本章`LyShark`将带大家学习如何在内核中使用标准的`Socket`套接字通信接口，我们都知道`Windows`应用层下可直接调用`WinSocket`来实现网络通信，但在内核模式下应用层API接口无法使用，内核模式下有一套专有的`WSK`通信接口，我们对WSK进行封装，让其与应用层调用规范保持一致，并实现内核与内核直接通过`Socket`通信的案例。

当然在早期如果需要实现网络通信一般都会采用`TDI`框架，但在新版本`Windows10`系统上虽然依然可以使用TDI接口，但是`LyShark`并不推荐使用，因为微软已经对接口搁置了，为了使WSK通信更加易用，我们需要封装内核层中的通信API，新建`LySocket.hpp`头文件，该文件中封装了WSK通信API接口，其封装格式与应用层接口保持了高度一致，当需要在内核中使用Socket通信时可直接引入本文件。

我们需要使用`WDM`驱动程序，并配置以下参数。

- 配置属性 -> 连接器 -> 输入-> 附加依赖 -> $(DDK_LIB_PATH)\Netio.lib
- 配置属性 -> C/C++ -> 常规 -> 设置 警告等级2级 (警告视为错误关闭)

配置好以后，我们就开始吧，先来看看服务端如何实现！

对于`服务端`来说，驱动通信必须保证服务端开启多线程来处理异步请求，不然驱动加载后系统会处于等待状态，而一旦等待则系统将会卡死，那么对于服务端`DriverEntry`入口说我们不能让其等待，必须使用`PsCreateSystemThread`来启用系统线程，该函数属于WDM的一部分，官方定义如下；

```
NTSTATUS PsCreateSystemThread(
  [out]           PHANDLE            ThreadHandle,
  [in]            ULONG              DesiredAccess,
  [in, optional]  POBJECT_ATTRIBUTES ObjectAttributes,
  [in, optional]  HANDLE             ProcessHandle,
  [out, optional] PCLIENT_ID         ClientId,
  [in]            PKSTART_ROUTINE    StartRoutine,
  [in, optional]  PVOID              StartContext
);
```

我们使用`PsCreateSystemThread`函数开辟线程`TcpListenWorker`在线程内部执行如下流程启动驱动服务端，由于我们自己封装实现了标准接口组，所以使用起来几乎与应用层无任何差异了。

- CreateSocket 创建套接字
- Bind 绑定套接字
- Accept 等待接收请求
- Receive 用于接收返回值
- Send 用于发送返回值

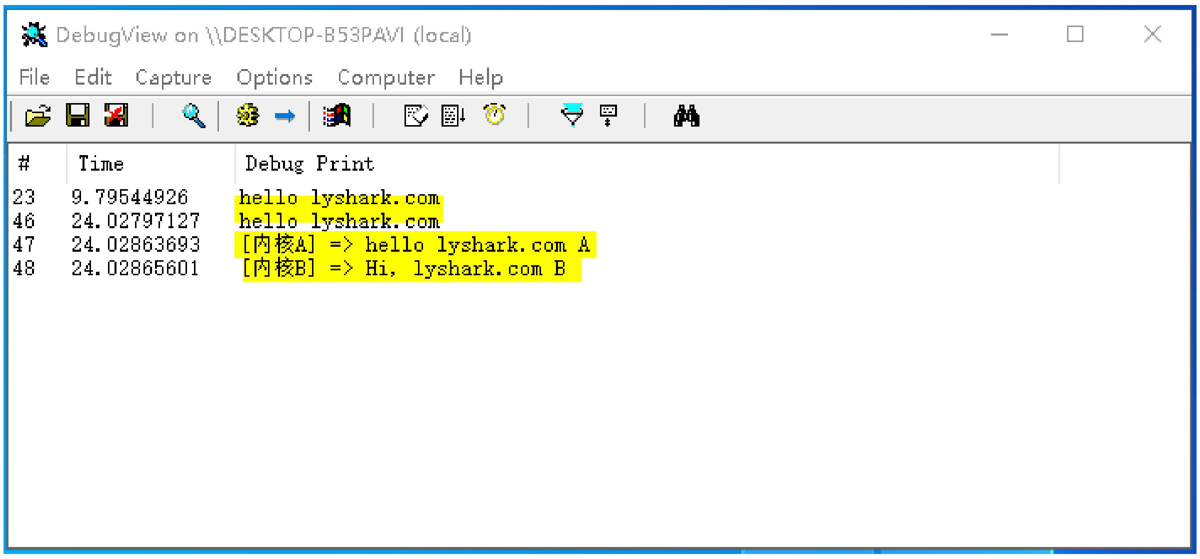
```
// 署名权
// right to sign one's name on a piece of work
// PowerBy: LyShark
// Email: me@lyshark.com

#include "LySocket.hpp"

PETHREAD m_EThread = NULL;

// 线程函数
// PowerBy: LySHark
VOID TcpListenWorker(PVOID Context)
{
    WSK_SOCKET* paccept_socket = NULL;
    SOCKADDR_IN LocalAddress = { 0 };
    SOCKADDR_IN RemoteAddress = { 0 };
    NTSTATUS status = STATUS_UNSUCCESSFUL;

    // 创建套接字
    PWSK_SOCKET TcpSocket = CreateSocket(AF_INET, SOCK_STREAM, IPPROTO_TCP,
WSK_FLAG_LISTEN_SOCKET);
    if (TcpSocket == NULL)
    {
        return;
    }

    // 设置绑定地址
    LocalAddress.sin_family = AF_INET;
    LocalAddress.sin_addr.s_addr = INADDR_ANY;
    LocalAddress.sin_port = HTON_SHORT(8888);

    status = Bind(TcpSocket, (PSOCKADDR)&LocalAddress);
    if (!NT_SUCCESS(status))
    {
        return;
    }

    // 循环接收
    while (1)
    {
        CHAR* read_buffer = (CHAR*)ExAllocatePoolWithTag(NonPagedPool, 2048,
"read");
        paccept_socket = Accept(TcpSocket, (PSOCKADDR)&LocalAddress,
(PSOCKADDR)&RemoteAddress);
        if (paccept_socket == NULL)
        {
            continue;
        }

        // 接收数据
        memset(read_buffer, 0, 2048);
        int read_len = Receive(paccept_socket, read_buffer, 2048, 0);
        if (read_len != 0)
        {
            DbgPrint("[内核A] => %s \n", read_buffer);

            // 发送数据
            char send_buffer[2048] = "Hi, lyshark.com B";
            Send(paccept_socket, send_buffer, strlen(send_buffer), 0);

            // 接收确认包
            memset(read_buffer, 0, 2048);
            Receive(paccept_socket, read_buffer, 2, 0);
        }

        // 清理堆
        if (read_buffer != NULL)
        {
            ExFreePool(read_buffer);
        }

        // 关闭当前套接字
        if (paccept_socket)
        {
            CloseSocket(paccept_socket);
        }
    }

    if (TcpSocket)
    {
        CloseSocket(TcpSocket);
    }
    PsTerminateSystemThread(STATUS_SUCCESS);
    return;
}

// 关闭套接字
VOID UnDriver(PDRIVER_OBJECT driver)
{
    WSKCleanup();
    KeWaitForSingleObject(m_EThread, Executive, KernelMode, FALSE, NULL);
    if (m_EThread != NULL)
    {
        ObDereferenceObject(m_EThread);
    }
}

NTSTATUS DriverEntry(IN PDRIVER_OBJECT Driver, PUNICODE_STRING RegistryPath)
{
    DbgPrint("hello lyshark.com \n");

    // 初始化
    WSKStartup();

    HANDLE hThread = NULL;
    NTSTATUS status = STATUS_UNSUCCESSFUL;

    // 创建系统线程
    status = PsCreateSystemThread(&hThread, THREAD_ALL_ACCESS, NULL, NULL, NULL,
TcpListenWorker, NULL);
    if (!NT_SUCCESS(status))
    {
        return status;
    }

    // 获取线程EProcess结构
    status = ObReferenceObjectByHandle(hThread, THREAD_ALL_ACCESS, NULL,
KernelMode, (PVOID*)&m_EThread, NULL);
    if (NT_SUCCESS(status) == FALSE)
    {
        return status;
    }

    ZwClose(hThread);
    Driver->DriverUnload = UnDriver;
    return STATUS_SUCCESS;
}
```

对于客户端来说，只需要创建套接字并连接到指定地址即可，这个过程大体上可以总结为如下；

- CreateSocket 创建套接字
- Bind 绑定套接字
- Connect 链接服务端驱动
- Send 发送数据到服务端
- Receive 接收数据到服务端

```
// 署名权
// right to sign one's name on a piece of work
// PowerBy: LyShark
// Email: me@lyshark.com

#include "LySocket.hpp"

VOID UnDriver(PDRIVER_OBJECT driver)
{
    // 卸载并关闭Socket库
    WSKCleanup();
}

NTSTATUS DriverEntry(IN PDRIVER_OBJECT Driver, PUNICODE_STRING RegistryPath)
{
    DbgPrint("hello lyshark.com \n");
    // 初始化
    WSKStartup();

    NTSTATUS       status = STATUS_SUCCESS;
    SOCKADDR_IN    LocalAddress = { 0, };
    SOCKADDR_IN    RemoteAddress = { 0, };

    // 创建套接字
    PWSK_SOCKET TcpSocket = CreateSocket(AF_INET, SOCK_STREAM, IPPROTO_TCP,
WSK_FLAG_CONNECTION_SOCKET);
    if (TcpSocket == NULL)
    {
        Driver->DriverUnload = UnDriver;
        return STATUS_SUCCESS;
    }

    LocalAddress.sin_family = AF_INET;
    LocalAddress.sin_addr.s_addr = INADDR_ANY;
    status = Bind(TcpSocket, (PSOCKADDR)&LocalAddress);

    // 绑定失败则关闭驱动
    if (!NT_SUCCESS(status))
    {
        CloseSocket(TcpSocket);

        Driver->DriverUnload = UnDriver;
        return STATUS_SUCCESS;
    }

    // 初始化服务端地址与端口信息
    ULONG address[4] = { 127, 0, 0, 1 };

    RemoteAddress.sin_family = AF_INET;
    RemoteAddress.sin_addr.s_addr = change_uint(address[0], address[1],
address[2], address[3]);
    RemoteAddress.sin_port = HTON_SHORT(8888);

    status = Connect(TcpSocket, (PSOCKADDR)&RemoteAddress);

    // 连接服务端,如果失败则关闭驱动
    if (!NT_SUCCESS(status))
    {
        CloseSocket(TcpSocket);
        Driver->DriverUnload = UnDriver;
        return STATUS_SUCCESS;
    }

    // 发送数据
    char send_buffer[2048] = "hello lyshark.com A";
    Send(TcpSocket, send_buffer, strlen(send_buffer), 0);

    // 接收数据
    CHAR* read_buffer = (CHAR*)ExAllocatePoolWithTag(NonPagedPool, 2048, "read");

    memset(read_buffer, 0, 1024);
    Receive(TcpSocket, read_buffer, 2048, 0);
    DbgPrint("[内核B] => %s \n", read_buffer);

    // 发送确认包
    Send(TcpSocket, "ok", 2, 0);

    // 释放内存
    ExFreePool(read_buffer);
    CloseSocket(TcpSocket);
    Driver->DriverUnload = UnDriver;
    return STATUS_SUCCESS;
}
```

编译两个驱动程序，首先运行`server.sys`驱动，运行后该驱动会在后台等待客户端连接，接着运行`client.sys`屏幕上可输出如下提示，说明通信已经建立了。


DebugView on \\DESKTOP-B53PAVI (local)
File Edit Capture Options Computer Help

```
#     Time            Debug Print
23    9.79544926      hello lyshark.com
46    24.02797127     hello lyshark.com
47    24.02863693     [内核A] => hello lyshark.com A
48    24.02865601      [内核B] => Hi, lyshark.com B
```