Passive Network Analysis Using Libtrace

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Outline

- Introduction and Basics
- The Libtrace Tools
- Simple Libtrace Programming
- Advanced Topics

Part Four

- Advanced Topics
  - Advanced protocol analysis
  - A practical example
  - Overview of projects using libtrace
    - Network visualisation with BSOD
  - The future of libtrace
  - Question time

Protocol Analysis

- Libtrace provides functions to jump directly to the header at a particular layer
  - Metadata layer, e.g. RadioTap, Prism, Linux SLL
  - Layer 2 (aka link layer), e.g. Ethernet, 802.11
  - Layer 3 (aka IP layer), e.g. IP, IPv6
  - Transport layer, e.g. TCP, UDP, ICMP

Protocol Analysis

```
void *trace_get_packet_meta(libtrace_packet_t *packet,
 libtrace_linktype_t *linktype, uint32_t *remaining);


void *trace_get_layer2(libtrace_packet_t *packet,
 libtrace_linktype_t *linktype, uint32_t *remaining);


void *trace_get_layer3(libtrace_packet_t *packet, uint16_t
 *ethertype, uint32_t *remaining);


void *trace_get_transport(libtrace_packet_t *packet, uint8_t
 *proto, uint32_t *remaining);
```

Protocol Analysis

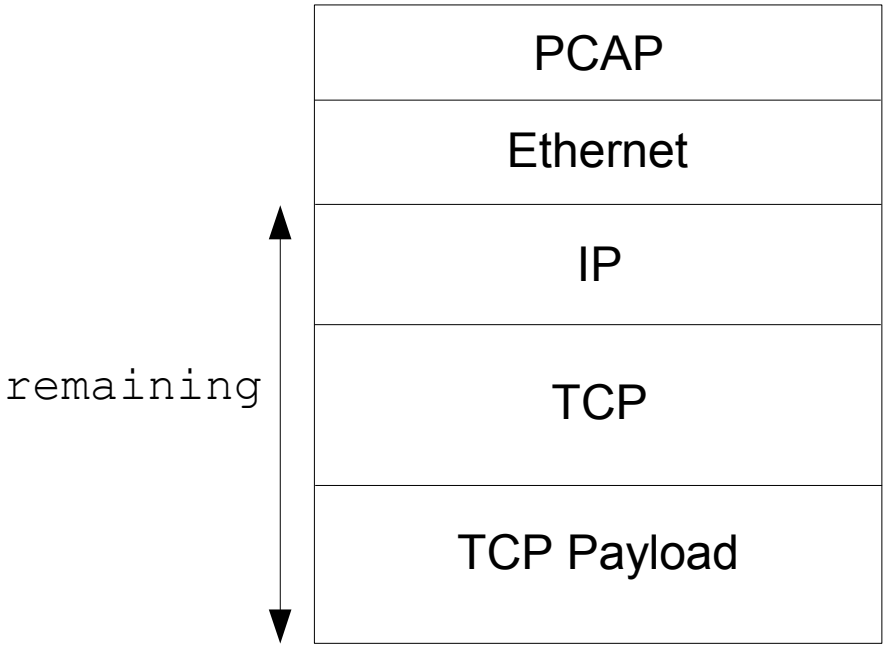
- Each function returns a void pointer to the header
  - If no header is present at that layer, NULL is returned
- Cast the pointer to the appropriate header based on type
  - The second parameter is set to signify the protocol type

Protocol Analysis

- Libtrace defines structures for most common headers
  - IP – libtrace_ip_t
  - IPv6 – libtrace_ip6_t
  - TCP – libtrace_tcp_t
  - UDP – libtrace_udp_t
  - ICMP – libtrace_icmp_t
  - Ethernet – libtrace_ether_t
  - VLAN – libtrace_8021q_t
  - 802.11 – libtrace_80211_t
- Many others as well – check out libtrace.h for a full list

Protocol Analysis

- Third parameter: `remaining`
  - Set by the protocol analysis function to contain the number of bytes between the start of the header and the end of the packet
  - Other analysis functions require a correct `remaining` value
  - Example: `remaining` after calling trace_get_layer3

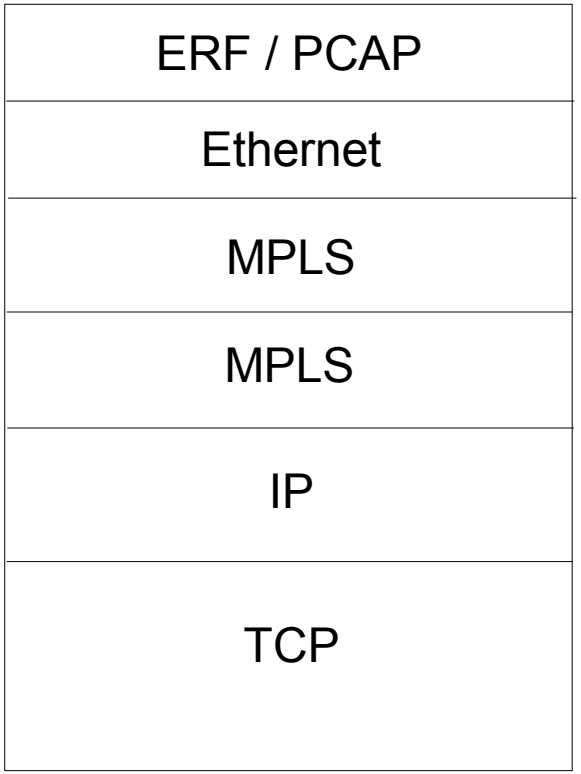


Protocol Analysis

- Example - httpcount.c
  - Rewriting our HTTP counter using the protocol analysis API

Advanced Protocol Analysis

- Remember our MPLS packet from earlier?



Advanced Protocol Analysis

- We can't jump directly to the MPLS headers
  - `trace_get_layer2()` will give us the Ethernet header
  - `trace_get_layer3()` will give us the IP header

Advanced Protocol Analysis

```
void *trace_get_payload_from_layer2(void *l2,
 libtrace_linktype_t linktype, uint16_t *ethertype,
 uint32_t *remaining);
```

- Returns a pointer to the first header after the given layer 2 header
- Returns NULL if the layer 2 header was incomplete
- `linktype` must be set to the type of the layer 2 header
- `ethertype` will be set to indicate the type of the returned header
- `remaining` will be decremented by the size of the skipped header
- Check the value of `remaining` upon return!

Advanced Protocol Analysis

- Example - mplscount.c
  - Counting MPLS packets

Advanced Protocol Analysis

```
void *trace_get_payload_from_mpls(void *mpls, uint16_t
  *type, uint32_t *remaining);
```

- Returns a pointer to the first header after the given MPLS header
- Returns NULL if an MPLS header is not passed in
- Returns NULL if the MPLS header is incomplete
- `type` must be set to the type of the header passed in
- `type` will be updated to indicate the type of the returned header
- `remaining` will be decremented by the size of the skipped header
- Check the value of `remaining` upon return!

Advanced Protocol Analysis

- Example - mplstag.c
  - Printing all the MPLS tags in a packet

Advanced Protocol Analysis

```
void *trace_get_payload_from_vlan(void *vlan, uint16_t
  *type, uint32_t *remaining);
```

- Returns a pointer to the first header after the given VLAN header
- Returns NULL if the header passed in is not a VLAN header
- Returns NULL if the VLAN header is incomplete
- `type` must be set to the type of the header passed in
- `type` will be updated to indicate the type of the returned header
- `remaining` will be decremented by the size of the skipped header
- Check the value of `remaining` upon return!

Advanced Protocol Analysis

```
void *trace_get_payload_from_pppoe(void *pppoe, uint16_t
  *type, uint32_t *remaining);
```

- Returns a pointer to the first header after the given PPPoE header
  - Also skips the subsequent PPP header
- Returns NULL if the PPPoE or PPP header is incomplete
- `type` will be updated to indicate the type of the returned header
- `remaining` will be decremented by the size of the skipped header
- Check the value of `remaining` upon return!

Advanced Protocol Analysis

```
void *trace_get_payload_from_ip(libtrace_ip_t *ip, uint8_t
  *proto, uint32_t *remaining);
```

```
void *trace_get_payload_from_ip6(libtrace_ip6_t *ip, uint8_t
  *proto, uint32_t *remaining);
```

- Returns a pointer to the first header after the given IP header
- Returns NULL if the IP header is incomplete
- `proto` is set to indicate the protocol of the returned header
- `remaining` operates just as with the previous functions

Advanced Protocol Analysis

```
void *trace_get_payload_from_tcp(libtrace_tcp_t *tcp,
 uint32_t *remaining);
```

```
void *trace_get_payload_from_udp(libtrace_udp_t *udp,
 uint32_t *remaining);
```

```
void *trace_get_payload_from_icmp(libtrace_icmp_t *icmp,
 uint32_t *remaining);
```

- Returns a pointer to the data after the given transport header
- Returns NULL if the header is incomplete
- `remaining` operates just as with the previous functions
- No indication is given as to the protocol of the returned data

A Practical Example

- Determining the amount of header overhead
  - Step through each of the headers to calculate total for a packet
    - Include link and meta-data layers
      - Therefore, I can't jump straight to the IP header
  - Also calculate post-transport payload size to compare against
  - Produce statistics for both TCP and UDP traffic
  - Periodically output stats so we can create a pretty graph

- End result: headerdemo.c

Ruby Libtrace

- Written by Nevil Brownlee (University of Auckland)

- Combine the features of ruby with libtrace
  - Exception handling
  - Iterators
  - Garbage collection

- Other languages
  - Python bindings suffered from poor performance
  - Implementations from libtrace users are most welcome

Libtrace Projects

- WDCap
  - http://research.wand.net.nz/software/wdcap.php
  - Tool for capturing and writing traces
  - Driving force behind much of the early libtrace development
  - Modular components allow capture to be customised
    - Packet snapping and anonymisation
    - Output trace file rotation
    - Direction tagging
    - Exporting of captured packets over a network

Libtrace Projects

- Maji – an implementation of an IPFIX meter
  - http://research.wand.net.nz/software/maji.php
  - Packets are read using libtrace
  - Many information elements are extracted using libtrace functions
    - i.e. any elements that can be found in a protocol header
  - Hoping for a release before the end of 2008
- More information about IPFIX (including links to RFCs)
  - http://www.ietf.org/html.charters/ipfix-charter.html

Libtrace Projects

- Nettest
  - http://nettest.wand.net.nz/
  - Passive network performance measurement applet
  - Collects performance statistics from NZ broadband users
  - Measurements are all done using libtrace
  - Compare results
    - ISPs
    - Service plans
    - Cities

Libtrace Projects

- TCP object extraction
  - Determine application-level objects using only packet headers
  - Search for non-MSS sized packets to find object boundaries
  - Paper published at ATNAC 2007
    - http://www.wand.net.nz/pubDetail.php?id=224

Libtrace Projects

- BSOD
  - http://research.wand.net.nz/software/visualisation.php
  - Real-time 3D graphical view of network traffic
  - Input can be any libtrace-supported format
    - Especially live capture formats!
  - BSOD server processes the trace or live capture
  - BSOD client displays the 3D visualisation

Libtrace Projects

- BSOD demonstration

The Future

- Enhancements planned for upcoming libtrace releases
  - New IO system enabling (de)compression in a separate thread
  - Revamp of the tool UI to fix inconsistencies
  - Support for new protocols and trace formats
  - General performance enhancements

- Further suggestions are also welcome!

The End

- Any final questions?

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