://127.0.0.1:8081/data

```
[ptbxzrt@localhost build]$ curl http://127.0.0.1:8081/data
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB[ptbxzrt@lo
calhost build]$ |
```

10. test_proxy

启动test_proxy

./examples/test_proxy

```
[ptbxzrt@localhost build]$ ./examples/test_proxy
Spinning up a thread: 1
Spinning up a thread: 2
Spinning up a thread: 3
Spinning up a thread: 4
Spinning up a thread: 5
Spinning up a thread: 6
Spinning up a thread: 7
Spinning up a thread: 8
|
```

开启另外一个会话窗口，运行以下命令

curl –x http://127.0.0.1:8081 http://182.61.200.7:80

这条curl命令会一直卡住，不会返回，看起来很奇怪。因此我又使用最原始的libevhtp做了实验，发现的现象也是一直卡住，也就是说，在该命令下，二者的表现情况是一样的

```
[ptbxzrt@localhost build]$ curl -x http://127.0.0.1:8081 http://182.61.200.7:80
|
```

11. test_query

test_query和底层网络IO没有关系，它主要是测试http头文件解析的功能

./examples/test_query

```
  OK     a=b;key=val                                 {"a": "b;key=val"}
  OK     a;b=val                                     {"a;b": "val"}
  OK     end_empty_string=                 (error)   <error>
  OK     end_null                          (error)   <error>
  OK     hexa=some%20&hexb=bla%0                     {"hexa": "some%20", "hexb": "bla%0"}
  OK     hexa=some%20;hexb=bla                       {"hexa": "some%20;hexb=bla"}
  OK     hexa%z=some                                 {"hexa%z": "some"}
  OK     aaa=some%az                       (error)   <error>
- ignore_hex_tests
  OK     hexa=some%20&hexb=bla%0&hexc=%              {"hexa": "some%20", "hexb": "bla%0", "hexc": "%"}
  OK     hexa%z=some                                 {"hexa%z": "some"}
  OK     aaa=some%zz                                 {"aaa": "some%zz"}
- allow_empty_tests
  OK     end_empty_string=                           {"end_empty_string": ""}
- allow_null_tests
  OK     end_null                                    {"end_null": (null)}
- treat_semicolon_as_sep_tests
  OK     a=b;key=val                                 {"a": "b", "key": "val"}
  OK     a;b=val                           (error)   <error>
- lenient_tests
  OK     a=b;key&c=val                               {"a": "b", "key": (null), "c": "val"}
  OK     a=b;key=val                                 {"a": "b", "key": "val"}
  OK     end_empty_string=                           {"end_empty_string": ""}
  OK     end_null                                    {"end_null": (null)}
  OK     hexa=some%a;hexb=bl%0&hexc=%az              {"hexa": "some%a", "hexb": "bl%0", "hexc": "%az"}

[ptbxzrt@localhost build]$
```

12. test_vhost

启动test_vhost

./examples/test_vhost

```
[ptbxzrt@localhost build]$ ./examples/test_vhost
```

开启另外一个会话窗口，运行以下命令

curl –i –X POST http://127.0.0.1:8081/host1

curl –i –X POST http://127.0.0.1:8081/localhost

返回404，奇怪的结果，因此我又使用最原始的libevhtp做了实验，发现也是返回404

```
[ptbxzrt@localhost build]$ curl -i -X POST http://127.0.0.1:8081/host1
HTTP/1.1 404 Not Found
Content-Length: 0
Content-Type: text/plain

[ptbxzrt@localhost build]$ curl -i -X POST http://127.0.0.1:8081/localhost
HTTP/1.1 404 Not Found
Content-Length: 0
Content-Type: text/plain
```