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The PROXY protocol
Versions 1 & 2

Abstract

The PROXY protocol provides a convenient way to safely transport connection information such as a client's address across multiple layers of NAT or TCP proxies. It is designed to require little changes to existing components and to limit the performance impact caused by the processing of the transported information.

Revision history

2010/10/29 - first version
2011/03/20 - update: implementation and security considerations
2012/06/21 - add support for binary format
2012/11/19 - final review and fixes
2014/05/18 - modify and extend PROXY protocol version 2
2014/06/11 - fix example code to consider ver+cmd merge
2014/06/14 - fix v2 header check in example code, and update Forwarded spec
2014/07/12 - update list of implementations (add Squid)
2015/05/02 - update list of implementations and format of the TLV add-ons

1. Background

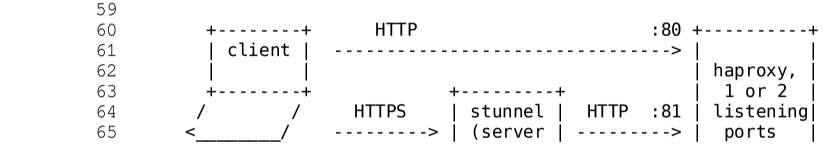
Relaying TCP connections through proxies generally involves a loss of the original TCP connection parameters such as source and destination addresses, ports, and so on. Some protocols make it a little bit easier to transfer such information. For SMTP, Postfix authors have proposed the XCLIENT protocol [1] which received broad adoption and is particularly suited to mail exchanges. For HTTP, there is the "Forwarded" extension [2], which aims at replacing the omnipresent "X-Forwarded-For" header which carries information about the original source address, and the less common X-Original-To which carries information about the destination address.

However, both mechanisms require a knowledge of the underlying protocol to be implemented in intermediaries.

Then comes a new class of products which we'll call "dumb proxies", not because they don't do anything, but because they're processing protocol-agnostic data. Both Stunnel[3] and Stud[4] are examples of such "dumb proxies". They talk raw TCP on one side, and raw SSL on the other one, and do that reliably, without any knowledge of what protocol is transported on top of the connection. Haproxy running in pure TCP mode obviously falls into that category as well.

The problem with such a proxy when it is combined with another one such as haproxy, is to adapt it to talk the higher level protocol. A patch is available for Stunnel to make it capable of inserting an X-Forwarded-For header in the first HTTP request of each incoming connection. Haproxy is able not to add another one when the connection comes from Stunnel, so that it's possible to hide it from the servers.

The typical architecture becomes the following one :



The problem appears when haproxy runs with keep-alive on the side towards the client. The Stunnel patch will only add the X-Forwarded-For header to the first request of each connection and all subsequent requests will not have it. One solution could be to improve the patch to make it support keep-alive and parse all forwarded data, whether they're announced with a Content-Length or with a Transfer-Encoding, taking care of special methods such as HEAD which announce data without transfering them, etc... In fact, it would require implementing a full HTTP stack in Stunnel. It would then become a lot more complex, a lot less reliable and would not anymore be the "dumb proxy" that fits every purposes.

In practice, we don't need to add a header for each request because we'll emit the exact same information every time : the information related to the client side connection. We could then cache that information in haproxy and use it for every other request. But that becomes dangerous and is still limited to HTTP only.

Another approach consists in prepending each connection with a header reporting the characteristics of the other side's connection. This method is simpler to implement, does not require any protocol-specific knowledge on either side, and completely fits the purpose since what is desired precisely is to know the other side's connection endpoints. It is easy to perform for the sender (just send a short header once the connection is established) and to parse for the receiver (simply perform one read() on the incoming connection to fill in addresses after an accept). The protocol used to carry connection information across proxies was thus called the PROXY protocol.

2. The PROXY protocol header

This document uses a few terms that are worth explaining here :
  - "connection initiator" is the party requesting a new connection
  - "connection target" is the party accepting a connection request
  - "client" is the party for which a connection was requested
  - "server" is the party to which the client desired to connect
  - "proxy" is the party intercepting and relaying the connection from the client to the server.
  - "sender" is the party sending data over a connection.
  - "receiver" is the party receiving data from the sender.
  - "header" or "PROXY protocol header" is the block of connection information the connection initiator prepends at the beginning of a connection, which makes it the sender from the protocol point of view.

The PROXY protocol's goal is to fill the server's internal structures with the information collected by the proxy that the server would have been able to get by itself if the client was connecting directly to the server instead of via a proxy. The information carried by the protocol are the ones the server would get using getsockname() and getpeername() :
  - address family (AF_INET for IPv4, AF_INET6 for IPv6, AF_UNIX)
  - socket protocol (SOCK_STREAM for TCP, SOCK_DGRAM for UDP)
  - layer 3 source and destination addresses
  - layer 4 source and destination ports if any

Unlike the XCLIENT protocol, the PROXY protocol was designed with limited extensibility in order to help the receiver parse it very fast. Version 1 was focused on keeping it human-readable for better debugging possibilities, which is always desirable for early adoption when few implementations exist. Version 2 adds support for a binary encoding of the header which is much more efficient to produce and to parse, especially when dealing with IPv6 addresses that are expensive to emit in ASCII form and to parse.

In both cases, the protocol simply consists in an easily parsable header placed

by the connection initiator at the beginning of each connection. The protocol is intentionally stateless in that it does not expect the sender to wait for the receiver before sending the header, nor the receiver to send anything back.

This specification supports two header formats, a human-readable format which is the only format supported in version 1 of the protocol, and a binary format which is only supported in version 2. Both formats were designed to ensure that the header cannot be confused with common higher level protocols such as HTTP, SSL/TLS, FTP or SMTP, and that both formats are easily distinguishable one from each other for the receiver.

Version 1 senders MAY only produce the human-readable header format. Version 2 senders MAY only produce the binary header format. Version 1 receivers MUST at least implement the human-readable header format. Version 2 receivers MUST at least implement the binary header format, and it is recommended that they also implement the human-readable header format for better interoperability and ease of upgrade when facing version 1 senders.

Both formats are designed to fit in the smallest TCP segment that any TCP/IP host is required to support (576 - 40 = 536 bytes). This ensures that the whole header will always be delivered at once when the socket buffers are still empty at the beginning of a connection. The sender must always ensure that the header is sent at once, so that the transport layer maintains atomicity along the path to the receiver. The receiver may be tolerant to partial headers or may simply drop the connection when receiving a partial header. Recommendation is to be tolerant, but implementation constraints may not always easily permit this. It is important to note that nothing forces any intermediary to forward the whole header at once, because TCP is a streaming protocol which may be processed one byte at a time if desired, causing the header to be fragmented when reaching the receiver. But due to the places where such a protocol is used, the above simplification generally is acceptable because the risk of crossing such a device handling one byte at a time is close to zero.

The receiver MUST NOT start processing the connection before it receives a complete and valid PROXY protocol header. This is particularly important for protocols where the receiver is expected to speak first (eg: SMTP, FTP or SSH). The receiver may apply a short timeout and decide to abort the connection if the protocol header is not seen within a few seconds (at least 3 seconds to cover a TCP retransmit).

The receiver MUST be configured to only receive the protocol described in this specification and MUST not try to guess whether the protocol header is present or not. This means that the protocol explicitly prevents port sharing between public and private access. Otherwise it would open a major security breach by allowing untrusted parties to spoof their connection addresses. The receiver SHOULD ensure proper access filtering so that only trusted proxies are allowed to use this protocol.

Some proxies are smart enough to understand transported protocols and to reuse idle server connections for multiple messages. This typically happens in HTTP where requests from multiple clients may be sent over the same connection. Such proxies MUST NOT implement this protocol on multiplexed connections because the receiver would use the address advertised in the PROXY header as the address of all forwarded requests's senders. In fact, such proxies are not dumb proxies, and since they do have a complete understanding of the transported protocol, they MUST use the facilities provided by this protocol to present the client's address.

2.1. Human-readable header format (Version 1)

This is the format specified in version 1 of the protocol. It consists in one line of ASCII text matching exactly the following block, sent immediately and at once upon the connection establishment and prepended before any data flowing from the sender to the receiver :

  - a string identifying the protocol : "PROXY" (\x50 \x52 \x4F \x58 \x59)
    Seeing this string indicates that this is version 1 of the protocol.

  - exactly one space : " " (\x20)

  - a string indicating the proxied INET protocol and family. As of version 1,
    only "TCP4" (\x54 \x43 \x50 \x34) for TCP over IPv4, and "TCP6"
    (\x54 \x43 \x50 \x36) for TCP over IPv6 are allowed. Other, unsupported,
    or unknown protocols must be reported with the name "UNKNOWN" (\x55 \x4E
    \x4B \x4E \x4F \x57 \x4E). For "UNKNOWN", the rest of the line before the
    CRLF may be omitted by the sender, and the receiver must ignore anything
    presented before the CRLF is found. Note that an earlier version of this
    specification suggested to use this when sending health checks, but this
    causes issues with servers that reject the "UNKNOWN" keyword. Thus is it
    now recommended not to send "UNKNOWN" when the connection is expected to
    be accepted, but only when it is not possible to correctly fill the PROXY
    line.

  - exactly one space : " " (\x20)

  - the layer 3 source address in its canonical format. IPv4 addresses must be
    indicated as a series of exactly 4 integers in the range [0..255] inclusive
    written in decimal representation separated by exactly one dot between each
    other. Heading zeroes are not permitted in front of numbers in order to
    avoid any possible confusion with octal numbers. IPv6 addresses must be
    indicated as series of 4 hexadecimal digits (upper or lower case) delimited
    by colons between each other, with the acceptance of one double colon
    sequence to replace the largest acceptable range of consecutive zeroes. The
    total number of decoded bits must exactly be 128. The advertised protocol
    family dictates what format to use.

  - exactly one space : " " (\x20)

  - the layer 3 destination address in its canonical format. It is the same
    format as the layer 3 source address and matches the same family.

  - exactly one space : " " (\x20)

  - the TCP source port represented as a decimal integer in the range
    [0..65535] inclusive. Heading zeroes are not permitted in front of numbers
    in order to avoid any possible confusion with octal numbers.

  - exactly one space : " " (\x20)

  - the TCP destination port represented as a decimal integer in the range
    [0..65535] inclusive. Heading zeroes are not permitted in front of numbers
    in order to avoid any possible confusion with octal numbers.

  - the CRLF sequence (\x0D \x0A)

The maximum line lengths the receiver must support including the CRLF are :
  - TCP/IPv4 :
      "PROXY TCP4 255.255.255.255 255.255.255.255 65535 65535\r\n"
    => 5 + 1 + 4 + 1 + 15 + 1 + 15 + 1 + 5 + 1 + 5 + 2 = 56 chars

  - TCP/IPv6 :
      "PROXY TCP6 ffff:f...f:ffff ffff:f...f:ffff 65535 65535\r\n"
    => 5 + 1 + 4 + 1 + 39 + 1 + 39 + 1 + 5 + 1 + 5 + 2 = 104 chars

  - unknown connection (short form) :
      "PROXY UNKNOWN\r\n"
    => 5 + 1 + 7 + 2 = 15 chars

  - worst case (optional fields set to 0xff) :
      "PROXY UNKNOWN ffff:f...f:ffff ffff:f...f:ffff 65535 65535\r\n"
    => 5 + 1 + 7 + 1 + 39 + 1 + 39 + 1 + 5 + 1 + 5 + 2 = 107 chars

So a 108-byte buffer is always enough to store all the line and a trailing zero
for string processing.

The receiver must wait for the CRLF sequence before starting to decode the
addresses in order to ensure they are complete and properly parsed. If the CRLF
sequence is not found in the first 107 characters, the receiver should declare
the line invalid. A receiver may reject an incomplete line which does not
contain the CRLF sequence in the first atomic read operation. The receiver must
not tolerate a single CR or LF character to end the line when a complete CRLF
sequence is expected.

Any sequence which does not exactly match the protocol must be discarded and
cause the receiver to abort the connection. It is recommended to abort the
connection as soon as possible so that the sender gets a chance to notice the
anomaly and log it.

If the announced transport protocol is "UNKNOWN", then the receiver knows that
the sender speaks the correct PROXY protocol with the appropriate version, and
SHOULD accept the connection and use the real connection's parameters as if
there were no PROXY protocol header on the wire. However, senders SHOULD not
use the "UNKNOWN" protocol when they are the initiators of outgoing connections
because some receivers may reject them. When a load balancing proxy has to send
health checks to a server, it SHOULD build a valid PROXY line which it will
fill with a getsockname()/getpeername() pair indicating the addresses used. It
is important to understand that doing so is not appropriate when some source
address translation is performed between the sender and the receiver.

An example of such a line before an HTTP request would look like this (CR
marked as "\r" and LF marked as "\n") :

    PROXY TCP4 192.168.0.1 192.168.0.11 56324 443\r\n
    GET / HTTP/1.1\r\n
    Host: 192.168.0.11\r\n
    \r\n

For the sender, the header line is easy to put into the output buffers once the
connection is established. Note that since the line is always shorter than an
MSS, the sender is guaranteed to always be able to emit it at once and should
not even bother handling partial sends. For the receiver, once the header is
parsed, it is easy to skip it from the input buffers. Please consult section 9
for implementation suggestions.

2.2. Binary header format (version 2)

Producing human-readable IPv6 addresses and parsing them is very inefficient,
due to the multiple possible representation formats and the handling of compact
address format. It was also not possible to specify address families outside
IPv4/IPv6 nor non-TCP protocols. Another drawback of the human-readable format
is the fact that implementations need to parse all characters to find the
trailing CRLF, which makes it harder to read only the exact bytes count. Last,
the UNKNOWN address type has not always been accepted by servers as a valid
protocol because of its imprecise meaning.

Version 2 of the protocol thus introduces a new binary format which remains
distinguishable from version 1 and from other commonly used protocols. It was
specially designed in order to be incompatible with a wide range of protocols
and to be rejected by a number of common implementations of these protocols
when unexpectedly presented (please see section 7). Also for better processing
efficiency, IPv4 and IPv6 addresses are respectively aligned on 4 and 16 bytes
boundaries.

The binary header format starts with a constant 12 bytes block containing the
protocol signature :

   \x0D \x0A \x0D \x0A \x00 \x0D \x0A \x51 \x55 \x49 \x54 \x0A

Note that this block contains a null byte at the 5th position, so it must not
be handled as a null-terminated string.

The next byte (the 13th one) is the protocol version and command.

The highest four bits contains the version. As of this specification, it must
always be sent as \x2 and the receiver must only accept this value.

The lowest four bits represents the command :
  - \x0 : LOCAL : the connection was established on purpose by the proxy
    without being relayed. The connection endpoints are the sender and the
    receiver. Such connections exist when the proxy sends health-checks to the
    server. The receiver must accept this connection as valid and must use the
    real connection endpoints and discard the protocol block including the
    family which is ignored.

  - \x1 : PROXY : the connection was established on behalf of another node,
    and reflects the original connection endpoints. The receiver must then use
    the information provided in the protocol block to get original the address.

  - other values are unassigned and must not be emitted by senders. Receivers
    must drop connections presenting unexpected values here.

The 14th byte contains the transport protocol and address family. The highest 4
bits contain the address family, the lowest 4 bits contain the protocol.

The address family maps to the original socket family without necessarily
matching the values internally used by the system. It may be one of :

  - 0x0 : AF_UNSPEC : the connection is forwarded for an unknown, unspecified
    or unsupported protocol. The sender should use this family when sending
    LOCAL commands or when dealing with unsupported protocol families. The
    receiver is free to accept the connection anyway and use the real endpoint
    addresses or to reject it. The receiver should ignore address information.

  - 0x1 : AF_INET : the forwarded connection uses the AF_INET address family
    (IPv4). The addresses are exactly 4 bytes each in network byte order,
    followed by transport protocol information (typically ports).

  - 0x2 : AF_INET6 : the forwarded connection uses the AF_INET6 address family
    (IPv6). The addresses are exactly 16 bytes each in network byte order,
    followed by transport protocol information (typically ports).

  - 0x3 : AF_UNIX : the forwarded connection uses the AF_UNIX address family
    (UNIX). The addresses are exactly 108 bytes each.

  - other values are unspecified and must not be emitted in version 2 of this
    protocol and must be rejected as invalid by receivers.

The transport protocol is specified in the lowest 4 bits of the the 14th byte :

  - 0x0 : UNSPEC : the connection is forwarded for an unknown, unspecified
    or unsupported protocol. The sender should use this family when sending
    LOCAL commands or when dealing with unsupported protocol families. The
    receiver is free to accept the connection anyway and use the real endpoint
    addresses or to reject it. The receiver should ignore address information.

  - 0x1 : STREAM : the forwarded connection uses a SOCK_STREAM protocol (eg:
    TCP or UNIX_STREAM). When used with AF_INET/AF_INET6 (TCP), the addresses

```
391       are followed by the source and destination ports represented on 2 bytes
392       each in network byte order.
393
394     - 0x2 : DGRAM : the forwarded connection uses a SOCK_DGRAM protocol (eg:
395       UDP or UNIX_DGRAM). When used with AF_INET/AF_INET6 (UDP), the addresses
396       are followed by the source and destination ports represented on 2 bytes
397       each in network byte order.
398
399     - other values are unspecified and must not be emitted in version 2 of this
400       protocol and must be rejected as invalid by receivers.
401
402   In practice, the following protocol bytes are expected :
403
404     - \x00 : UNSPEC : the connection is forwarded for an unknown, unspecified
405       or unsupported protocol. The sender should use this family when sending
406       LOCAL commands or when dealing with unsupported protocol families. When
407       used with a LOCAL command, the receiver must accept the connection and
408       ignore any address information. For other commands, the receiver is free
409       to accept the connection anyway and use the real endpoints addresses or to
410       reject the connection. The receiver should ignore address information.
411
412     - \x11 : TCP over IPv4 : the forwarded connection uses TCP over the AF_INET
413       protocol family. Address length is 2*4 + 2*2 = 12 bytes.
414
415     - \x12 : UDP over IPv4 : the forwarded connection uses UDP over the AF_INET
416       protocol family. Address length is 2*4 + 2*2 = 12 bytes.
417
418     - \x21 : TCP over IPv6 : the forwarded connection uses TCP over the AF_INET6
419       protocol family. Address length is 2*16 + 2*2 = 36 bytes.
420
421     - \x22 : UDP over IPv6 : the forwarded connection uses UDP over the AF_INET6
422       protocol family. Address length is 2*16 + 2*2 = 36 bytes.
423
424     - \x31 : UNIX stream : the forwarded connection uses SOCK_STREAM over the
425       AF_UNIX protocol family. Address length is 2*108 = 216 bytes.
426
427     - \x32 : UNIX datagram : the forwarded connection uses SOCK_DGRAM over the
428       AF_UNIX protocol family. Address length is 2*108 = 216 bytes.
429
430
431   Only the UNSPEC protocol byte (\x00) is mandatory. A receiver is not required
432   to implement other ones, provided that it automatically falls back to the
433   UNSPEC mode for the valid combinations above that it does not support.
434
435   The 15th and 16th bytes is the address length in bytes in network endien order.
436   It is used so that the receiver knows how many address bytes to skip even when
437   it does not implement the presented protocol. Thus the length of the protocol
438   header in bytes is always exactly 16 + this value. When a sender presents a
439   LOCAL connection, it should not present any address so it sets this field to
440   zero. Receivers MUST always consider this field to skip the appropriate number
441   of bytes and must not assume zero is presented for LOCAL connections. When a
442   receiver accepts an incoming connection showing an UNSPEC address family or
443   protocol, it may or may not decide to log the address information if present.
444
445   So the 16-byte version 2 header can be described this way :
446
447       struct proxy_hdr_v2 {
448           uint8_t sig[12];  /* hex 0D 0A 0D 0A 00 0D 0A 51 55 49 54 0A */
449           uint8_t ver_cmd;  /* protocol version and command */
450           uint8_t fam;      /* protocol family and address */
451           uint16_t len;     /* number of following bytes part of the header */
452       };
453
454   Starting from the 17th byte, addresses are presented in network byte order.
455   The address order is always the same :
```



```
456     - source layer 3 address in network byte order
457     - destination layer 3 address in network byte order
458     - source layer 4 address if any, in network byte order (port)
459     - destination layer 4 address if any, in network byte order (port)
460
461   The address block may directly be sent from or received into the following
462   union which makes it easy to cast from/to the relevant socket native structs
463   depending on the address type :
464
465       union proxy_addr {
466           struct {        /* for TCP/UDP over IPv4, len = 12 */
467               uint32_t src_addr;
468               uint32_t dst_addr;
469               uint16_t src_port;
470               uint16_t dst_port;
471           } ipv4_addr;
472           struct {        /* for TCP/UDP over IPv6, len = 36 */
473                uint8_t  src_addr[16];
474                uint8_t  dst_addr[16];
475                uint16_t src_port;
476                uint16_t dst_port;
477           } ipv6_addr;
478           struct {        /* for AF_UNIX sockets, len = 216 */
479                uint8_t src_addr[108];
480                uint8_t dst_addr[108];
481           } unix_addr;
482       };
483
484   The sender must ensure that all the protocol header is sent at once. This block
485   is always smaller than an MSS, so there is no reason for it to be segmented at
486   the beginning of the connection. The receiver should also process the header
487   at once. The receiver must not start to parse an address before the whole
488   address block is received. The receiver must also reject incoming connections
489   containing partial protocol headers.
490
491   A receiver may be configured to support both version 1 and version 2 of the
492   protocol. Identifying the protocol version is easy :
493
494       - if the incoming byte count is 16 or above and the 13 first bytes match
495         the protocol signature block followed by the protocol version 2 :
496
497               \x0D\x0A\x0D\x0A\x00\x0D\x0A\x51\x55\x49\x54\x0A\x02
498
499       - otherwise, if the incoming byte count is 8 or above, and the 5 first
500         characters match the ASCII representation of "PROXY" then the protocol
501         must be parsed as version 1 :
502
503               \x50\x52\x4F\x58\x59
504
505       - otherwise the protocol is not covered by this specification and the
506         connection must be dropped.
507
508   If the length specified in the PROXY protocol header indicates that additional
509   bytes are part of the header beyond the address information, a receiver may
510   choose to skip over and ignore those bytes, or attempt to interpret those
511   bytes.
512
513   The information in those bytes will be arranged in Type-Length-Value (TLV
514   vectors) in the following format.  The first byte is the Type of the vector.
515   The second two bytes represent the length in bytes of the value (not included
516   the Type and Length bytes), and following the length field is the number of
517   bytes specified by the length.
518
519           struct pp2_tlv {
520               uint8_t type;
```

```
            uint8_t length_hi;
            uint8_t length_lo;
            uint8_t value[0];
        };
```

The following types have already been registered for the <type> field :

```
        #define PP2_TYPE_ALPN           0x01
        #define PP2_TYPE_AUTHORITY      0x02
        #define PP2_TYPE_SSL            0x20
        #define PP2_SUBTYPE_SSL_VERSION 0x21
        #define PP2_SUBTYPE_SSL_CN      0x22
        #define PP2_TYPE_NETNS          0x30
```

2.2.1. The PP2_TYPE_SSL type and subtypes

For the type PP2_TYPE_SSL, the value is itselv a defined like this :

```
        struct pp2_tlv_ssl {
                uint8_t  client;
                uint32_t verify;
                struct pp2_tlv sub_tlv[0];
        };
```

The <verify> field will be zero if the client presented a certificate
and it was successfully verified, and non-zero otherwise.

The <client> field is made of a bit field from the following values,
indicating which element is present :

```
        #define PP2_CLIENT_SSL          0x01
        #define PP2_CLIENT_CERT_CONN    0x02
        #define PP2_CLIENT_CERT_SESS    0x04
```

Note, that each of these elements may lead to extra data being appended to
this TLV using a second level of TLV encapsulation. It is thus possible to
find multiple TLV values after this field. The total length of the pp2_tlv_ssl
TLV will reflect this.

The PP2_CLIENT_SSL flag indicates that the client connected over SSL/TLS. When
this field is present, the string representation of the TLS version is appended
at the end of the field in the TLV format using the type PP2_SUBTYPE_SSL_VERSION.

PP2_CLIENT_CERT_CONN indicates that the client provided a certificate over the
current connection. PP2_CLIENT_CERT_SESS indicates that the client provided a
certificate at least once over the TLS session this connection belongs to.

In all cases, the string representation (in UTF8) of the Common Name field
(OID: 2.5.4.3) of the client certificate's DistinguishedName, is appended
using the TLV format and the type PP2_SUBTYPE_SSL_CN.

2.2.2. The PP2_TYPE_NETNS type

The type PP2_TYPE_NETNS defines the value as the string representation of the
namespace's name.

3. Implementations

Haproxy 1.5 implements version 1 of the PROXY protocol on both sides :
  - the listening sockets accept the protocol when the "accept-proxy" setting
    is passed to the "bind" keyword. Connections accepted on such listeners
    will behave just as if the source really was the one advertised in the

    protocol. This is true for logging, ACLs, content filtering, transparent
    proxying, etc...

  - the protocol may be used to connect to servers if the "send-proxy" setting
    is present on the "server" line. It is enabled on a per-server basis, so it
    is possible to have it enabled for remote servers only and still have local
    ones behave differently. If the incoming connection was accepted with the
    "accept-proxy", then the relayed information is the one advertised in this
    connection's PROXY line.

  - Haproxy 1.5 also implements version 2 of the PROXY protocol as a sender. In
    addition, a TLV with limited, optional, SSL information has been added.

Stunnel added support for version 1 of the protocol for outgoing connections in
version 4.45.

Stud added support for version 1 of the protocol for outgoing connections on
2011/06/29.

Postfix added support for version 1 of the protocol for incoming connections
in smtpd and postscreen in version 2.10.

A patch is available for Stud[5] to implement version 1 of the protocol on
incoming connections.

Support for versions 1 and 2 of the protocol was added to Varnish 4.1 [6].

Exim added support for version 1 and version 2 of the protocol for incoming
connections on 2014/05/13, and will be released as part of version 4.83.

Squid added support for versions 1 and 2 of the protocol in version 3.5 [7].

Jetty 9.3.0 supports protocol version 1.

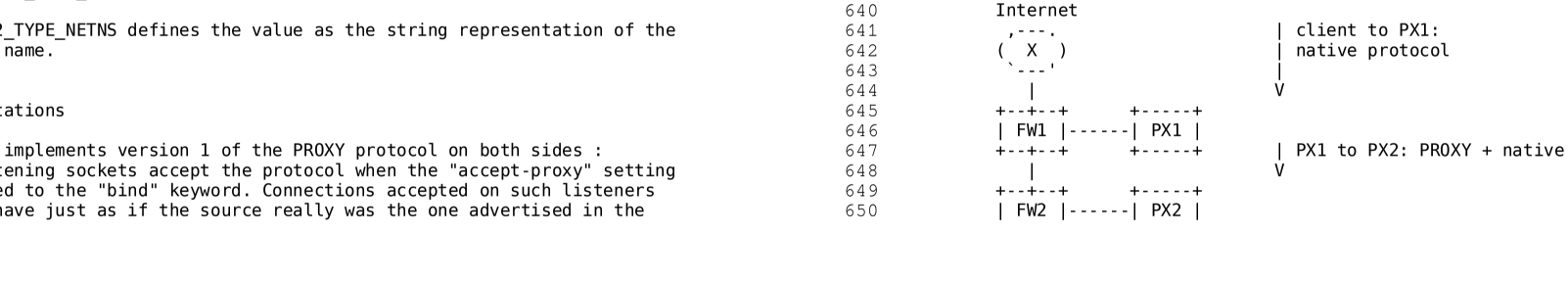
The protocol is simple enough that it is expected that other implementations
will appear, especially in environments such as SMTP, IMAP, FTP, RDP where the
client's address is an important piece of information for the server and some
intermediaries. In fact, several proprietary deployments have already done so
on FTP and SMTP servers.

Proxy developers are encouraged to implement this protocol, because it will
make their products much more transparent in complex infrastructures, and will
get rid of a number of issues related to logging and access control.

4. Architectural benefits

4.1. Multiple layers

Using the PROXY protocol instead of transparent proxy provides several benefits
in multiple-layer infrastructures. The first immediate benefit is that it
becomes possible to chain multiple layers of proxies and always present the
original IP address. for instance, let's consider the following 2-layer proxy
architecture :



```
          +--+--+      +-----+       | PX2 to SRV: PROXY + native
             |                        V
          +--+--+
          | SRV |
          +-----+
```

Firewall FW1 receives traffic from internet-based clients and forwards it to reverse-proxy PX1. PX1 adds a PROXY header then forwards to PX2 via FW2. PX2 is configured to read the PROXY header and to emit it on output. It then joins the origin server SRV and presents the original client's address there. Since all TCP connections endpoints are real machines and are not spoofed, there is no issue for the return traffic to pass via the firewalls and reverse proxies. Using transparent proxy, this would be quite difficult because the firewalls would have to deal with the client's address coming from the proxies in the DMZ and would have to correctly route the return traffic there instead of using the default route.

4.2. IPv4 and IPv6 integration

The protocol also eases IPv4 and IPv6 integration : if only the first layer (FW1 and PX1) is IPv6-capable, it is still possible to present the original client's IPv6 address to the target server eventhough the whole chain is only connected via IPv4.

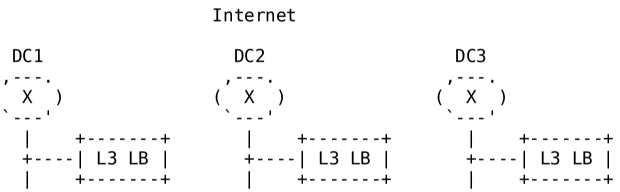
4.3. Multiple return paths

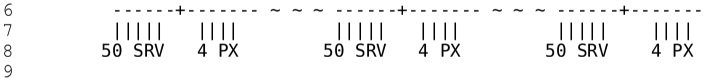
When transparent proxy is used, it is not possible to run multiple proxies because the return traffic would follow the default route instead of finding the proper proxy. Some tricks are sometimes possible using multiple server addresses and policy routing but these are very limited.

Using the PROXY protocol, this problem disappears as the servers don't need to route to the client, just to the proxy that forwarded the connection. So it is perfectly possible to run a proxy farm in front of a very large server farm and have it working effortless, even when dealing with multiple sites.

This is particularly important in Cloud-like environments where there is little choice of binding to random addresses and where the lower processing power per node generally requires multiple front nodes.

The example below illustrates the following case : virtualized infrastructures are deployed in 3 datacenters (DC1..DC3). Each DC uses its own VIP which is handled by the hosting provider's layer 3 load balancer. This load balancer routes the traffic to a farm of layer 7 SSL/cache offloaders which load balance among their local servers. The VIPs are advertised by geolocalised DNS so that clients generally stick to a given DC. Since clients are not guaranteed to stick to one DC, the L7 load balancing proxies have to know the other DCs' servers that may be reached via the hosting provider's LAN or via the internet. The L7 proxies use the PROXY protocol to join the servers behind them, so that even inter-DC traffic can forward the original client's address and the return path is unambiguous. This would not be possible using transparent proxy because most often the L7 proxies would not be able to spoof an address, and this would never work between datacenters.





5. Security considerations

Version 1 of the protocol header (the human-readable format) was designed so as to be distinguishable from HTTP. It will not parse as a valid HTTP request and an HTTP request will not parse as a valid proxy request. Version 2 add to use a non-parsable binary signature to make many products fail on this block. The signature was designed to cause immediate failure on HTTP, SSL/TLS, SMTP, FTP, and POP. It also causes aborts on LDAP and RDP servers (see section 6). That makes it easier to enforce its use under certain connections and at the same time, it ensures that improperly configured servers are quickly detected.

Implementers should be very careful about not trying to automatically detect whether they have to decode the header or not, but rather they must only rely on a configuration parameter. Indeed, if the opportunity is left to a normal client to use the protocol, he will be able to hide his activities or make them appear as coming from someone else. However, accepting the header only from a number of known sources should be safe.

6. Validation

The version 2 protocol signature has been sent to a wide variety of protocols and implementations including old ones. The following protocol and products have been tested to ensure the best possible behaviour when the signature was presented, even with minimal implementations :

```
  - HTTP :
    - Apache 1.3.33    : connection abort        => pass/optimal
    - Nginx 0.7.69     : 400 Bad Request + abort => pass/optimal
    - lighttpd 1.4.20  : 400 Bad Request + abort => pass/optimal
    - thttpd 2.20c     : 400 Bad Request + abort => pass/optimal
    - mini-httpd-1.19  : 400 Bad Request + abort => pass/optimal
    - haproxy 1.4.21   : 400 Bad Request + abort => pass/optimal
    - Squid 3          : 400 Bad Request + abort => pass/optimal
  - SSL :
    - stud 0.3.47      : connection abort        => pass/optimal
    - stunnel 4.45     : connection abort        => pass/optimal
    - nginx 0.7.69     : 400 Bad Request + abort => pass/optimal
  - FTP :
    - Pure-ftpd 1.0.20 : 3*500 then 221 Goodbye  => pass/optimal
    - vsftpd 2.0.1     : 3*530 then 221 Goodbye  => pass/optimal
  - SMTP :
    - postfix 2.3      : 3*500 + 221 Bye         => pass/optimal
    - exim 4.69        : 554 + connection abort  => pass/optimal
  - POP :
    - dovecot 1.0.10   : 3*ERR + Logout          => pass/optimal
  - IMAP :
    - dovecot 1.0.10   : 5*ERR + hang            => pass/non-optimal
  - LDAP :
    - openldap 2.3     : abort                   => pass/optimal
  - SSH :
    - openssh 3.9p1    : abort                   => pass/optimal
  - RDP :
    - Windows XP SP3   : abort                   => pass/optimal
```

This means that most protocols and implementations will not be confused by an incoming connection exhibiting the protocol signature, which avoids issues when facing misconfigurations.

7. Future developments

It is possible that the protocol may slightly evolve to present other information such as the incoming network interface, or the origin addresses in case of network address translation happening before the first proxy, but this is not identified as a requirement right now. Some deep thinking has been spent on this and it appears that trying to add a few more information open a pandora box with many information from MAC addresses to SSL client certificates, which would make the protocol much more complex. So at this point it is not planned. Suggestions on improvements are welcome.

8. Contacts and links

Please use w@1wt.eu to send any comments to the author.

The following links were referenced in the document.

[1] http://www.postfix.org/XCLIENT_README.html
[2] http://tools.ietf.org/html/rfc7239
[3] http://www.stunnel.org/
[4] https://github.com/bumptech/stud
[5] https://github.com/bumptech/stud/pull/81
[6] https://www.varnish-cache.org/docs/trunk/phk/ssl_again.html
[7] http://wiki.squid-cache.org/Squid-3.5

9. Sample code

The code below is an example of how a receiver may deal with both versions of the protocol header for TCP over IPv4 or IPv6. The function is supposed to be called upon a read event. Addresses may be directly copied into their final memory location since they're transported in network byte order. The sending side is even simpler and can easily be deduced from this sample code.

```
  struct sockaddr_storage from; /* already filled by accept() */
  struct sockaddr_storage to;   /* already filled by getsockname() */
  const char v2sig[12] = "\x0D\x0A\x0D\x0A\x00\x0D\x0A\x51\x55\x49\x54\x0A";

  /* returns 0 if needs to poll, <0 upon error or >0 if it did the job */
  int read_evt(int fd)
  {
      union {
          struct {
              char line[108];
          } v1;
          struct {
              uint8_t sig[12];
              uint8_t ver_cmd;
              uint8_t fam;
              uint16_t len;
              union {
                  struct {  /* for TCP/UDP over IPv4, len = 12 */
                      uint32_t src_addr;
                      uint32_t dst_addr;
                      uint16_t src_port;
                      uint16_t dst_port;
                  } ip4;
                  struct {  /* for TCP/UDP over IPv6, len = 36 */
                       uint8_t  src_addr[16];
                       uint8_t  dst_addr[16];
                       uint16_t src_port;
                       uint16_t dst_port;
                  } ip6;
                  struct {  /* for AF_UNIX sockets, len = 216 */
```



```
                      uint8_t src_addr[108];
                      uint8_t dst_addr[108];
                  } unx;
              } addr;
          } v2;
      } hdr;

      int size, ret;

      do {
          ret = recv(fd, &hdr, sizeof(hdr), MSG_PEEK);
      } while (ret == -1 && errno == EINTR);

      if (ret == -1)
          return (errno == EAGAIN) ? 0 : -1;

      if (ret >= 16 && memcmp(&hdr.v2, v2sig, 12) == 0 &&
          (hdr.v2.ver_cmd & 0xF0) == 0x20) {
          size = 16 + hdr.v2.len;
          if (ret < size)
              return -1; /* truncated or too large header */

          switch (hdr.v2.ver_cmd & 0xF) {
          case 0x01: /* PROXY command */
              switch (hdr.v2.fam) {
              case 0x11:  /* TCPv4 */
                  ((struct sockaddr_in *)&from)->sin_family = AF_INET;
                  ((struct sockaddr_in *)&from)->sin_addr.s_addr =
                      hdr.v2.addr.ip4.src_addr;
                  ((struct sockaddr_in *)&from)->sin_port =
                      hdr.v2.addr.ip4.src_port;
                  ((struct sockaddr_in *)&to)->sin_family = AF_INET;
                  ((struct sockaddr_in *)&to)->sin_addr.s_addr =
                      hdr.v2.addr.ip4.dst_addr;
                  ((struct sockaddr_in *)&to)->sin_port =
                      hdr.v2.addr.ip4.dst_port;
                  goto done;
              case 0x21:  /* TCPv6 */
                  ((struct sockaddr_in6 *)&from)->sin6_family = AF_INET6;
                  memcpy(&((struct sockaddr_in6 *)&from)->sin6_addr,
                      hdr.v2.addr.ip6.src_addr, 16);
                  ((struct sockaddr_in6 *)&from)->sin6_port =
                      hdr.v2.addr.ip6.src_port;
                  ((struct sockaddr_in6 *)&to)->sin6_family = AF_INET6;
                  memcpy(&((struct sockaddr_in6 *)&to)->sin6_addr,
                      hdr.v2.addr.ip6.dst_addr, 16);
                  ((struct sockaddr_in6 *)&to)->sin6_port =
                      hdr.v2.addr.ip6.dst_port;
                  goto done;
              }
              /* unsupported protocol, keep local connection address */
              break;
          case 0x00: /* LOCAL command */
              /* keep local connection address for LOCAL */
              break;
          default:
              return -1; /* not a supported command */
          }
      }
      else if (ret >= 8 && memcmp(hdr.v1.line, "PROXY", 5) == 0) {
          char *end = memchr(hdr.v1.line, '\r', ret - 1);
          if (!end || end[1] != '\n')
              return -1; /* partial or invalid header */
          *end = '\0'; /* terminate the string to ease parsing */
          size = end + 2 - hdr.v1.line; /* skip header + CRLF */
```

```
            /* parse the V1 header using favorite address parsers like inet_pton.
             * return -1 upon error, or simply fall through to accept.
             */
        }
        else {
            /* Wrong protocol */
            return -1;
        }

    done:
        /* we need to consume the appropriate amount of data from the socket */
        do {
            ret = recv(fd, &hdr, size, 0);
        } while (ret == -1 && errno == EINTR);
        return (ret >= 0) ? 1 : -1;
    }
```