Introducción a la librería de desarrollo `librawnet`

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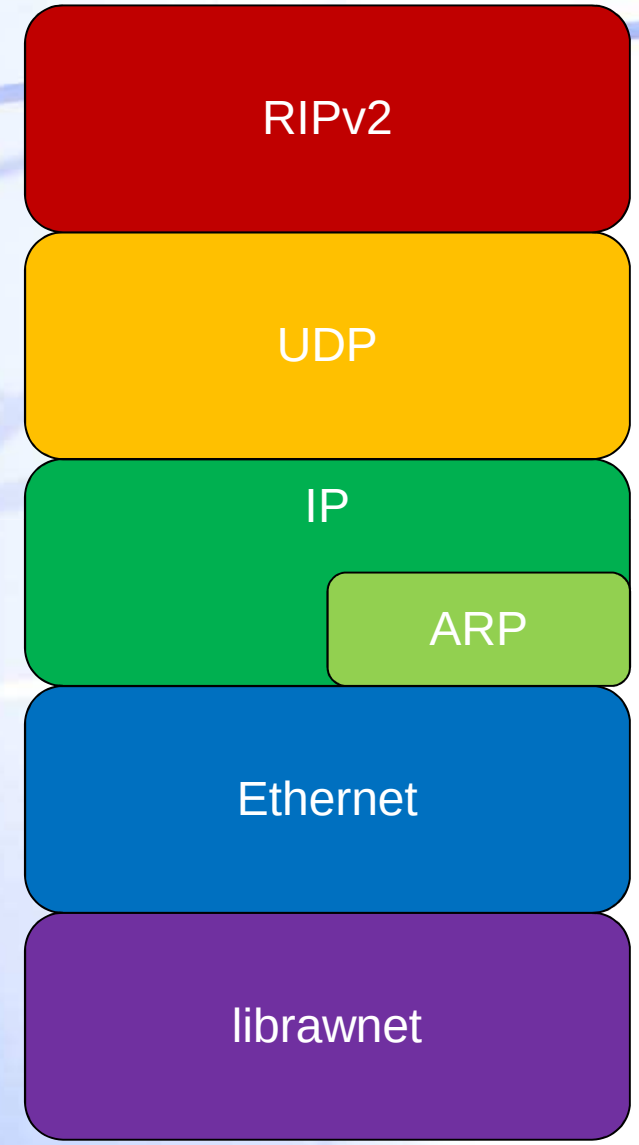
Pila de Protocolos RIPv2



Protocolo de Encaminamiento

Nivel de Transporte

Nivel de Red

Nivel de Enlace

Nivel "*Físico*"

librawnet

- **Librería para la programación de protocolos de red "*en crudo*":**
  - Permite acceder directamente a los interfaces de red del equipo.
- **Los paquetes enviados/recibidos no han sido procesados por la pila de protocolos del equipo:**
  - Es necesario añadir/procesar las **cabeceras** de todos los protocolos de la pila que se desea desarrollar.
  - Realmente el *kernel* y `librawnet` reciben una **copia** de todos los paquetes recibidos por la tarjeta de red.
- **`librawnet` proporciona dos módulos:**
  - Gestión de los interfaces de red, envío/recepción de paquetes "*crudos*": `rawnet.h (man rawnet)`
  - Temporizadores con precisión de milisegundos: `timerms.h (man timerms)`

timerms.h

- **Obtener tiempo actual:**

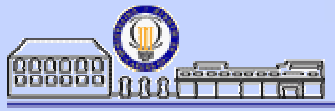
```
long long int timerms_time();
```

- **(Re)iniciar temporizador:**

```
long long int timerms_reset ( timerms_t * timer,
                              long int timeout );
/* 'timeout' >= 0: 'timer' expira en 'timeout' ms
   'timeout'  < 0: Temporizador "infinito" */
```

- **Consultar estado temporizador:**

```
long int timerms_elapsed ( timerms_t * timer );
long int timerms_left ( timerms_t * timer );
```



timerms.h: Ejemplo de uso (I)

- **Temporizador que expira a los 500 ms:**

```
timerms_t timer;
long int timeout = 500;
long long int now = timerms_reset(&timer, timeout);
long elapsed_time = timerms_elapsed(&timer);/* elapsed_time == 0 */
long time_left = timerms_left(&timer);      /* time_left == 500 */
...
elapsed_time = timerms_elapsed(&timer);   /* elapsed_time == 100 */
time_left = timerms_left(&timer);         /* time_left == 400 */
...
elapsed_time = timerms_elapsed(&timer);   /* elapsed_time == 500 */
time_left = timerms_left(&timer);         /* time_left == 0 */
...
elapsed_time = timerms_elapsed(&timer);  /* elapsed_time == 1000 */
time_left = timerms_left(&timer);         /* time_left == 0 */
```

timerms.h: Ejemplo de uso (II)

- **Temporizador "*infinito*":**

```
timerms_t timer;
long int timeout = -1;
long long int now = timerms_reset(&timer, timeout);
long elapsed_time = timerms_elapsed(&timer);/* elapsed_time == 0 */
long int time_left = timerms_left(&timer);  /* time_left < -1 */
...
elapsed_time = timerms_elapsed(&timer);  /* elapsed_time == 1000 */
time_left = timerms_left(&timer);        /* time_left < -1 */
```

rawnet.h

- Operaciones con interfaces "*crudos*":

```
rawiface_t * rawiface_open ( char* ifname );
char* rawiface_getname ( rawiface_t * iface );
int rawiface_getaddr ( rawiface_t * iface, char addr[] );
int rawiface_getmtu ( rawiface_t * iface );
int rawiface_close ( rawiface_t * iface );
```

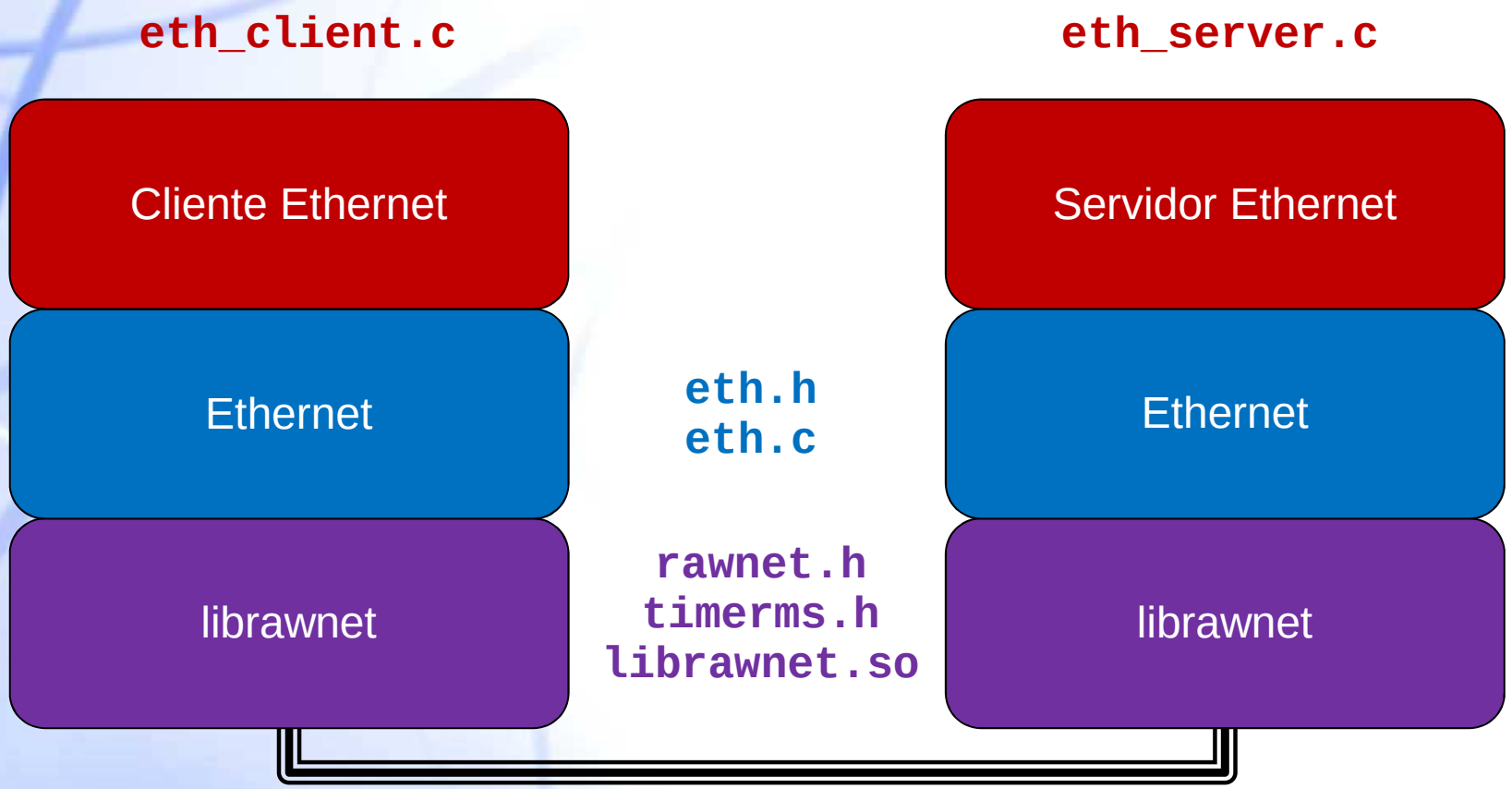
- Enviar/Recibir paquetes "*crudos*":

```
int rawnet_send ( rawiface_t * iface, char * pkt, int pkt_len );
int rawnet_recv ( rawiface_t * iface, char buffer[], int buf_len,
                  long int timeout );
int rawnet_poll ( rawiface_t * ifaces[], int ifnum,
                  long int timeout );
```

- Gestión de errores:

```
char* rawnet_strerror();
```

Ejemplo: Cliente / Servidor Ethernet



eth.h

- Direcciones MAC:

```
#define MAC_ADDR_SIZE 6
typedef unsigned char mac_addr_t [MAC_ADDR_SIZE];
mac_addr_t BROADCAST_MAC_ADDR = {0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF};
#define MAC_ADDR_STR_LENGTH 18
void eth_mac_str ( mac_addr_t addr, char str[] );
int eth_str_mac ( char* str, mac_addr_t addr );
```

- Operaciones con interfaces Ethernet:

```
eth_iface_t * eth_open ( char* ifname );
char * eth_getname ( eth_iface_t * iface );
void eth_getaddr ( eth_iface_t * iface, mac_addr_t addr );
int eth_close ( eth_iface_t * iface );
```

- Enviar/Recibir tramas Ethernet:

```
int eth_send ( eth_iface_t * iface, mac_addr_t dst, uint16_t type,
               unsigned char * payload, int payload_len );
int eth_recv ( eth_iface_t * iface, mac_addr_t src, uint16_t type,
               unsigned char buffer[], long int timeout );
int eth_poll ( eth_iface_t * ifaces[], int ifnum, long int timeout );
```

eth_open()

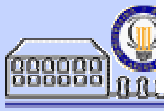
```
#include “eth.h”
#include <rawnet.h>
#include <timerms.h>

typedef struct eth_iface {
  rawiface_t * raw_iface; /* Manejador del interfaz “crudo" */
  mac_addr_t mac_address; /* Dirección MAC del interfaz. */
} eth_iface_t;

eth_iface_t * eth_open ( char* ifname ) {
  struct eth_iface * eth_iface;
  eth_iface = malloc(sizeof(struct eth_iface));

  rawiface_t * raw_iface = rawiface_open(ifname);
  if (raw_iface == NULL) { return NULL; }
  eth_iface->raw_iface = raw_iface;

  rawiface_getaddr(raw_iface, eth_iface->mac_address);
  return eth_iface;
}
```



eth_send() (I)

```
struct eth_frame {
  mac_addr_t dest_addr;           /* Dirección MAC destino */
  mac_addr_t src_addr;            /* Dirección MAC origen */
  uint16_t type;                  /* Campo 'Tipo' */
  unsigned char payload[ETH_MTU]; /* Campo 'Payload' */
};

int eth_send ( eth_iface_t * iface, mac_addr_t dst, uint16_t type,
               unsigned char * payload, int payload_len ) {

  /* Crear la Trama Ethernet y rellenar todos los campos */
  struct eth_frame eth_frame;
  memcpy(eth_frame.dest_addr, dst, MAC_ADDR_SIZE);
  memcpy(eth_frame.src_addr, iface->mac_address, MAC_ADDR_SIZE);
  eth_frame.type = htons(type);
  memcpy(eth_frame.payload, payload, payload_len);
  int eth_frame_len = ETH_HEADER_SIZE + payload_len;
  …
```

eth_send() (II)

```
  /* Imprimir trama Ethernet */
  char* iface_name = eth_getname(iface);
  eth_mac_str(dst, mac_addr_str);
  printf("eth_send(type=0x%04x, payload[%d]) > %s/%s\n",
           type, payload_len, iface_name, mac_addr_str);
  print_pkt((unsigned char *) &eth_frame, eth_frame_len, ETH_HEADER_SIZE);

  /* Enviar la trama Ethernet creada con rawnet_send() */
  bytes_sent = rawnet_send(iface->raw_iface, (unsigned char *)
                           &eth_frame, eth_frame_len);
  if (bytes_sent == -1) {
    fprintf(stderr, "eth_send(): ERROR en rawnet_send(): %s\n“,
            rawnet_strerror());
    return -1;
  }
  return (bytes_sent - ETH_HEADER_SIZE);
}
```

eth_recv() (I)

```
int eth_recv ( eth_iface_t * iface, mac_addr_t src, uint16_t type,
               unsigned char buffer[], long int timeout ) {
  timerms_reset(&timer, timeout);
  do {
    long int time_left = timerms_left(&timer);
    /* Recibir trama del interfaz Ethernet */
    unsigned char eth_buffer[ETH_FRAME_MAX_SIZE];
    int frame_len = rawnet_recv (iface->raw_iface, eth_buffer,
                                 ETH_FRAME_MAX_SIZE, time_left);
    if ((frame_len == -1) || (frame_len == 0)) { return frame_len; }
    /* Comprobar si es la trama que nos han pedido */
    struct eth_frame * eth_frame_ptr = (struct eth_frame *) eth_buffer;
    int is_my_mac = (memcmp(eth_frame_ptr->dest_addr, iface->mac_address,
                            MAC_ADDR_SIZE) == 0);
    int is_target_type = (ntohs(eth_frame_ptr->type) == type);
  } while ( ! (is_my_mac && is_target_type) );
  …
```

eth_recv() (II)

```
  …
  /* Trama recibida con el 'Type' solicitado. */

  /* Copiar datos y dirección MAC origen */
  memcpy(src, eth_frame_ptr->src_addr, MAC_ADDR_SIZE);
  payload_len = frame_len - ETH_HEADER_SIZE;
  memcpy(buffer, eth_frame_ptr->payload, payload_len);

  /* Imprimir trama recibida */
  eth_mac_str(src, mac_addr_str);
  char* iface_name = eth_getname(iface);
  printf("eth_recv(type=0x%04x, payload[%d]) < %s/%s\n",
         type, payload_len, iface_name, mac_addr_str);
  print_pkt((unsigned char *) eth_frame_ptr, frame_len, ETH_HEADER_SIZE);

  return payload_len;
}
```

eth_client.c

```
int main ( int argc, char * argv[] ){
  /* Procesar argumentos */
  if (argc != 5) {
    printf("Uso: %s <iface> <tipo> <mac> <long>\n", argv[0]); exit(-1);
  }
  /* Abrir la interfaz Ethernet */
  eth_iface_t * eth_iface = eth_open(iface_name);
  if (eth_iface == NULL) { exit(-1); }
  /* Enviar trama Ethernet al Servidor */
  int err = eth_send(eth_iface, server_addr, eth_type, payload, payload_len);
  if (err == -1) { exit(-1); }
  /* Recibir trama Ethernet del Servidor y procesar errores */
  len = eth_recv(eth_iface, src_addr, eth_type, buffer, 2000);
  if (len <= 0) { fprintf(stderr, "%s: ERROR en eth_recv()\n", myself);
  } else { printf("Recibidos %d bytes del Servidor Ethernet\n", len); }
  /* Cerrar interfaz Ethernet */
  eth_close(eth_iface);
  return 0;
}
```

eth_server.c

```
int main ( int argc, char * argv[] ){
  /* Procesar parámetros */
  if (argc != 3) { printf("Uso: %s <iface> <tipo>\n", argv[0]); exit(-1); }
  /* Abrir la interfaz Ethernet */
  eth_iface_t * eth_iface = eth_open(iface_name);
  if (eth_iface == NULL) { exit(-1); }
  while(1) {
    /* Recibir trama Ethernet del Cliente */
    printf("Escuchando tramas Ethernet (tipo=0x%04x) ...\n", eth_type);
    int payload_len = eth_recv(eth_iface, src_addr, eth_type, buffer, timeout);
    if (payload_len == -1) { break; }
    /* Enviar la misma trama Ethernet de vuelta al Cliente */
    int len = eth_send(eth_iface, src_addr, eth_type, buffer, payload_len);
    if (len == -1) { break; }
    printf("Enviado %d bytes al Cliente Ethernet:\n“, payload_len);
  }
  /* Cerrar interfaz Ethernet */
  eth_close(eth_iface);
  return 0;
}
```

Desarrollar protocolos con `librawnet`

- **Acceder a los interfaces y enviar/recibir paquetes en crudo requiere permisos especiales**
  - Compilar con: `rawnetcc /tmp/<prog> <f1.c> <f2.c> …`
- **Ejemplo**: `rawnetcc /tmp/eth_client eth.c eth_client.c`
  1. Compila el ejecutable:

     ```
     /usr/bin/gcc -o /tmp/eth_client eth.c eth_client.c –lrawnet
     ```

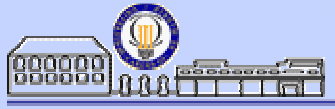
  2. Otorga permisos especiales:

     ```
     /usr/sbin/setcap cap_net_raw,cap_net_admin=eip /tmp/eth_client
     ```

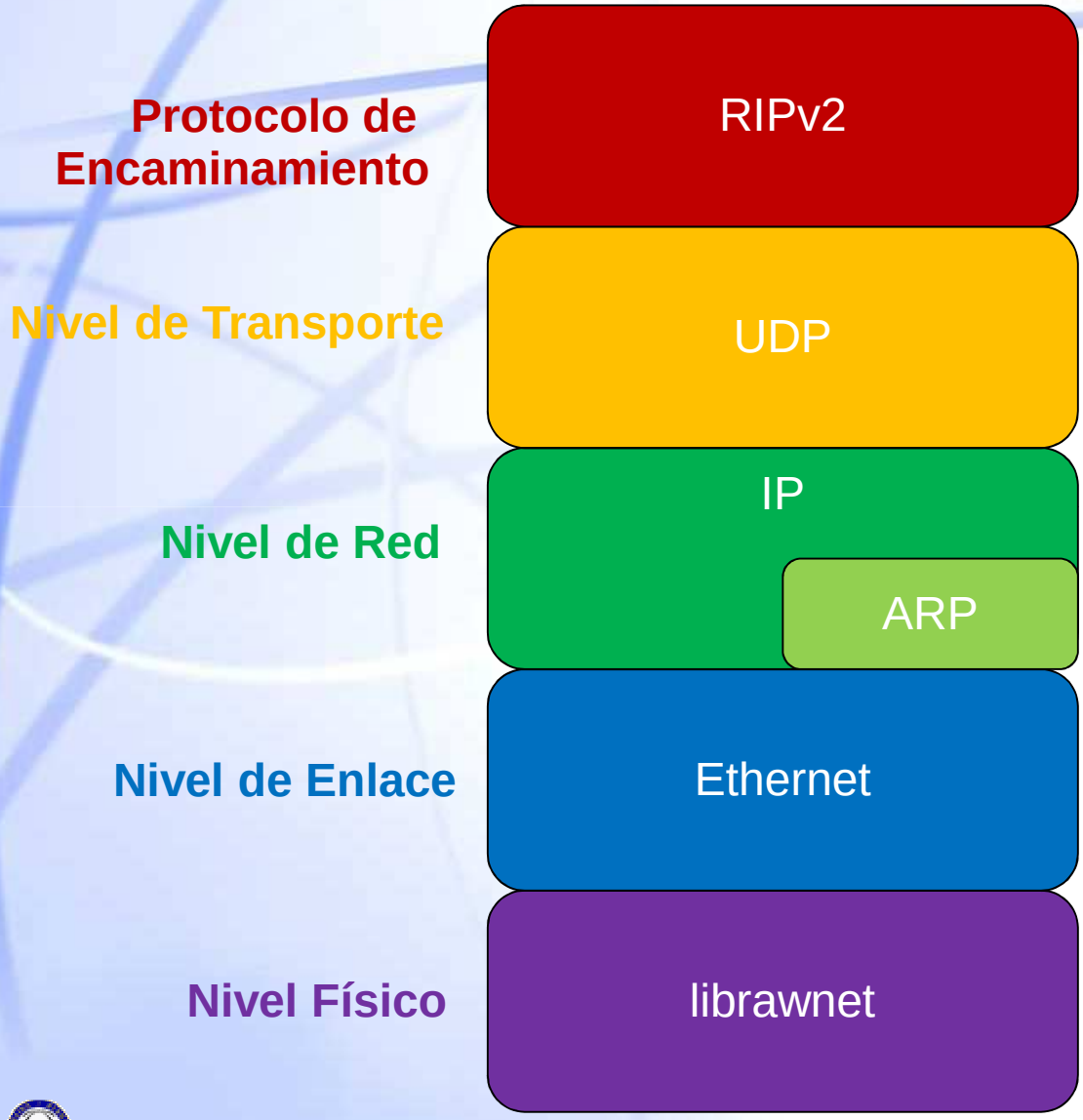
     ó

     ```
     /usr/bin/chown root.root /tmp/eth_client
     /usr/bin/chmod 4755 /tmp/eth_client
     ```

- **Depurar tráfico enviado con `Wireshark`**
  - `xhost +`
  - `sudo wireshark`



Pila de Protocolos RIPv2



`ripv2_daemon.c`

`udp.h` `udp_client.c`
`udp.c` `udp_server.c`

`ip.h` `ip_client.c`
`ip.c` `ip_server.c`
`arp.h` `arp_client.c`
`arp.c`

`eth.h` `eth_client.c`
`eth.c` `eth_server.c`

`rawnet.h`
`timerms.h`
`librawnet.so`

arp.h

```
#include “eth.h”

#define IPv4_ADDR_SIZE 4
typedef unsigned char ipv4_addr_t[IPv4_ADDR_SIZE];

int arp_resolve ( eth_iface_t * iface,
                  ipv4_addr_t dest,
                  mac_addr_t mac );
```