repolinux

Repolho's linux blog

LIBNET

Libnet 1.1 tutorial

2011-09-18 | REPOLINUX | 25 COMMENTS

Index

Introduction

Before you try any of this, you need to have libnet installed and you need to know how to use `su` (or `sudo`). You can download the most up-to-date version of libnet I know of here (http://sourceforge.net/projects/libnet-dev/) (development goes on here (https://github.com/sam-github/libnet)).

You can download all the sample code you'll find throughout this tutorial here (https://github.com/repolho/Libnet-1.1-tutorial-examples). No need to copy and paste.

How libnet works

Here's what you need to do to start injecting packets:

1) Fire up libnet with `libnet_init()`.
2) Build all headers, from the highest layer to the lowest. Say you'd like to build a UDP packet over IPv4 over Ethernet, with full control over all headers. You would need to call `libnet_build_udp()`, `libnet_build_ipv4()` and `libnet_build_ethernet()`, in this particular order.
3) Write the packet with `libnet_write()`.
4) Prepare for sending another packet by doing *one* of the following:
4a) Clear the packet with `libnet_clear_packet()`. Go back to 2) and write a different packet.
4b) Go back to 2) and update the packet using the same build functions, but feeding them the tags they returned on the last call.
5) When done sending all the packets you wanted to, clean up with `libnet_destroy()` and exit.

Understanding that logic is the hardest part. Now all you need to do is take a closer look at each function. `man libnet-functions.h` and `man libnet-headers.h` are going to be your best friends at this point.

The libnet context

Almost every libnet function receives a pointer of type `libnet_t*` to what is called the *libnet context* (called `l` in libnet's functions). This is merely all your stuff that libnet has stored in memory, like your

headers and so on. It allows you to reuse and modify your previously created packets (see the section on tags), or even to have two or more stacks of headers in memory so you can alternate between them without having destroy and rebuild them every time.

Make sure to create the context at the beginning of your program and only destroy it at the end, when you're done sending packets. That is, *don't initialize and destroy a new context for every new packet you build*. Besides taking a lot more time to allocate and free all the memory, if you do it fast enough, it will even crash your program. So don't.

Receiving packets and checking your own

Libnet is only useful for *injecting* packets, not for *capturing* them. Libnet is actually incapable of receiving packets at all. If your program requires this functionality, please refer to libpcap (http://www.tcpdump.org/pcap.htm).

To merely look at which replies you're receiving, or to look at your own packets which libnet is sending, you can use any sniffer. The best one is said to be wireshark (https://www.wireshark.org/), while tcpdump (http://www.tcpdump.org/) is a lighter command line alternative.

Tip on working with libnet and pcap: (If you don't understand anything I'm saying here, don't worry, come back after reading the rest of the tutorial, especially the part on the build functions.) When using information from captured packets in libnet functions, I find it is best to use the whole captured packet as a `u_char[]` (or `u_int8_t[]`, same thing), find the appropriate bytes, and then recast them to whatever type the libnet function is expecting. You can also cast the packet (or the relevant portions) as structs for a cleaner code, but then you should still use `u_char[]` for each field. This is in contrast with trying to use the structs recommended in the pcap tutorial above. Doing so might cause the program to select the wrong bytes (the first time I tried to do this, instead of getting the 4 bytes from the source address, I ended up with the last 2 bytes, and then the first 2 from the destination address; the struct was fine, but the program would shift 2 bytes when casting the address to a `u_int32_t`).

Note that addresses require no extra work at all, since they're certainly in network order in the packet, and that's what libnet is expecting as well.

So, for example, suppose you want to use the source IP address from a captured packet as the destination address in your own packet. So you have your callback function that `pcap_loop()` is calling when it sniffs a packet, which it passes along as a `u_char[]`. Let's say the packet you got is whatever over IP over ethernet, so you know the source IP address will start at the 27th byte of the packet (ethernet header is 14 bytes long, source address is the 13th byte in IP header). Since C counts from 0, this will be at `packet[26]`. So it'll look something like:

```
void build_reply(..., const uchar *packet) {
    u_char *ip_src = packet[26];
    ...
    ip_tag = libnet_build_ipv4(..., *(u_int_32t*)ip_src, ...);
    ...
}
```

The bottom line is *work with pointers to bytes, cast when necessary*.

Compiling

To compile the following examples and also your own programs, you'll need to at least link with `-lnet`. For reference, here's what I use:

```
gcc -ggdb -Wall `libnet-config --defines`
    `libnet-config --libs` example.c -o example
```

Integer types

C standards allow different architectures to implement char, short int, int and long int types in different amounts of bits (http://en.wikipedia.org/wiki/C_syntax#Integral_types), according to some rules. That's usually fine. When you are dealing with networking, however, you can't have headers with different sizes because they were built on different architectures, right? That's why libnet uses fixed length integer types (http://en.wikipedia.org/wiki/Stdint.h). The most important ones you'll encounter will be `u_int32_t`, which means a 32-bit unsigned integer, and `u_int8_t` which means an unsigned byte.

Here's what you need to know:
If there is a `u`, it's unsigned.
If there is no `u`, it's signed.
`int` means "integer".
8, 16, 32, 64 mean 8 bits (1 byte), 16 bits (2 bytes), 32 bits (4 bytes), 64 bits (8 bytes).
`t` means "type".

Note that `u_char`, `uchar`, `u_int8_t` and `uint8_t` should all mean the same thing on most architectures.

Errors

When calling `libnet_init()` (see below), you'll need a string (`errbuf`) to learn more about an error. After `libnet_init()` has been successfully called, though, you will get your error messages from a different source:

```
char * libnet_geterror (libnet_t *l)
```

All it needs is the context. Call it when you want to know more about the last error you've got.

Enough talk, let's start coding.

Initializing and closing libnet

`libnet-functions.h` gives us the prototype for `libnet_init()`:

```
libnet_t * libnet_init (int injection_type, char *device,
    char *err_buf)
```

From last to first:

- `err_buf` is a string which will hold an error message if something goes wrong.
- `device` is the device's name (as in `"eth0"`) or its IP address (as in `"10.0.0.1"`). If device is set to NULL, libnet will try to find a device for you. **Warning:**If you encounter any strange errors when creating headers or writing packets, try passing a device here (eth0, wlan0, lo) instead of `NULL`.
- `injection_type` is the injection type, as in from the link layer up or from the network layer up. We'll use `LIBNET_RAW4` (IPv4 and above) and `LIBNET_LINK` (link layer and above).

The function returns a pointer to the libnet context, which you'll need for all header building functions.

Let's try it out:

Example 1: init.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/01_init.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>

int main() {

  libnet_t *l;  /* the libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE];

  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  libnet_destroy(l);
  return 0;
}
```

Or we can provide a device name or IP address as an argument:

Example 2: init_devname.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/02_init_devname.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>

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

  libnet_t *l;  /* the libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE];

  if ( argc == 1 ) {
    fprintf(stderr,"Usage: %s device\n", argv[0]);
    exit(EXIT_FAILURE);
  }

  l = libnet_init(LIBNET_RAW4, argv[1], errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  libnet_destroy(l);
  return 0;
}
```

Addresses

If you are going to handle IPv4 and Ethernet addresses, you will be dealing with a `u_int32_t` (unsigned 32 bits [4 bytes] integer) for each IP address and a `u_int8_t[6]` array (unsigned 8 bits [1 byte] integer) for Ethernet. When you get one of these addresses from libnet, you will get them in network byte order. Even if your architecture stores integers in little-endian order (e.g., x86 and x86_64), you will get your addresses in memory with most significant bytes first (lower addresses) and least significant bytes last (higher addresses). Hopefully, the next example will illustrate that.

Warning: Make sure to differentiate between numerical addresses stored in byte arrays and string representations of addresses stored in char arrays. The first might look like `u_int8_t[] = {127, 0, 0, 1}`, while the latter would look like `char[] = "127.0.0.1"` which equals `char[] = {'1', '2', '7', '.', '0', '.', '0', '.', '1', '\0' }`. They are not the same thing. Build functions will always ask for numerical addresses, while name-resolving functions will ask for or return strings (and return or ask for the corresponding numerical address). Addresses extracted from packets read by `libpcap` will be numerical, not strings.

The functions you need for dealing with IPv4 address to string, string to IPv4 address and string to

Ethernet address are:

```
char* libnet_addr2name4 (u_int32_t in, u_int8_t use_name)

u_int32_t libnet_name2addr4 (libnet_t *l, char *host_name,
    u_int8_t use_name)

u_int8_t* libnet_hex_aton (int8_t * s, int * len)
```

`libnet_addr2name4()` will take the 4 bytes address `in` and return a string with its dotted decimal representation (e.g., 192.168.0.1) if `use_name` is `LIBNET_DONT_RESOLVE`, or its DNS name (e.g., google.com) if `use_name` is `LIBNET_RESOLVE`.

`libnet_name2addr4()` will do the exact opposite of `libnet_addr2name4()`, and will also need the libnet context as its first argument.

`libnet_hex_aton()` will take a string (`int8_t* == char*`) of two digits hexadecimal numbers separated by colons (e.g., 00:30:0A:67:A6:5C) and return that address in a `u_int8_t` array. The array's length is stored in `len` (for Ethernet, it's usually 6). As we can see on `man libnet-functions.h`, `libnet_hex_aton()` implicitly calls `malloc()` and that memory needs to be freed after you are done with it. Remember this.

To accomplish the opposite effect of `libnet_hex_aton()` you can call printf with "%02X" for each byte, separating them with colons. We'll do that in the following example.

Example 3: addr.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/03_addr.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

int main() {

  libnet_t *l;  /* the libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE];
  char ip_addr_str[16], mac_addr_str[18];
  u_int32_t ip_addr;
  u_int8_t *ip_addr_p, *mac_addr;
  int i, length;  /* for libnet_hex_aton() */

  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  /* IP address */

  printf("IP address: ");
  scanf("%15s",ip_addr_str);

  ip_addr = libnet_name2addr4(l, ip_addr_str,\
                 LIBNET_DONT_RESOLVE);

  if ( ip_addr != -1 ) {

    /* ip_addr is ready to be used in a build function.
     * We'll print its contents to stdout to check if
     *  everything went fine. */

    /* libnet_name2addr4 returns the address in network
     * order (big endian). */

    ip_addr_p = (u_int8_t*)(&ip_addr);
    /* Check your system's endianess: */
    /*
    printf("ip_addr:   %08X\n", ip_addr);
    printf("ip_addr_p: %02X%02X%02X%02X\n", ip_addr_p[0],\
        ip_addr_p[1], ip_addr_p[2], ip_addr_p[3]);
    */

    printf("Address read: %d.%d.%d.%d\n", ip_addr_p[0],\
        ip_addr_p[1], ip_addr_p[2], ip_addr_p[3]);

    /* This would output the same thing, but I wanted to
     * show you how the address is stored in memory. */
```

```
    /*
    printf("Address read: %s\n", libnet_addr2name4(ip_addr,\
        LIBNET_DONT_RESOLVE));
    */
  }
  else
    fprintf(stderr, "Error converting IP address.\n");

  /* MAC address */

  printf("MAC address: ");
  scanf("%17s", mac_addr_str);

  mac_addr = libnet_hex_aton(mac_addr_str, &length);

  if (mac_addr != NULL) {

    /* mac_addr is ready to be used in a build function.
     * We'll print its contents to stdout to check if
     * everything went fine. */

    printf("Address read: ");
    for ( i=0; i < length; i++) {
      printf("%02X", mac_addr[i]);
      if ( i < length-1 )
        printf(":");
    }
    printf("\n");

    /* Remember to free the memory allocated by
     * libnet_hex_aton() */
    free(mac_addr);
  }
  else
    fprintf(stderr, "Error converting MAC address.\n");

  libnet_destroy(l);
  return 0;
}
```

Here you can see one of many casting tricks you might need in the future. On line 42, we'll cast `&ip_addr` into a `u_int8_t*` and store it in `ip_addr_p`. We are turning what would be a pointer to a 4 byte integer into a pointer to an array of 4 single bytes. The reason we do that is so that even if your system uses little-endian integers, we'll be able to read the bytes in the correct order (most significant first). If you are on a PC, try uncommenting lines 44-46; you should get the same thing except that all bytes are swapped (2 hex digits == 1 byte). You should also note that we could have accomplished the same result with `libnet_addr2name4()`. Uncomment lines 53-54 to check.

It may also be very useful to get our own IP and MAC addresses from libnet. For that, we'll need:

```
u_int32_t libnet_get_ipaddr4 (libnet_t *l)

libnet_ether_addr * libnet_get_hwaddr (libnet_t *l)
```

No explanation needed, except for the libnet_ether_addr type:

```
struct libnet_ether_addr {
    u_char  ether_addr_octet[6]; /* Ethernet address */
};
```

It's just a struct with an array of 6 unsigned bytes like the one we used above.

Warning: If you get the error `ioctl(): Can't assign requested address` when calling `libnet_get_ipaddr4()` , it probably means your network device doesn't have an IP address assigned to it. If you're sure that it does, then libnet is probably using the wrong device (e.g. you think it is using `wlan0`, but it's actually using `eth0`). If `libnet_get_hwaddr()` is working, try calling `ifconfig` (`ipconfig` if you're on windows) and compare the interface's MAC address to what libnet is reporting. If it really is selecting the wrong interface, pass the right one instead of `NULL` when calling `libnet_init()`.

Here's an example of their usage:

Example 4: get_own_addr.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/04_get_own_addr.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

int main() {

  libnet_t *l;  /* libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE];
  u_int32_t ip_addr;
  struct libnet_ether_addr *mac_addr;

  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  ip_addr = libnet_get_ipaddr4(l);
  if ( ip_addr != -1 )
    printf("IP address: %s\n", libnet_addr2name4(ip_addr,\
                            LIBNET_DONT_RESOLVE));
  else
    fprintf(stderr, "Couldn't get own IP address: %s\n",\
                    libnet_geterror(l));

  mac_addr = libnet_get_hwaddr(l);
  if ( mac_addr != NULL )
    printf("MAC address: %02X:%02X:%02X:%02X:%02X:%02X\n",\
        mac_addr->ether_addr_octet[0],\
        mac_addr->ether_addr_octet[1],\
        mac_addr->ether_addr_octet[2],\
        mac_addr->ether_addr_octet[3],\
        mac_addr->ether_addr_octet[4],\
        mac_addr->ether_addr_octet[5]);
  else
    fprintf(stderr, "Couldn't get own MAC address: %s\n",\
                    libnet_geterror(l));

  libnet_destroy(l);
  return 0;
}
```

The build functions

Libnet makes available a build function for each type of header you may want to use in your packet. As you might notice, some of these functions have a smaller version of themselves, called autobuild. The build functions will let you control every piece of information the header will carry. Usually, however, you will only want to fill out the most important fields and let libnet handle the rest, therefore we have the autobuild functions.

In all subsequent examples, I'll use the autobuild funtions wherever possible. Do not hesitate to try out their build counterparts, though. You'll just need to know your headers (i.e., now is a good time to read those RFCs). For example, here's the regular IPv4 build function:

```
libnet_ptag_t libnet_build_ipv4 (u_int16_t len,
    u_int8_t tos, u_int16_t id, u_int16_t frag,
    u_int8_t ttl, u_int8_t prot, u_int16_t sum,
    u_int32_t src, u_int32_t dst, u_int8_t * payload,
    u_int32_t payload_s, libnet_t * l, libnet_ptag_t ptag)
```

`len` is total packet length (from the network layer POV, i.e. not including the link layer header);
`tos` is type of service (useless, set to 0);
`id` is the sequential id number (leave as 0 for the kernel to fill it in for you);
`frag` is fragmentation flags and offset (0 for no fragmentation (if do want it, checkout advanced mode below));
`prot` is the next header's protocol (useful macros are `IPPROTO_ICMP`, `IPPROTO_TCP`, `IPPROTO_UDP`);
`ttl` is time to live, the number of hops before a router discards your packet considering it entered a routing loop (usually set to 64 or 255, or incremented from 1 for tracerouting, for example);
`sum` is the checksum (leave as 0 for the kernel to fill it in);
`src` and `dst` are the source and destination addresses;
`payload` and `payload_s` are a pointer to and length of the payload (`NULL` and 0 if there's none);
`l` and `ptag` are libnet's context and the tag used to modify this header (see next section).

As you can see, the actual header stuff is straightforward. If in doubt, refer to your textbook or wikipedia. If still in doubt, set to 0. ;)

Warning: If you're building an application layer header on top of IPv4, *do not pass the payload to* `libnet_build_ipv4()`. Pass it to the TCP or UDP build functions, otherwise you'll get an IP header, the payload, and then the next header.

Alright, let's build and sent an ICMP echo request to an address read from stdin. That packet will carry a 10 byte payload that could be any size (up to (64K – 28) bytes, or the link layer protocol's MTU if unwilling to fragment) and anything. In this case, it's a string that goes "libnet :D". When we pass it to `libnet_build_icmpv4_echo()`, we cast it as `u_int8_t*`. If we were reading the packet on the

other end or even reading its reply, all we would need to do is cast it back to `char*`. As mentioned above, when you do not wish to send any data, simply pass `NULL` as the payload and 0 as its length.

We'll need these:

```
libnet_ptag_t libnet_build_icmpv4_echo (u_int8_t type,
    u_int8_t code, u_int16_t sum, u_int16_t id,
    u_int16_t seq, u_int8_t * payload, u_int32_t payload_s,
    libnet_t * l, libnet_ptag_t ptag)

libnet_ptag_t libnet_autobuild_ipv4 (u_int16_t len,
    u_int8_t prot, u_int32_t dst, libnet_t *l)
```

For `libnet_build_icmp4_echo()`, we'll be interested in `seq` (sequence number) and `id` (identification number), `payload` (the extra data we're sending), `payload_s` (the payload's size). `l` is the libnet context we initialized with `libnet_init()`. Don't worry about the `libnet_ptag_t` type and `ptag`, we will talk about them later when we are sending multiple packets (sending-multiple-packets).

`libnet_autobuild_ipv4()` is straightforward. Go take a look at both functions' descriptions in `man libnet-functions.h`.

We will use libnet's pseudo-random number generating abilities for the first time. It's pretty easy: seed the generator with `libnet_seed_prand()`, and then get as many numbers as you like with `libnet_get_prand()`. Go take a look at those functions' descriptions in `man libnet-functions.h` also.

Example 5: ping.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/05_ping.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

int main() {

  libnet_t *l;  /* libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE], ip_addr_str[16];
  u_int32_t ip_addr;
  u_int16_t id, seq;
  char payload[] = "libnet :D";
  int bytes_written;

  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  /* Generating a random id */

  libnet_seed_prand (l);
  id = (u_int16_t)libnet_get_prand(LIBNET_PR16);

  /* Getting destination IP address */

  printf("Destination IP address: ");
  scanf("%15s",ip_addr_str);

  ip_addr = libnet_name2addr4(l, ip_addr_str,\
                 LIBNET_DONT_RESOLVE);

  if ( ip_addr == -1 ) {
    fprintf(stderr, "Error converting IP address.\n");
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building ICMP header */

  seq = 1;

  if (libnet_build_icmpv4_echo(ICMP_ECHO, 0, 0, id, seq,\
        (u_int8_t*)payload,sizeof(payload), l, 0) == -1)
  {
    fprintf(stderr, "Error building ICMP header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
```

```
  }

  /* Building IP header */

  if (libnet_autobuild_ipv4(LIBNET_IPV4_H +\
        LIBNET_ICMPV4_ECHO_H + sizeof(payload),\
        IPPROTO_ICMP, ip_addr, l) == -1 )
  {
    fprintf(stderr, "Error building IP header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Writing packet */

  bytes_written = libnet_write(l);
  if ( bytes_written != -1 )
    printf("%d bytes written.\n", bytes_written);
  else
    fprintf(stderr, "Error writing packet: %s\n",\
        libnet_geterror(l));

  libnet_destroy(l);
  return 0;
}
```

Note that we built `libnet_build_icmpv4_echo()` and `libnet_autobuild_ipv4()` in this particular order.

In both functions we needed some macros for the headers sizes (`LIBNET_IPV4_H`, `LIBNET_ICMPV4_ECHO_H`), upper layer (not really, but IP thinks it is) protocol (`IPPROTO_ICMP`) and ICMP packet type (`ICMP_ECHO`). All of these can be found in `man libnet-headers.h`. Actually, `IPPROTO_ICMP` is not there and I'm not really sure where it is, but you can just write it down.

Here's what tcpdump sniffed when I (10.0.0.3) used that program to ping my adsl modem (10.0.0.1).

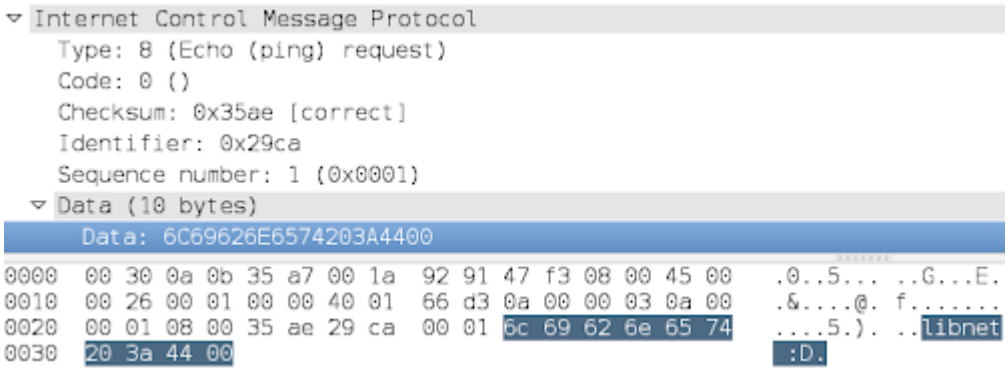
```
# tcpdump -n -ttt icmp

000000 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 3276,
    seq 1, length 18

000936 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 3276,
    seq 1, length 18
```

`length` refers to the data carried by IP which is 10 bytes from the payload and 8 bytes from the ICMP header. When I ran the program it outputted "38 bytes written." That's because we called `libnet_init`() with `LIBNET_RAW4`, so it is only telling us how many bytes were written to the link layer, not to the wire.

Here's the payload in wireshark:



(https://picasaweb.google.com/lh/photo/NsjOwISUkkZoyly78p11Fg?feat=embedwebsite)

Now let's do something similar on the link layer. The following example sends an ARP request for the IP address read from stdin. We'll need:

```
libnet_ptag_t libnet_autobuild_arp (u_int16_t op,
    u_int8_t * sha, u_int8_t * spa, u_int8_t * tha,
    u_int8_t * tpa, libnet_t * l)

libnet_ptag_t libnet_autobuild_ethernet (u_int8_t * dst,
    u_int16_t type, libnet_t * l)
```

Read their descriptions in `man libnet-functions.h`. Read the respective RFCs if you need more information.

Example 6: arp.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/06_arp.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

int main() {

  libnet_t *l;  /* the libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE], target_ip_addr_str[16];
  u_int32_t target_ip_addr, src_ip_addr;
  u_int8_t mac_broadcast_addr[6] = {0xff, 0xff, 0xff, 0xff,\
          0xff, 0xff},
     mac_zero_addr[6] = {0x0, 0x0, 0x0, 0x0, 0x0, 0x0};
  struct libnet_ether_addr *src_mac_addr;
  int bytes_written;

  l = libnet_init(LIBNET_LINK, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  /* Getting our own MAC and IP addresses */

  src_ip_addr = libnet_get_ipaddr4(l);
  if ( src_ip_addr == -1 ) {
    fprintf(stderr, "Couldn't get own IP address: %s\n",\
                    libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  src_mac_addr = libnet_get_hwaddr(l);
  if ( src_mac_addr == NULL ) {
    fprintf(stderr, "Couldn't get own IP address: %s\n",\
                    libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Getting target IP address */

  printf("Target IP address: ");
  scanf("%15s",target_ip_addr_str);

  target_ip_addr = libnet_name2addr4(l, target_ip_addr_str,\
      LIBNET_DONT_RESOLVE);

  if ( target_ip_addr == -1 ) {
    fprintf(stderr, "Error converting IP address.\n");
```

```
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building ARP header */

  if ( libnet_autobuild_arp (ARPOP_REQUEST,\
      src_mac_addr->ether_addr_octet,\
      (u_int8_t*)(&src_ip_addr), mac_zero_addr,\
      (u_int8_t*)(&target_ip_addr), l) == -1)
  {
    fprintf(stderr, "Error building ARP header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building Ethernet header */

  if ( libnet_autobuild_ethernet (mac_broadcast_addr,\
                          ETHERTYPE_ARP, l) == -1 )
  {
    fprintf(stderr, "Error building Ethernet header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Writing packet */

  bytes_written = libnet_write(l);
  if ( bytes_written != -1 )
    printf("%d bytes written.\n", bytes_written);
  else
    fprintf(stderr, "Error writing packet: %s\n",\
        libnet_geterror(l));

  libnet_destroy(l);
  return 0;
}
```

As previously mentioned, we need to call `libnet_init()` with `LIBNET_LINK`. Note that `libnet_autobuild_arp()` (`libnet_build_arp()` too) expects IPv4 addresses as an array of 4 `u_int8_t`, instead of the `u_int32_t` that `libnet_autobuild_ipv4()`/`libnet_build_ipv4()` expected. You can see above that a simple cast solves the problem.

Here's what tcpdump sniffed when I used that example to request my modem's (10.0.0.1) MAC address:

```
# tcpdump -n -ttt arp

000000 arp who-has 10.0.0.1 tell 10.0.0.3

000456 arp reply 10.0.0.1 is-at 00:30:0a:67:a6:5c
```

The MAC address has been altered to protect my modem's secret identity.

The output I got when running it was "42 bytes written." This time, these are bytes written to the wire and not the link layer (the ARP header is always 28 bytes long; the Ethernet header, 14).

Sending multiple packets

So, now you can send a single packet successfully, but how do you send multiple packets in a row? Well, you can choose between using tags to modify already built headers, or calling `libnet_clear_packet()` and rebuilding all headers from scratch.

Tags are integers with a `libnet_ptag_t` type. When you call a build function, it will return a tag. That tag identifies the header built inside libnet's context. When you are calling a build function for the first time, you can pass 0 as the tag, or a tag initialized with `tag = LIBNET_PTAG_INITIALIZER`. That will make the function build a new header, and wrap it around what is already built. When calling a build function again, you should pass the tag it returned the previous time, so that the header will be modified instead of a new one being built.

If you do not wish to modify an existing header, you need to erase it with `libnet_clear_packet()`. Libnet suggests you only do this when you are about to build a completely different packet with completely different protocols, using the same context. Since I'm lazy, though, I'll do exactly what I'm telling you not to do below on my libnet_clear_packet() example. Please don't follow my example, use tags whenever possible.

Warning: Clearing packets and recreating them as fast as you can is known to crash programs, so if you're planning on firing big amounts of packets, you should be using tags.

Now, if you really are in a situation where it's better to clear the packet, go ahead and call `libnet_clear_packet()`, and then you can build new headers passing 0 as the tag. Remember that you will need to rebuild *all* headers, and that you will need to do it from the upper layers to the lower ones just like the first time.

Here's how you should use tags:

Example 7: reping_tags.c (https://github.com/repolho/Libnet-1.1-

tutorial-examples/blob/master/07_reping_tags.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>
#include <unistd.h>

int main() {

  libnet_t *l;  /* libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE], ip_addr_str[16];
  u_int32_t ip_addr;
  libnet_ptag_t icmp_tag, ip_tag;
  u_int16_t id, seq;
  int i;

  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  icmp_tag = ip_tag = LIBNET_PTAG_INITIALIZER;

  /* Generating a random id */

  libnet_seed_prand(l);
  id = (u_int16_t)libnet_get_prand(LIBNET_PR16);

  /* Getting destination IP address */

  printf("Destination IP address: ");
  scanf("%15s",ip_addr_str);

  ip_addr = libnet_name2addr4(l, ip_addr_str,\
      LIBNET_DONT_RESOLVE);

  if ( ip_addr == -1 ) {
    fprintf(stderr, "Error converting IP address.\n");
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building ICMP header */

  seq = 1;

  icmp_tag = libnet_build_icmpv4_echo(ICMP_ECHO, 0, 0, id,\
                  seq, NULL, 0, l, 0);

  if (icmp_tag == -1) {
```

```
    fprintf(stderr, "Error building ICMP header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building IP header */

  ip_tag = libnet_autobuild_ipv4(LIBNET_IPV4_H +\
      LIBNET_ICMPV4_ECHO_H, IPPROTO_ICMP, ip_addr, l);

  if (ip_tag == -1) {
    fprintf(stderr, "Error building IP header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Writing 4 packets */

  for ( i = 0; i < 4; i++ ) {

    /* Updating the ICMP header */
    icmp_tag = libnet_build_icmpv4_echo(ICMP_ECHO, 0, 0,\
        id, (seq + i), NULL, 0, l, icmp_tag);

    if (icmp_tag == -1) {
      fprintf(stderr, "Error building ICMP header: %s\n",\
          libnet_geterror(l));
      libnet_destroy(l);
      exit(EXIT_FAILURE);
    }

    if ( libnet_write(l) == -1 )
      fprintf(stderr, "Error writing packet: %s\n",\
          libnet_geterror(l));

    /* Waiting 1 second between each packet */
    sleep(1);

  }

  libnet_destroy(l);
  return 0;

}
```

Just remember that when we are calling `libnet_build_icmpv4_echo()` for any time other than the first, we are not building it, just modifying the already built header.

Here's tcpdump's output:

```
# tcpdump -n -ttt icmp

000000 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 26873,
    seq 1, length 8

000486 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 26873,
    seq 1, length 8

999623 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 26873,
    seq 2, length 8

000479 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 26873,
    seq 2, length 8

999568 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 26873,
    seq 3, length 8

000533 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 26873,
    seq 3, length 8

999519 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 26873,
    seq 4, length 8

000805 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 26873,
    seq 4, length 8
```

Now let's try the same thing using `libnet_clear_packet()`. As stated above, this is a waste of CPU time, and I'm only doing it because I'm lazy.

Example 8: reping_clear.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/08_reping_clear.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>
#include <unistd.h>

int main() {

  libnet_t *l;  /* libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE], ip_addr_str[16];
  u_int32_t ip_addr;
  u_int16_t id, seq;
  int i;

  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  /* Generating a random id */

  libnet_seed_prand(l);
  id = (u_int16_t)libnet_get_prand(LIBNET_PR16);

  /* Getting destination IP address */

  printf("Destination IP address: ");
  scanf("%15s",ip_addr_str);

  ip_addr = libnet_name2addr4(l, ip_addr_str,\
      LIBNET_DONT_RESOLVE);

  if ( ip_addr == -1 ) {
    fprintf(stderr, "Error converting IP address.\n");
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Writing 4 packets */

  seq = 1;

  for ( i = 0; i < 4; i++ ) {

    /* Building the ICMP header */
    if ( libnet_build_icmpv4_echo(ICMP_ECHO, 0, 0, id,\
        (seq + i), NULL, 0, l, 0) == -1 ) {
      fprintf(stderr, "Error building ICMP header: %s\n",\
          libnet_geterror(l));
```

```
      libnet_destroy(l);
      exit(EXIT_FAILURE);
    }

    /* Building the IP header */
    if ( libnet_autobuild_ipv4(LIBNET_IPV4_H + \
          LIBNET_ICMPV4_ECHO_H, IPPROTO_ICMP,\
          ip_addr, l) == -1 ) {
      fprintf(stderr, "Error building IP header: %s\n",\
          libnet_geterror(l));
      libnet_destroy(l);
      exit(EXIT_FAILURE);
    }

    if ( libnet_write(l) == -1 )
      fprintf(stderr, "Error writing packet: %s\n",\
          libnet_geterror(l));

    /* Clearing the packet */
    /* Comment this to see what happens when you rebuild
     * headers without calling libnet_clear_packet() */
    libnet_clear_packet(l);

    /* Waiting 1 second between each packet */
    sleep(1);

  }

  libnet_destroy(l);
  return 0;
}
```

Note that you have to rebuild the whole packet again, and that you must do it in the correct order (upper layer to lower layer) again.

Well, that wasn't interesting at all. Let's try commenting out `libnet_clear_packet()` and see what happens:

```
# tcpdump -n -ttt icmp

000000 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 9701,
    seq 1, length 8

000486 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 9701,
    seq 1, length 8

999605 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 9701,
    seq 2, length 36

000483 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 9701,
    seq 2, length 36

999596 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 9701,
    seq 3, length 64

000500 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 9701,
    seq 3, length 64

999585 IP 10.0.0.3 > 10.0.0.1: ICMP echo request, id 9701,
    seq 4, length 92

000558 IP 10.0.0.1 > 10.0.0.3: ICMP echo reply,   id 9701,
    seq 4, length 92
```

You should remember from the first time we tried sending an ICMP echo request that it is 20 (IP header) + 8 (ICMP header) + 0 (payload size) bytes long when going to the link layer. You should also remember that the length outputted by tcpdump refers to the data carried by IP. Now let's try this: 8 bytes (ICMP header for the second packet) + 28 bytes (previous packet as seen by the libnet context) == 36 bytes. Now add 20 bytes (IP header for the second packet) and 8 more bytes (ICMP header for the third packet), and we get 64. Do this again and you will get 92 for the last packet.

What we can see here is that when we forget to call `libnet_clear_packet()`, all headers we build again will go before the ones already built, and carry them as if they were payload we meant to send in that packet.

IP fragmentation and libnet

If you need to send a packet bigger than the MTU at hand using libnet, you'll need to fragment it yourself. Not only will libnet not help you in doing it, it will actually get in the way, by calculating the upper-layer checksum using only the first fragment's payload, causing your packet to get discarded at destination. To get the correct checksum, you can create one big packet, have libnet calculate the

checksum, then retrieve it without writing the packet to the wire. To do this, we'll have to take a look at libnet's advanced mode.

Advanced mode

Libnet has a few advanced functions, which are only available when you open it in advanced mode. If you remember when we looked into libnet_init(), we could choose to deal with the link layer or not by using `LIBNET_LINK` and `LIBNET_RAW4` respectively as the injection type. For advanced mode, we would use `LIBNET_LINK_ADV` and `LIBNET_RAW4_ADV` in the same way. Except that we won't actually use `LIBNET_RAW4_ADV` since all advanced functions seem to require `LIBNET_LINK_ADV`.

Anyway, in advanced mode, you'll have access to:

```
int libnet_adv_cull_header (libnet_t * l,
    libnet_ptag_t ptag, u_int8_t ** header,
    u_int32_t * header_s)
```

This function will give you a pointer (in `u_int8_t ** header`) to the header referenced by `ptag`. `header_s` will point to a `u_int32_t` containing the size of the header.

Here's an example:

Example 9: cull_header.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/09_cull_header.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

int main() {

  /* Builds an IP header and prints it */

  libnet_t *l;
  char errbuf[LIBNET_ERRBUF_SIZE];
  libnet_ptag_t ip_tag;
  u_int8_t *ip_header;
  u_int32_t ip_header_size;
  int i;

  l = libnet_init(LIBNET_LINK_ADV, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  /* Building IP header, size = 20 bytes, dest address =
   * 0.0.0.0, upper layer protocol = 0 */
  ip_tag = libnet_autobuild_ipv4(20, 0, 0, l);
  if ( ip_tag == -1 ) {
    fprintf(stderr, "Error building IP header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Getting a pointer to the header */
  if (libnet_adv_cull_header(l, ip_tag, &ip_header,\
       &ip_header_size) == -1) {
    fprintf(stderr,"libnet_adv_cull_header() failed: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Printing the header */
  for (i=0; i < ip_header_size; i++) {
    printf("%02X ", ip_header[i]);
  }
  printf("\n");

  libnet_destroy(l);
  return 0;
}
```

```
# ./cull_header

45 00 00 14 00 00 00 00 40 00 00 00 0A 00 00 03 00 00 00 00
```

Similarly, there's:

```
int libnet_adv_cull_packet (libnet_t * l,
    u_int8_t ** packet, u_int32_t * packet_s)
```

This one works the same way, but gives you a pointer to whole packet which you should have already built. If you call it, you'll need to free the memory later with

```
void libnet_adv_free_packet (libnet_t * l,
    u_int8_t * packet)
```

If you modify the packet from `libnet_adv_cull_packet()` or build your own packet from scratch, you can send it with

```
int libnet_adv_write_link (libnet_t * l, u_int8_t * packet,
    u_int32_t packet_s)
```

To exemplify, I'll rewrite the ARP example I used when talking about the build_functions, but I'll build the ARP header without the target IP address and add it directly into the packet:

Example 10: cull_packet.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/10_cull_packet.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

int main() {

  /* Builds an ARP request, then pulls it from libnet,
   * changes the target IP address and writes it. */

  libnet_t *l;
  char errbuf[LIBNET_ERRBUF_SIZE], target_ip_addr_str[16];
  u_int32_t src_ip_addr, target_ip_addr = 0;
  u_int8_t mac_broadcast_addr[6] = {0xff, 0xff, 0xff, 0xff,\
      0xff, 0xff},
  mac_zero_addr[6] = {0x0, 0x0, 0x0, 0x0, 0x0, 0x0};
  struct libnet_ether_addr *src_mac_addr;
  int i;

  u_int8_t *packet, *target_ip_addr_p;
  u_int32_t packet_size;


  l = libnet_init(LIBNET_LINK_ADV, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  /* Getting our own MAC and IP addresses */
  src_ip_addr = libnet_get_ipaddr4(l);
  if ( src_ip_addr == -1 ) {
    fprintf(stderr, "Couldn't get own IP address: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  src_mac_addr = libnet_get_hwaddr(l);
  if ( src_mac_addr == NULL ) {
    fprintf(stderr, "Couldn't get own IP address: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building ARP header with target IP address = 0.0.0.0 */
  if ( libnet_autobuild_arp (ARPOP_REQUEST,\
      src_mac_addr->ether_addr_octet,\
      (u_int8_t*)(&src_ip_addr), mac_zero_addr,\
```

```
    (u_int8_t*)(&target_ip_addr), l) == -1)
{
  fprintf(stderr, "Error building ARP header: %s\n",\
      libnet_geterror(l));
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

/* Building Ethernet header */
if ( libnet_autobuild_ethernet (mac_broadcast_addr,\
    ETHERTYPE_ARP, l) == -1 )
{
  fprintf(stderr, "Error building Ethernet header: %s\n",\
      libnet_geterror(l));
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

/* Pulling the packet */
if (libnet_adv_cull_packet(l, &packet, &packet_size)\
     == -1) {
  fprintf(stderr,"libnet_adv_cull_packet() failed: %s\n",\
      libnet_geterror(l));
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

/* Getting target IP address */
printf("Target IP address: ");
scanf("%15s",target_ip_addr_str);

target_ip_addr = libnet_name2addr4(l, target_ip_addr_str,\
    LIBNET_DONT_RESOLVE);

if ( target_ip_addr == -1 ) {
  fprintf(stderr, "Error converting IP address.\n");
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

/* Changing the target */
/* We want to change the 39th, 40th, 41st and 42nd bytes:
 * Ethernet header (14) + ARP's hw(2), proto(2), hw
 * size(1), proto size(1), opcode(2), src hw addr(6), src
 * ip add(4), target hw addr(6) = 38 */
if (packet_size >= 42) {
  target_ip_addr_p = (u_int8_t *)&target_ip_addr;
  for (i=0; i < 4; i++) {
    packet[38+i] = target_ip_addr_p[i];
  }
}
```

```
  /* Writing packet */
  if (libnet_adv_write_link(l, packet, packet_size) == -1) {
    fprintf(stderr, "Error writing packet: %s\n",\
        libnet_geterror(l));
  }

  /* Freeing up the memory */
  libnet_adv_free_packet(l, packet);

  libnet_destroy(l);
  return 0;
}
```

```
# tcpdump -n -ttt arp

000000 arp who-has 10.0.0.1 tell 10.0.0.3

000459 arp reply 10.0.0.1 is-at 00:30:0a:67:a6:5c
```

Now, let's move on to the useful stuff.

IP fragmentation with libnet

As stated above, the only way I was able to fragment packets with libnet was implementing the fragmentation myself. In this example, I'll send an ICMP echo request with arbitrarily big random payload. The MTU I chose is Ethernet's 1500 bytes, since that's what I have here. I hope it will be simple to adapt the code to send a TCP or UDP packet with any kind of payload.

Example 11: frag_ping.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/11_frag_ping.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

#define MTU 1500

libnet_t *l;  /* libnet context */

void frag_and_send(u_int8_t *payload,\
    u_int32_t total_pload_size);

u_int16_t get_sum(u_int8_t *payload, \
    u_int32_t total_pload_size, u_int16_t id,\
    u_int16_t seq);

int main() {

  int i;
  char errbuf[LIBNET_ERRBUF_SIZE];
  /* It's a good idea to have the payload as an array of
   * bytes. If yours isn't, make a pointer to it and cast
   * it.*/
  u_int8_t payload[3000];

  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr,\
        "libnet_init() failed (raw4, 1st call): %s\n",\
        errbuf);
    exit(EXIT_FAILURE);
  }

  /* Generating random payload */
  libnet_seed_prand (l);

  for (i = 0; i < sizeof(payload); i++) {
    payload[i] = libnet_get_prand(LIBNET_PR8);
  }

  /* Building and sending the fragments */
  frag_and_send(payload, sizeof(payload));

  libnet_destroy(l);
  return 0;
}

void frag_and_send(u_int8_t *payload,\
    u_int32_t total_pload_size) {
```

```
/* Builds and sends the first packet, calling get_sum() to
 * get the correct checksum for the ICMP packet (with the
 * whole payload). Then builds and sends IP fragments
 * until all the payload is sent. */

char ip_addr_str[16];
u_int32_t ip_addr, src_addr;
u_int16_t id, seq, ip_id;
/* hdr_offset = fragmentation flags + offset (in bytes)
 * divided by 8 */
int pload_offset, hdr_offset;
int bytes_written, max_pload_size, packet_pload_size;
libnet_ptag_t ip_tag;

/* Generating random IDs */

id = (u_int16_t)libnet_get_prand(LIBNET_PR16);
/* We need a non-zero id number for the IP headers,
 * otherwise libnet will increase it after each
 * build_ipv4, breaking the fragments */
ip_id = (u_int16_t)libnet_get_prand(LIBNET_PR16);

seq = 1;

/* Getting IP addresses */

src_addr = libnet_get_ipaddr4(l);
if ( src_addr == -1 ) {
  fprintf(stderr, "Couldn't get own IP address: %s\n",\
      libnet_geterror(l));
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

printf("Destination IP address: ");
scanf("%15s",ip_addr_str);

ip_addr = libnet_name2addr4(l, ip_addr_str,\
    LIBNET_DONT_RESOLVE);

if ( ip_addr == -1 ) {
  fprintf(stderr, "Error converting IP address.\n");
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

/* Getting max payload size */

max_pload_size = (MTU - LIBNET_IPV4_H);
/* making it a multiple of 8 */
max_pload_size -= (max_pload_size % 8);
```

```
pload_offset = 0;

/* Building the first packet, which carries the ICMP
 * header */

/* We're doing (payload size - icmp header size) and not
 * checking if it's a multiple of 8 because we know the
 * header is 8 bytes long */
if ( total_pload_size > (max_pload_size - \
        LIBNET_ICMPV4_ECHO_H) ) {
  hdr_offset = IP_MF;
  packet_pload_size = max_pload_size - \
      LIBNET_ICMPV4_ECHO_H;
}
else {
  hdr_offset = 0;
  packet_pload_size = total_pload_size;
}

/* ICMP header */
if ( libnet_build_icmpv4_echo(ICMP_ECHO, 0, \
        get_sum(payload, total_pload_size, id, seq),\
        id, seq, payload, packet_pload_size, l, 0) == -1 )
{
  fprintf(stderr, "Error building ICMP header: %s\n", \
      libnet_geterror(l));
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

/* First IP header (no payload, offset == 0) */
if ( libnet_build_ipv4((LIBNET_IPV4_H + \
        LIBNET_ICMPV4_ECHO_H + packet_pload_size), 0,\
      ip_id, hdr_offset, 255, IPPROTO_ICMP, 0, src_addr,\
      ip_addr, NULL, 0, l, 0) == -1 )
{
  fprintf(stderr, "Error building IP header: %s\n",\
      libnet_geterror(l));
  libnet_destroy(l);
  exit(EXIT_FAILURE);
}

/* Writing packet */

bytes_written = libnet_write(l);

if ( bytes_written != -1 )
  printf("%d bytes written.\n", bytes_written);
else
  fprintf(stderr, "Error writing packet: %s\n", \
        libnet_geterror(l));
```

```
/* Updating the offset */
pload_offset += packet_pload_size;

/* Clearing */
/* We need to get rid of the ICMP header to build the
 * other fragments */
libnet_clear_packet(l);

ip_tag = LIBNET_PTAG_INITIALIZER;

/* Looping until all the payload is sent */
while ( total_pload_size > pload_offset ) {

  /* Building IP header */

  /* checking if there will be more fragments */
  if ((total_pload_size - pload_offset) > max_pload_size)
  {
    /* In IP's eyes, the ICMP header in the first packet
     * needs to be in the offset, so we add its size to
     * the payload offset here */
    hdr_offset = IP_MF + (pload_offset + \
        LIBNET_ICMPV4_ECHO_H)/8;
    packet_pload_size = max_pload_size;
  }
  else {
    /* See above */
    hdr_offset = (pload_offset + LIBNET_ICMPV4_ECHO_H)/8;
    packet_pload_size = total_pload_size - pload_offset;
  }

  ip_tag = libnet_build_ipv4( \
      (LIBNET_IPV4_H + max_pload_size), 0, ip_id,\
      hdr_offset, 255, IPPROTO_ICMP, 0, src_addr,\
      ip_addr, (payload + pload_offset),\
      packet_pload_size, l, ip_tag);

  if ( ip_tag == -1 ) {
    fprintf(stderr, "Error building IP header: %s\n", \
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }


  /* Writing packet */

  bytes_written = libnet_write(l);

  if ( bytes_written != -1 )
    printf("%d bytes written.\n", bytes_written);
  else
```

```
      fprintf(stderr, "Error writing packet: %s\n", \
          libnet_geterror(l));

    /* Updating the offset */
    pload_offset += packet_pload_size;
  }
}

u_int16_t get_sum(u_int8_t *payload,\
    u_int32_t total_pload_size, u_int16_t id, u_int16_t seq)
{

  /* Builds the ICMP header with the whole payload, gets
   * the checksum from it and returns it (in host order). */

  char errbuf[LIBNET_ERRBUF_SIZE];
  libnet_ptag_t icmp_tag;
  u_int8_t *packet;
  u_int32_t packet_size;
  u_int16_t *sum_p, sum;
  u_int8_t dummy_dst[6] = {0, 0, 0, 0, 0, 0};

  icmp_tag = LIBNET_PTAG_INITIALIZER;

  /* Switching to advanced link mode */
  /* Nothing should be built yet and all random numbers
   * should be already generated. */
  libnet_destroy(l);
  l = libnet_init(LIBNET_LINK_ADV, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr,"libnet_init() failed (link_adv): %s\n",\
        errbuf);
    exit(EXIT_FAILURE);
  }

  /* Building the header */
  icmp_tag = libnet_build_icmpv4_echo(ICMP_ECHO, 0, 0, id,\
      seq, payload, total_pload_size, l, icmp_tag);

  if ( icmp_tag == -1 ) {

    fprintf(stderr, "Error building ICMP header: %s\n", \
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building dummy IP header */
  if ( libnet_autobuild_ipv4((LIBNET_IPV4_H + \
          LIBNET_ICMPV4_ECHO_H +total_pload_size), \
        IPPROTO_ICMP, 0, l) == -1 ) {
    fprintf(stderr, "Error building dummy IP header: %s\n",\
```

```
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building dummy Ethernet header */
  if ( libnet_autobuild_ethernet (dummy_dst, ETHERTYPE_IP,\
          l) == -1 ) {
    fprintf(stderr,\
        "Error building dummy Ethernet header: %s\n",
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }


  /* Pulling the packet */
  if (libnet_adv_cull_packet(l, &packet, &packet_size)\
      == -1) {
    fprintf(stderr, "Error pulling the packet: %s\n", \
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Grabbing the checksum */
  /* We want the 37th and 38th bytes: eth header (14) + ip
   * header (20) + icmp type and code (2) = 36 */
  sum_p = (u_int16_t*)(packet + 36);
  sum = ntohs(*sum_p);

  /* Freeing memory */
  libnet_adv_free_packet(l, packet);

  /* Clearing the header */
  libnet_clear_packet(l);

  /* Switching back to IPv4 raw socket mode */
  libnet_destroy(l);
  l = libnet_init(LIBNET_RAW4, NULL, errbuf);
  if ( l == NULL ) {
    fprintf(stderr,\
        "libnet_init() failed (raw4, 2nd call): %s\n",\
        errbuf);
    exit(EXIT_FAILURE);
  }

  return sum;
}
```

I've trimmed and formated tcpdump's output as much as possible for clarity.

```
# tcpdump -n -ttt -vv icmp

000000 IP (id 28896, offset 0, flags [+], length 1500)
    10.0.0.3 > 10.0.0.1: ICMP echo request, id 3371, seq 1

000034 IP (id 28896, offset 1480, flags [+], length 1500)
    10.0.0.3 > 10.0.0.1

000012 IP (id 28896, offset 2960, flags [none], length 68)
    10.0.0.3 > 10.0.0.1


001657 IP (id 41612, offset 0, flags [+], length 1500)
    10.0.0.1 > 10.0.0.3: ICMP echo reply, id 3371, seq 1

000215 IP (id 41612, offset 1480, flags [+], length 1500)
    10.0.0.1 > 10.0.0.3

000007 IP (id 41612, offset 2960, flags [none], length 68)
    10.0.0.1 > 10.0.0.3
```

IPv6

Note: Before we begin I'd like to point out that in the following examples I'll be using a few functions that are not available on `<libnet-1.1.6` (namely, `libnet_build_icmpv6_echo()` and `libnet_autobuild_ipv6()` (which implies `libnet_get_ipaddr6()`)). If your distribution only has a dated version of libnet, you can get the latest one from github (https://github.com/sam-github/libnet). I'll be using these functions just because they'll make my life easier in the examples below, but you don't actually need them for building IPv6 packets (well, at least not TCP/UDP over IPv6).

IPv6 addresses

Libnet stores IPv6 addresses using the following structure, defined in libnet-headers.h:

```
/*
 * IPv6 address
 */
struct libnet_in6_addr
{
  union
  {
    uint8_t   __u6_addr8[16];
    uint16_t  __u6_addr16[8];
    uint32_t  __u6_addr32[4];
  } __u6_addr;  /* 128-bit IP6 address */
};
```

Which isn't very different from the uint8_t arrays used for ethernet addresses.

Note: To understand how these functions return errors and how I handle that in the following example, please read the next section.

For converting IPv6 addresses from text to `struct libnet_in6_addr` and vice-versa, we'll use functions analogous to those we used for IPv4 addresses:

```
void libnet_addr2name6_r(struct libnet_in6_addr addr,
    uint8_t use_name, char *host_name, int host_name_len)

struct libnet_in6_addr libnet_name2addr6 (libnet_t *l,
    char *host_name, uint8_t use_name)
```

You might remember that `use_name` can be `LIBNET_RESOLVE`, if you want to resolve DNS names, or `LIBNET_DONT_RESOLVE` if you'll be using an actual address and want to avoid a DNS lookup. Also notice that `libnet_addr2name6_r()` does not allocate the string for you, as `libnet_addr2name4()` did, so you'll have to do it and pass it as an argument, together with its size.

Here you can see these guys in action:

Example 12: addr6.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/12_addr6.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

#define BYTES_IN_IPV6_ADDR 16
#define MAX_CHARS_IN_IPV6_ADDR 39

int libnet_in6_addr_cmp(struct libnet_in6_addr addr1, \
    struct libnet_in6_addr addr2) {
  /* Returns != 0 if addresses are equal, 0 otherwise. */

  uint32_t *p1 = (uint32_t*)&addr1.__u6_addr, \
     *p2 = (uint32_t*)&addr2.__u6_addr;

  return ((p1[0] == p2[0]) && (p1[1] == p2[1]) && \
      (p1[2] == p2[2]) && (p1[3] == p2[3]));
}

int main() {

  libnet_t *l; /* the libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE];
  int i;

  char ipv6_addr_str[MAX_CHARS_IN_IPV6_ADDR+1];
  struct libnet_in6_addr ipv6_addr;
  u_int8_t *ipv6_addr_p;

  l = libnet_init(LIBNET_RAW6, NULL, errbuf);
  if ( l == NULL ) {
  fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  printf("Enter an IPv6 address: ");
  /* too lazy not to hardcode this: */
  scanf("%39s",ipv6_addr_str);

  ipv6_addr = libnet_name2addr6(l, ipv6_addr_str, \
                 LIBNET_DONT_RESOLVE);

  if (libnet_in6_addr_cmp(ipv6_addr, in6addr_error) != 0) {
    fprintf(stderr, "Error converting IPv6 address.\n");
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  ipv6_addr_p = (u_int8_t*)&ipv6_addr.__u6_addr;
  printf("libnet_name2addr6() returned: ");
```

```
  for ( i=0; i < BYTES_IN_IPV6_ADDR; i++) {
    printf("%02x", ipv6_addr_p[i]);
    if ((i % 2 == 1) && i < BYTES_IN_IPV6_ADDR -1)
      printf(":");
  }
  printf("\n");

  ipv6_addr_str[0] = '';
  libnet_addr2name6_r(ipv6_addr, LIBNET_DONT_RESOLVE, \
                  ipv6_addr_str, MAX_CHARS_IN_IPV6_ADDR);
  printf("libnet_addr2name6() says it's: %s\n", \
                  ipv6_addr_str);

  libnet_destroy(l);
  return 0;
}
```

You may also remember that we looked into `libnet_get_ipaddr4()`, which returns your own IPv4 address. The analagous `libnet_get_ipaddr6()` is one of the functions mentioned above which are available only on >=libnet-1.1.6. You don't really need it if you'll be spoofing your packets' source address or if you can hardcode your own address or something similar. If you do have it available, it is just as straightforward as `libnet_get_ipaddr4()`:

```
struct libnet_in6_addr
libnet_get_ipaddr6(libnet_t *l)
```

IPv6 address errors

IPv4 address functions reported errors by returning 255.255.255.255, which is stored in a `uint_32t` as thirty-two 1s, which we could neatly check by comparing to -1, as in

```
if (ipv4_addr == -1)
  /* error handling */
```

The IPv6 functions do the same thing, using the constant `in6addr_error`:

```
const struct libnet_in6_addr
    in6addr_error = IN6ADDR_ERROR_INIT;
```

defined in `libnet-macros.h` as

```
#define IN6ADDR_ERROR_INIT { { { 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
    0xff, 0xff, 0xff } } }
```

Unfortunately, if we try to check it the same way as with IPv4, it will come out a little bit less neat:

```
if (*(uint32_t*)&ipv6_addr.__u6_addr == -1 && \
      *((uint32_t*)&ipv6_addr.__u6_addr +1) == -1 && \
      *((uint32_t*)&ipv6_addr.__u6_addr +2) == -1 && \
      *((uint32_t*)&ipv6_addr.__u6_addr +3) == -1)
  /* error handling */
```

So, I actually use this:

```
int libnet_in6_addr_cmp(struct libnet_in6_addr addr1,
                        struct libnet_in6_addr addr2) {
  /* Returns != 0 if addresses are equal, 0 otherwise. */

  uint32_t *p1 = (uint32_t*)&addr1.__u6_addr, \
           *p2 = (uint32_t*)&addr2.__u6_addr;

  return ((p1[0] == p2[0]) && (p1[1] == p2[1]) && \
         (p1[2] == p2[2]) && (p1[3] == p2[3]));
}
```

and then just

```
if (libnet_in6_addr_cmp(ipv6_addr, in6addr_error) != 0)
  /* error handling */
```

IPv6 build functions

Earlier we used `libnet_autobuild_ipv4()`, which is really just a way to call `libnet_build_ipv4()` and have it fill in default values for pretty much everything. The analogous is `libnet_autobuild_ipv6()`, which, as I mentioned above, has only been implemented as of libnet-1.1.6. But again, you don't really need it, you can just use `libnet_build_ipv6()`:

```
libnet_ptag_t libnet_autobuild_ipv6 (uint16_t len,
    uint8_t nh, struct libnet_in6_addr dst, libnet_t *l,
    libnet_ptag_t ptag)

libnet_ptag_t libnet_build_ipv6 (uint8_t tc, uint32_t fl,
    uint16_t len, uint8_t nh, uint8_t hl,
    struct libnet_in6_addr src, struct libnet_in6_addr dst,
    const uint8_t *payload, uint32_t payload_s, libnet_t *l,
    libnet_ptag_t ptag)

libnet_ptag_t libnet_build_icmpv6_echo (uint8_t type,
        uint8_t code, uint16_t sum, uint16_t id,
        uint16_t seq, uint8_t *payload, uint32_t payload_s,
        libnet_t *l, libnet_ptag_t ptag)
```

As you can see, all you need, besides your own source address, is to set `tc` and `fl` to zero, and `hl` to 64 or 255 or whatever. In the example below I'll be using `libnet_autobuild_ipv6()` and `libnet_build_icmpv6_echo` (also >=libnet-1.1.6) to ping over IPv6, but hopefully you can easily adapt the code to inject your own TCP or UDP packets.

Example 13: ping6.c (https://github.com/repolho/Libnet-1.1-tutorial-examples/blob/master/13_ping6.c)

```
#include <stdio.h>
#include <stdlib.h>
#include <libnet.h>
#include <stdint.h>

#define MAX_CHARS_IN_IPV6_ADDR 39

int libnet_in6_addr_cmp(struct libnet_in6_addr addr1, \
    struct libnet_in6_addr addr2) {
  /* Returns != 0 if addresses are equal, 0 otherwise. */

  uint32_t *p1 = (uint32_t*)&addr1.__u6_addr, \
     *p2 = (uint32_t*)&addr2.__u6_addr;

  return ((p1[0] == p2[0]) && (p1[1] == p2[1]) && \
      (p1[2] == p2[2]) && (p1[3] == p2[3]));
}

int main() {

  libnet_t *l;  /* libnet context */
  char errbuf[LIBNET_ERRBUF_SIZE];

  char ip_addr_str[MAX_CHARS_IN_IPV6_ADDR+1];
  struct libnet_in6_addr ip_dst_addr;
  char payload[] = "libnet :D";
  u_int16_t id, seq;
  int bytes_written;

  l = libnet_init(LIBNET_RAW6, "eth0", errbuf);
  if ( l == NULL ) {
    fprintf(stderr, "libnet_init() failed: %s\n", errbuf);
    exit(EXIT_FAILURE);
  }

  /* Generating a random id */

  libnet_seed_prand (l);
  id = (u_int16_t)libnet_get_prand(LIBNET_PR16);

  /* Getting destination IP address */

  ip_addr_str[0] = '';

  printf("Destination IPv6 address: ");
  /* too lazy not to hardcode this: */
  scanf("%39s",ip_addr_str);

  ip_dst_addr = libnet_name2addr6(l, ip_addr_str, \
                  LIBNET_DONT_RESOLVE);
```

```
  if (libnet_in6_addr_cmp(ip_dst_addr, in6addr_error)) {
    fprintf(stderr, "Error converting IPv6 address.\n");
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building ICMP header */

  seq = 1;

  if (libnet_build_icmpv6_echo(ICMP6_ECHO, 0, 0, id, seq, \
        (u_int8_t*)payload, sizeof(payload), l, 0) == -1)
  {
    fprintf(stderr, "Error building ICMPv6 header: %s\n", \
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Building IP header */

  if (libnet_autobuild_ipv6(LIBNET_ICMPV6_ECHO_H + \
        sizeof(payload), IPPROTO_ICMP6, ip_dst_addr, \
        l, 0) == -1)
  {
    fprintf(stderr, "Error building IPv6 header: %s\n",\
        libnet_geterror(l));
    libnet_destroy(l);
    exit(EXIT_FAILURE);
  }

  /* Writing packet */

  bytes_written = libnet_write(l);
  if ( bytes_written != -1 )
    printf("%d bytes written.\n", bytes_written);
  else
    fprintf(stderr, "Error writing packet: %s\n",\
        libnet_geterror(l));

  libnet_destroy(l);
  return 0;
}
```

Here are the packets on tcpdump:

```
000000 IP6 fe80::82ee:73ff:ac9d:b582 >
        fe80::21e:bff:ba26:f210: ICMP6, echo request,
        seq 1, length 18

000289 IP6 fe80::21e:bff:ba26:f210 >
        fe80::82ee:73ff:ac9d:b582: ICMP6, echo reply,
        seq 1, length 18
```

And that's about it. Just replace your IPv4 functions with the IPv6 ones and you're good to go. You can find a few functions for doing more complex IPv6 header stuff at the `libnet-functions.h` man page, but, as was the case with IPv4 options, I think they are beyond the scope of this tutorial (and my own mastery of TCP/IP), so I'll just stop here.

Happy injecting.

25 thoughts on "Libnet 1.1 tutorial"

1. **NASKY** *says:*
   nice!

   thanks!

   2011-09-23 AT 00:28 | REPLY
2. **BYTES** *says:*
   Great tutorial, thanks a lot!

   2011-10-28 AT 10:53 | REPLY
3. **SFK** *says:*
   Nice tutorial. Looking forward for the IPv6!

   2011-11-09 AT 07:45 | REPLY
   - **REPOLINUX** ★ *says:*
     BOOM! IPv6 is up!

     Hope it didn't look like I was preparing something amazing or anything, I was just procrastinating. :)

     Cheers.

     2011-11-09 AT 21:16 | REPLY
4. **ALI** *says:*
   Thank you.

2011-12-21 AT 07:58 | REPLY

5. **USER10** *says:*
   My friend why when i try to compile any of the example i get this error

   /usr/include/libnet.h:96:6: error: missing binary operator before token “1”

   i’ve try to compile on ubuntu11.10 and linux mint but i have same problem, also i have installed libnet this way:
   sudo apt-get install libnet1-dev and i try to compile file this way:
   gcc -ggdb -Wall `libnet-config –defines` `libnet-config –libs` filename.c -o example
   p.s maybe this is too noob question but i can’t find solution on google about this problem.

   2013-08-25 AT 20:27 | REPLY
   - **REPOLINUX** *says:*
     Hey, there.

     You aren’t doing anything wrong, but it seems that the ubuntu package you installed is broken, since that header file belongs to it and it has a syntax error. I’d suggest you try one or more of the following options:

     - install a different version of the package
     - download the source code from github and compile it instead of using ubuntu’s package
     - ask for help in ubuntu’s forums, possibly file a bug report so they’ll fix the package

     Let me know if you need further assistance in doing any of those things.

     2013-08-26 AT 09:40 | REPLY

6. **USER10** *says:*
   Thank you very much about fast reply and solutions. I’ll try again with fresh installation with compiling :)

   2013-08-26 AT 22:10 | REPLY

7. **USER10** *says:*
   Hello again RepoLinux admin,
   I’ve viewed most of your examples about libnet and i can tall that are very very usefull, especially for noobs like me :]. Are there any other examples where is described process of editing/modifing packet that is catched with pcap ex. catch tcp packet(ipv4), edit his source ip and mac and send to another host with ip and mac that is fixed specified. I already search on google but don’t find clear tutorial about this(some are old and functions used there are not anymore used). What i’ve found so far, after i catch packet with pcap is this:
   Rebuild packet again with:
   Build ethernet header with libnet_build_ethernet
   Build ip header with libnet_build_ipv4
   Build tcp header with libnet_build_tcp
   and put modifications there. Problem is that i’m noob in pcap, libnet and c at all so i don’t have big picture how to make it work together pcap and libnet. Probably connection between pcap and libnet should be something like this:
   pcap_loop(handle, num_packets, GET_MODIFY_AND_SEND_PACKET, NULL);

   So if you have any examples in this field and if you can share will be great. If no, just ignore this comment.
   All the best user10.

   offtopic : If anyone have problem with compiling libnet examples can try this way:
   gcc -Wall -g `libnet-config –defines` -c init.c

gcc -Wall init.o -o init `libnet-config –libs`
sudo ./init
and if there is some problem with shared object just typing :
sudo ldconfig
probably will solve problems.

2013-09-04 AT 10:23 | REPLY

- **REPOLINUX** ★ *says:*
  Sorry, I haven't played with this stuff in years. I've built a few programs integrating pcap and libnet in the past, but they're long gone. The best I can really give you is the advice I included in the section titled "Tip on working with libnet and pcap." Maybe if you run into some specific problem with your program, I might be able to help, so feel free to comment if that happens.

  2013-09-09 AT 22:56 | REPLY

8. **CHARLIE** *says:*
   Hi,

   I am trying to get *any* version of libnet to work. Currently I am trying to install it on Ubuntu. I use sudo apt get libnet1-dev. It seems to install everything correctly, but the functions are completely different. For example, net_init is now libnet_init (with params) – and I am having a very difficult time finding documentation for this version of the library. Any help on determining how best to install the library would be much appreciated.

   2016-05-12 AT 18:16 | REPLY

   - **REPOLINUX** ★ *says:*
     Libnet 1.1 has always used libnet_init(), while libnet 1.0 used to use libnet_init_packet(). Neither used net_init(). Are you sure this library is the same libnet you're thinking of?

     All the code described in the post above should work with the libnet1-dev package you installed. If you run into any issues, feel free to leave another comment. Cheers.

     2016-05-13 AT 05:54 | REPLY

     - **CHARLIE** *says:*
       Thanks! I'm not sure what I was looking at — http://tjaden.strangesoft.net/libnet-HOWTO/libnet-HOWTO.html. Right now I think I have everything installed. I've tried using the apt install libnet1-dev and doing it manually. Most recently I directly downloaded the tar for libnet 1.1.6 and then manually installed. I used ./configure, make, make install. I think it is all there. The trouble I am having is getting it to link when I try even simple examples. I have a libnet.h and libnet folder with more header files in my /usr/include and I also have .a and other library files in /usr/local/lib/. For some reason It cannot find the libnet functions.

       Right now I get this error when I try to compile your example.c:
       undefined reference to 'libnet_init'
       undefined reference to 'libnet_destroy'

       I used exactly your command for compilation:
       gcc -ggdb -Wall `libnet-config –defines`
       `libnet-config –libs` example.c -o example

       Any suggestions of what to try/ how to link the library/ correctly compile would be very helpful!

Thanks!

2016-05-13 AT 12:40

- **REPOLINUX** *says:*
  Yeah, that looks like a homonymous unrelated lib.

  I tried installing libnet1-dev in a debian jessie machine I have available and all the examples above compiled and ran without issues (by just cloning the examples from github and running `make`). For reference, libnet1-dev pulled libnet1 and both are version 1.1.6+dfsg-3. The binaries got linked to /usr/lib/x86_64-linux-gnu/libnet.so.1, which is a link to libnet.so.1.7.0, both belonging to the libnet1 package.

  From the error message you got, it sounds like gcc is failing to get ld to link to the correct libnet.so, so here's a few things you can check:

  Run `libnet-config --libs` and check that it returns `-lnet`.

  Run `ldconfig -p | grep 'libnet\.so'` and see which copies of libnet ld knows of. Ideally, you should see the /usr/lib/ copy from the libnet1 package installed by apt-get and your own /usr/local/lib/ copy that you installed manually. If your local copy is missing, you might have to add /usr/local/lib to /etc/ld.so.conf (in my debian, it's in /etc/ld.so.conf.d/libc.conf) and then run ldconfig as root to update /etc/ld.so.cache. You should also NOT find some other leftover libnet.so that is neither the one apt-get installed nor the one you compiled yourself.

  For me, ldconfig finds:
  libnet.so.1 (libc6,x86-64) => /usr/lib/x86_64-linux-gnu/libnet.so.1
  libnet.so (libc6,x86-64) => /usr/lib/x86_64-linux-gnu/libnet.so

  Alternatively, you can also have gcc tell ld to show you where it is looking for the library, like so:

  ```
  gcc -lnet 01_init.c -Wl,--verbose | grep libnet
  ```

  Here's what it outputs for me:
  attempt to open /usr/lib/gcc/x86_64-linux-gnu/4.9/libnet.so failed
  attempt to open /usr/lib/gcc/x86_64-linux-gnu/4.9/libnet.a failed
  attempt to open /usr/lib/gcc/x86_64-linux-gnu/4.9/../../../x86_64-linux-gnu/libnet.so succeeded
  -lnet (/usr/lib/gcc/x86_64-linux-gnu/4.9/../../../x86_64-linux-gnu/libnet.so)

  So try these, and if you still can't get ld to find the correct libnet.so, let me know the output you're getting for each command and we can continue trying to pinpoint the cause from there.

  2016-05-13 AT 20:58

9. **CHARLIE** *says:*
   Thanks! The first few work for me, and then the gcc fails to find libnet.

   > libnet-config –libs
   -lnet
   > ldconfig -p | grep 'libney\.so'
   libnet.so.1 (libc6) => /usr/lib/i386-linux-gnu/libnet.so.1
   libnet.so.1 (libc6) => /usr/local/lib/libnet.so.1
   libnet.so (libc6) => /usr/local/lib/libnet.so

(I'll attach the result from the last command after this because its so long)

I think from what you said the first few results are generally good results.

2016-05-17 AT 18:06 | REPLY

- **CHARLIE** *says:*
  > gcc -lnet 01_init.c -Wl, –verbose | grep libnet

  Using built-in specs.
  COLLECT_GCC=gcc
  COLLECT_LTO_WRAPPER=/usr/lib/gcc/i686-linux-gnu/5/lto-wrapper
  Target: i686-linux-gnu
  Configured with: ../src/configure -v –with-pkgversion='Ubuntu 5.3.1-14ubuntu2' –with-bugurl=file:///usr/share/doc/gcc-5/README.Bugs –enable-languages=c,ada,c++,java,go,d,fortran,objc,obj-c++ –prefix=/usr –program-suffix=-5 –enable-shared –enable-linker-build-id –libexecdir=/usr/lib –without-included-gettext –enable-threads=posix –libdir=/usr/lib –enable-nls –with-sysroot=/ –enable-clocale=gnu –enable-libstdcxx-debug –enable-libstdcxx-time=yes –with-default-libstdcxx-abi=new –enable-gnu-unique-object –disable-vtable-verify –enable-libmpx –enable-plugin –with-system-zlib –disable-browser-plugin –enable-java-awt=gtk –enable-gtk-cairo –with-java-home=/usr/lib/jvm/java-1.5.0-gcj-5-i386/jre –enable-java-home –with-jvm-root-dir=/usr/lib/jvm/java-1.5.0-gcj-5-i386 –with-jvm-jar-dir=/usr/lib/jvm-exports/java-1.5.0-gcj-5-i386 –with-arch-directory=i386 –with-ecj-jar=/usr/share/java/eclipse-ecj.jar –enable-objc-gc –enable-targets=all –enable-multiarch –disable-werror –with-arch-32=i686 –with-multilib-list=m32,m64,mx32 –enable-multilib –with-tune=generic –enable-checking=release –build=i686-linux-gnu –host=i686-linux-gnu –target=i686-linux-gnu
  Thread model: posix
  gcc version 5.3.1 20160413 (Ubuntu 5.3.1-14ubuntu2)
  COLLECT_GCC_OPTIONS='-v' '-mtune=generic' '-march=i686'
  /usr/lib/gcc/i686-linux-gnu/5/cc1 -quiet -v -imultiarch i386-linux-gnu 01_init.c -quiet -dumpbase 01_init.c -mtune=generic -march=i686 -auxbase 01_init -version -fstack-protector-strong -Wformat -Wformat-security -o /tmp/ccOnm5DK.s
  GNU C11 (Ubuntu 5.3.1-14ubuntu2) version 5.3.1 20160413 (i686-linux-gnu)
  compiled by GNU C version 5.3.1 20160413, GMP version 6.1.0, MPFR version 3.1.4, MPC version 1.0.3
  GGC heuristics: –param ggc-min-expand=100 –param ggc-min-heapsize=131072
  ignoring nonexistent directory "/usr/local/include/i386-linux-gnu"
  ignoring nonexistent directory "/usr/lib/gcc/i686-linux-gnu/5/../../../../i686-linux-gnu/include"
  #include "…" search starts here:
  #include search starts here:
  /usr/lib/gcc/i686-linux-gnu/5/include
  /usr/local/include
  /usr/lib/gcc/i686-linux-gnu/5/include-fixed
  /usr/include/i386-linux-gnu
  /usr/include
  End of search list.
  GNU C11 (Ubuntu 5.3.1-14ubuntu2) version 5.3.1 20160413 (i686-linux-gnu)
  compiled by GNU C version 5.3.1 20160413, GMP version 6.1.0, MPFR version 3.1.4, MPC version 1.0.3
  GGC heuristics: –param ggc-min-expand=100 –param ggc-min-heapsize=131072
  Compiler executable checksum: 2a185e4b183ef4bda73eead5e3b72218

COLLECT_GCC_OPTIONS='-v' '-mtune=generic' '-march=i686'
as -v –32 -o /tmp/ccs3FXeZ.o /tmp/ccOnm5DK.s
GNU assembler version 2.26 (i686-linux-gnu) using BFD version (GNU Binutils for Ubuntu) 2.26
COMPILER_PATH=/usr/lib/gcc/i686-linux-gnu/5/:/usr/lib/gcc/i686-linux-gnu/5/:/usr/lib/gcc/i686-linux-gnu/:/usr/lib/gcc/i686-linux-gnu/5/:/usr/lib/gcc/i686-linux-gnu/
LIBRARY_PATH=/usr/lib/gcc/i686-linux-gnu/5/:/usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/:/usr/lib/gcc/i686-linux-gnu/5/../../../../lib/:/lib/i386-linux-gnu/:/lib/../lib/:/usr/lib/i386-linux-gnu/:/usr/lib/../lib/:/usr/lib/gcc/i686-linux-gnu/5/../../../:/lib/:/usr/lib/
COLLECT_GCC_OPTIONS='-v' '-mtune=generic' '-march=i686'
/usr/lib/gcc/i686-linux-gnu/5/collect2 -plugin /usr/lib/gcc/i686-linux-gnu/5/liblto_plugin.so -plugin-opt=/usr/lib/gcc/i686-linux-gnu/5/lto-wrapper -plugin-opt=-fresolution=/tmp/ccAnx5Rd.res -plugin-opt=-pass-through=-lgcc -plugin-opt=-pass-through=-lgcc_s -plugin-opt=-pass-through=-lc -plugin-opt=-pass-through=-lgcc -plugin-opt=-pass-through=-lgcc_s –sysroot=/ –build-id –eh-frame-hdr -m elf_i386 –hash-style=gnu –as-needed -dynamic-linker /lib/ld-linux.so.2 -z relro /usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/crt1.o /usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/crti.o /usr/lib/gcc/i686-linux-gnu/5/crtbegin.o -L/usr/lib/gcc/i686-linux-gnu/5 -L/usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu -L/usr/lib/gcc/i686-linux-gnu/5/../../../../lib -L/lib/i386-linux-gnu -L/lib/../lib -L/usr/lib/i386-linux-gnu -L/usr/lib/../lib -L/usr/lib/gcc/i686-linux-gnu/5/../../../.. -lnet /tmp/ccs3FXeZ.o "" -lgcc –as-needed -lgcc_s –no-as-needed -lc -lgcc –as-needed -lgcc_s –no-as-needed /usr/lib/gcc/i686-linux-gnu/5/crtend.o /usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/crtn.o
/usr/bin/ld: cannot find : No such file or directory
collect2: error: ld returned 1 exit status

//////////////////
Sorry for this,

And thanks again!

2016-05-17 AT 18:08 | REPLY

- **REPOLINUX** ★ *says:*
  I think you accidentally introduced a stray whitespace in the `-Wl,--verbose` option, which caused gcc to receive the –verbose argument and ld to receive an empty argument, which it then tried and filed to open as if it were a file. That's why you got a `cannot find : No such file or directory` instead of `cannot find filename: No such file or directory`.

  The format for that option is actually `-Wl,linker_option`. This tells gcc to forward the desired option to ld. In this case we want gcc to forward `--verbose` to ld, so please run that command again without the space between `-Wl,` and `--verbose`. Like so:

  ```
  gcc -lnet 01_init.c -Wl,--verbose | grep libnet
  ```

  2016-05-17 AT 19:17

- **REPOLINUX** ★ *says:*
  Also, I'm noticing that ldconfig found `/usr/lib/i386-linux-gnu/libnet.so.1`, but not `/usr/lib/i386-linux-gnu/libnet.so`. Could you post the output of
  `ls -l /usr/lib/i386-linux-gnu/libnet.so*`
  ?

Maybe also try reinstalling libnet1-dev and running `sudo ldconfig` then `ldconfig -p | grep 'libnet\.so'` again to see if it shows up.

2016-05-17 AT 20:02

10. **CHARLIE** *says:*
Sorry, my mistake:

> gcc -lnet 01_init.c -Wl,–verbose | grep libnet
attempt to open /usr/lib/gcc/i686-linux-gnu/5/libnet.so failed
attempt to open /usr/lib/gcc/i686-linux-gnu/5/libnet.a failed
attempt to open /usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/libnet.so failed
attempt to open /usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/libnet.a failed
attempt to open /usr/lib/gcc/i686-linux-gnu/5/../../../../lib/libnet.so failed
attempt to open /usr/lib/gcc/i686-linux-gnu/5/../../../../lib/libnet.a succeeded
/tmp/ccU77QgY.o: In function `main':
01_init.c:(.text+0x2e): undefined reference to `libnet_init'
01_init.c:(.text+0x75): undefined reference to `libnet_destroy'

> ls -l /usr/lib/i386-linux-gnu/libnet.so*
lrwxrwxrwx 1 root root 15 Jul 7 2014 /usr/lib/i386-linux-gnu/libnet.so.1 -> libnet.so.1.7.0
-rw-r–r– 1 root root 95728 Jul 7 2014 /usr/lib/i386-linux-gnu/libnet.so.1.7.0

I have not yet reinstalled, but:
> ldconfig -p | grep 'libnet\.so'
libnet.so.1 (libc6) => /usr/lib/i386-linux-gnu/libnet.so.1
libnet.so.1 (libc6) => /usr/local/lib/libnet.so.1
libnet.so (libc6) => /usr/local/lib/libnet.so

Is the libnet.so.1 (libc6) => /usr/lib/i386-linux-gnu/libnet.so that is missing critcal? Should I try the reinstallation? And if so, would you recommend using sudo apt… or a manual install.

2016-05-18 AT 09:49 | REPLY

- **REPOLINUX** ★ *says:*
It seems to be what's causing ld to attempt to link against libnet.a instead. I tried removing libnet.so on my system and got the same error you're getting.

$ gcc -lnet 01_init.c -Wl,–verbose | grep libnet
attempt to open /usr/lib/gcc/x86_64-linux-gnu/4.9/libnet.so failed
attempt to open /usr/lib/gcc/x86_64-linux-gnu/4.9/libnet.a failed
attempt to open /usr/lib/gcc/x86_64-linux-gnu/4.9/../../../x86_64-linux-gnu/libnet.so failed
attempt to open /usr/lib/gcc/x86_64-linux-gnu/4.9/../../../x86_64-linux-gnu/libnet.a succeeded
/tmp/ccRCLM1l.o: In function `main':
01_init.c:(.text+0x20): undefined reference to `libnet_init'
01_init.c:(.text+0x61): undefined reference to `libnet_destroy'
collect2: error: ld returned 1 exit status

You have two options here, either you remove libnet1-dev and libnet1 so ld will use your /usr/local copy of the library, or you reinstall libnet1-dev to fix the libnet.so link.

```
sudo apt-get install --reinstall libnet1-dev
```

You can also recreate the link manually if you prefer.

```
sudo ln -s libnet.so.1.7.0 /usr/lib/i386-linux-gnu/libnet.so
```

Whatever you choose, make sure you also run `sudo ldconfig` to update ld.so.cache when you're done.

2016-05-18 AT 15:54 | REPLY

11. **CHARLIE** *says:*
I tried that and I continue to have the same problems. I'm going to try to completely uninstall it and then try again.

After installing it via:
sudo apt-get install libnet1-dev
sudo ldconfig

I ran:
> gcc -lnet 01_init.c -Wl,–verbose | grep libnet
/attempt to open /usr/lib/gcc/i686-linux-gnu/5/libnet.so failed
attempt to open /usr/lib/gcc/i686-linux-gnu/5/libnet.a failed
attempt to open /usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/libnet.so succeeded
-lnet (/usr/lib/gcc/i686-linux-gnu/5/../../../i386-linux-gnu/libnet.so)
tmp/ccC5Pt29.o: In function `main':
01_init.c:(.text+0x2e): undefined reference to `libnet_init'
01_init.c:(.text+0x75): undefined reference to `libnet_destroy'

Again,
Thanks

2016-05-20 AT 09:45 | REPLY

- **REPOLINUX** ★ *says:*
I installed an ubuntu VM so I could reproduce the problem, and I was able to find what the issue is, even though I still don't know why it happens. The problem is just that ubuntu's ld will default to linking with `--as-needed`, while other distros still default to `--no-as-needed`. So compiling like this should work for you:

```
gcc -Wl,--no-as-needed -lnet 01_init.c -o 01_init
```

Note that `-Wl,--no-as-needed` must come before `-lnet`, otherwise it will have no effect.

I also updated the Makefile in the github repo, so if you clone it now, you should be able to use `make` to compile all examples.

I tried researching why –as-needed would break libnet, but I was unable to find an explanation. The only things I found were about referencing functions from libraries that were implicitly linked (because they are linked by other libraries that you explicitly linked), but that can't be the case here since the undefined references are to libnet functions. For now, I've given up on trying to understand the cause, but at least we have a workaround.

2016-05-24 AT 04:40 | REPLY

- **CHARLIE** *says:*
Awesome! It compiles! I'll play around with it now and try to get it going – but any idea why: libnet_init() failed: libnet_open_raw4(): SOCK_RAW allocation failed: Operation not permitted

would happen? I just cloned and haven't changed your the src code.

Thanks a bunch, and that's pretty impressive find,

-Charlie

2016-05-25 AT 10:57

- **REPOLINUX** ★ *says:*
Libnet needs root permissions in order to access the network interface directly, the same as libpcap, tcpdump, wireshark and so on. If you try running libnet_init() using LIBNET_RAW4 as an unprivileged user, you'll get that error. If you use LIBNET_LINK, you'll get this one instead:

```
libnet_open_link(): UID/EUID 0 or capability CAP_NET_RAW required
```

Similarly, if libnet tries to open the wrong interface, either because it failed to autodetect it or because you explicitly told it to open the wrong one, LIBNET_LINK will give out

```
libnet_check_iface(): interface_name is down
```

if the interface is down, or

```
libnet_check_iface() ioctl: No such device
```

if it doesn't exist. On the other hand, LIBNET_RAW4 will init without an error, and then fail once you try to perform some operation on the interface, for example:

```
libnet_get_ipaddr4(): ioctl(): Cannot assign requested address
```

2016-05-26 AT 00:09 | REPLY

12. **ROBERT GABRIEL** *says:*
Thank you, brilliant! I'm rewriting the TCP RST hijacker from HTAOE book and following your tutorial. Cheers mate!

2020-04-12 AT 21:15 | REPLY