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PPP Predictor Compression Protocol

Status of This Memo

Abstract

The Point-to-Point Protocol (PPP) [1] provides a standard method of encapsulating multiple protocol datagrams over point-to-point links.

The PPP Compression Control Protocol [2] provides a method for transporting multi-protocol datagrams over PPP encapsulated links.

This document describes the use of the Predictor data compression algorithm for compressing PPP encapsulated packets.

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1. Introduction

Predictor is a high speed compression algorithm, available without license fees. The compression ratio obtained using predictor is not as good as other compression algorithms, but it remains one of the fastest algorithms available.

Note that although care has been taken to ensure that the following code does not infringe any patents, there is no assurance that it is

not covered by a patent.

2. Licensing

There are no license fees or costs associated with using the Predictor algorithm.

Use the following code at your own risk.

3. Predictor Packets

Before any Predictor packets may be communicated, PPP must reach the Network-Layer Protocol phase, and the Compression Control Protocol must reach the Opened state.

Exactly one Predictor datagram is encapsulated in the PPP Information field, where the PPP Protocol field indicates type hex 00FD (compressed datagram).

The maximum length of the Predictor datagram transmitted over a PPP link is the same as the maximum length of the Information field of a PPP encapsulated packet.

Prior to compression, the uncompressed data begins with the PPP Protocol number. This value MAY be compressed when Protocol-Field-Compression is negotiated.

PPP Link Control Protocol packets MUST NOT be send within compressed data.

3.1. Predictor theory

Predictor works by filling a guess table with values, based on the hash of the previous characters seen. Since we are either emitting the source data, or depending on the guess table, we add a flag bit for every byte of input, telling the decompressor if it should retrieve the byte from the compressed data stream, or the guess table. Blocking the input into groups of 8 characters means that we don’t have to bit-insert the compressed output - a flag byte preceeds every 8 bytes of compressed data. Each bit of the flag byte corresponds to one byte of reconstructed data.

Take the source file:

```
000000    4141 4141 4141 410a  4141 4141 4141 410a    AAAAAAA.AAAAAAA.
000010    4141 4141 4141 410a  4141 4141 4141 410a    AAAAAAA.AAAAAAA.
000020    4142 4142 4142 410a  4241 4241 4241 420a    ABABABA.BABABAB.
000030    7878 7878 7878 780a                         xxxxxxx.
```

Compressing the above data yields the following:

```
000000    6041 4141 4141 0a60  4141 4141 410a 6f41    ‘AAAAA.‘AAAAA.oA
000010    0a6f 410a 4142 4142  4142 0a60 4241 4241    .oA.ABABAB.‘BABA
000020    420a 6078 7878 7878  0a                    B.‘xxxx.
```

Reading the above data says:

```
flag = 0x60 - 2 bytes in this block were guessed correctly, 5 and 6.
     Reconstructed data is:    0 1 2 3 4 5 6 7
        File:                  A A A A A
        Guess table:                     A A
flag = 0x60 - 2 bytes in this block were guessed correctly, 5 and 6.
     Reconstructed data is:    0 1 2 3 4 5 6 7
        File:                  A A A A A
        Guess table:                     A A
flag = 0x6f - 6 bytes in this block were guessed correctly, 0-3, 5 and 6.
     Reconstructed data is:    0 1 2 3 4 5 6 7
        File:                        A
        Guess table:           A A A A   A A
flag = 0x6f - 6 bytes in this block were guessed correctly, 0-3, 5 and 6.
     Reconstructed data is:    0 1 2 3 4 5 6 7
        File:                        A
        Guess table:           A A A A   A A
flag = 0x41 - 2 bytes in this block were guessed correctly, 0 and 6.
     Reconstructed data is:    0 1 2 3 4 5 6 7
        File:                    B A B A B
        Guess table:           A           A
flag = 0x60 - 2 bytes in this block were guessed correctly, 5 and 6.
     Reconstructed data is:    0 1 2 3 4 5 6 7
        File:                  B A B A B
        Guess table:                     A B
flag = 0x60 - 2 bytes in this block were guessed correctly, 5 and 6
     Reconstructed data is:    0 1 2 3 4 5 6 7
        File:                  x x x x x
        Guess table:                     x x
```

And now, on to the source - note that it has been modified to work with a split block. If your data stream can’t be split within a block (e.g., compressing packets), then the code dealing with "final", and the memcpy are not required. You can detect this situation (or errors, for that matter) by observing that the flag byte indicates that more data is required from the compressed data stream, but you are out of data (len in decompress is <= 0). It *is* ok if len == 0, and flags indicate guess table usage.

```
#include <stdio.h>
#ifdef __STDC__
```

```
#include <stdlib.h>
#endif
#include <string.h>
/*
 * pred.c -- Test program for Dave Rand's rendition of the
 * predictor algorithm
 * Updated by: iand@labtam.labtam.oz.au (Ian Donaldson)
 * Updated by: Carsten Bormann <cabo@cs.tu-berlin.de>
 * Original  : Dave Rand <dlr@bungi.com>/<dave_rand@novell.com>
 */

/* The following hash code is the heart of the algorithm:
 * It builds a sliding hash sum of the previous 3-and-a-bit
 * characters which will be used to index the guess table.
 * A better hash function would result in additional compression,
 * at the expense of time.
 */
#define HASH(x) Hash = (Hash << 4) ^ (x)

static unsigned short int Hash;
static unsigned char GuessTable[65536];

static int
compress(source, dest, len)
unsigned char *source, *dest;
int len;
{
    int i, bitmask;
    unsigned char *flagdest, flags, *orgdest;

    orgdest = dest;
    while (len) {
        flagdest = dest++; flags = 0; /* All guess wrong initially */
        for (bitmask=1, i=0; i < 8 && len; i++, bitmask <<= 1) {
            if (GuessTable[Hash] == *source) {
                flags |= bitmask; /* Guess was right - don't output */
            } else {
                GuessTable[Hash] = *source;
                *dest++ = *source; /* Guess wrong, output char */
            }
            HASH(*source++);len--;
        }
        *flagdest = flags;
    }
    return(dest - orgdest);
}

static int
```

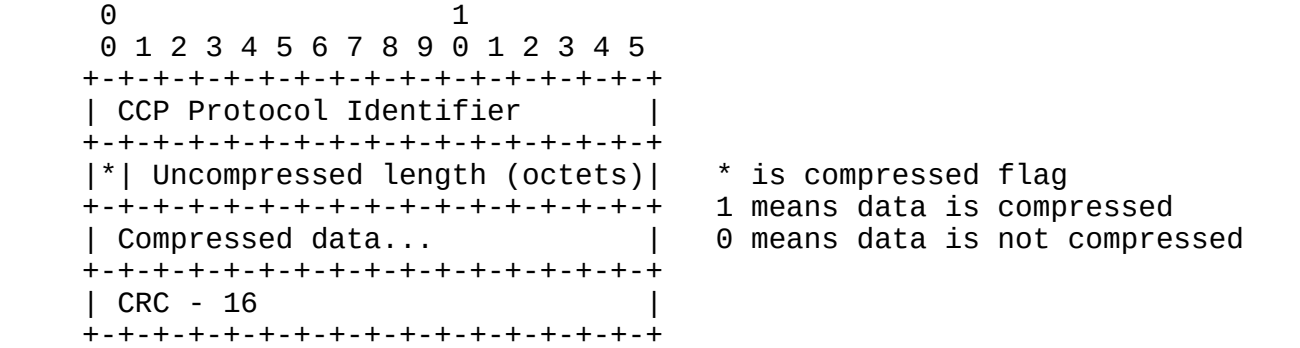
```
decompress(source, dest, lenp, final)
unsigned char *source, *dest;
int *lenp, final;
{
    int i, bitmask;
    unsigned char flags, *orgdest;
    int len = *lenp;
    orgdest = dest;
    while (len >= 9) {
        flags = *source++;
        for (i=0, bitmask = 1; i < 8; i++, bitmask <<= 1) {
            if (flags & bitmask) {
                *dest = GuessTable[Hash];       /* Guess correct */
            } else {
                GuessTable[Hash] = *source;     /* Guess wrong */
                *dest = *source++;          /* Read from source */
                len--;
            }
            HASH(*dest++);
        }
        len--;
    }
    while (final && len) {
        flags = *source++;
        len--;
        for (i=0, bitmask = 1; i < 8; i++, bitmask <<= 1) {
            if (flags & bitmask) {
                *dest = GuessTable[Hash];       /* Guess correct */
            } else {
                if (!len)
                    break;  /* we seem to be really done -- cabo */
                GuessTable[Hash] = *source;     /* Guess wrong */
                *dest = *source++;          /* Read from source */
                len--;
            }
            HASH(*dest++);
        }
    }
    *lenp = len;
    return(dest - orgdest);
}

#define SIZ1 8192

static void
compress_file(f) FILE *f; {
    char bufp[SIZ1];
    char bufc[SIZ1/8*9+9];
```

```
        int len1, len2;
        while ((len1 = fread(bufp, 1, SIZ1, f)) > 0) {
            len2 = compress((unsigned char *)bufp,
            (unsigned char *)bufc, len1);
            (void) fwrite(bufc, 1, len2, stdout);
        }
    }

    static void
    decompress_file(f) FILE *f; {
        char bufp[SIZ1+9];
        char bufc[SIZ1*9+9];
        int len1, len2, len3;

        len1 = 0;
        while ((len3 = fread(bufp+len1, 1, SIZ1, f)) > 0) {
            len1 += len3;
            len3 = len1;
            len2 = decompress((unsigned char *)bufp,
            (unsigned char *)bufc, &len1, 0);
            (void) fwrite(bufc, 1, len2, stdout);
            (void) memcpy(bufp, bufp+len3-len1, len1);
        }
        len2 = decompress((unsigned char *)bufp,
        (unsigned char *)bufc, &len1, 1);
        (void) fwrite(bufc, 1, len2, stdout);
    }

    int
    main(ac, av)
        int ac;
        char** av;
    {
        char **p = av+1;
        int dflag = 0;

        for (; --ac > 0; p++) {
            if (!strcmp(*p, "-d"))
                dflag = 1;
            else if (!strcmp(*p, "-"))
                (dflag?decompress_file:compress_file)(stdin);
            else {
                FILE *f = fopen(*p, "r");
                if (!f) {
                    perror(*p);
                    exit(1);
                }
                (dflag?decompress_file:compress_file)(f);
```

```
                (void) fclose(f);
            }
        }
        return(0);
    }
```

3.2. Encapsulation for Predictor type 1

The correct encapsulation for type 1 compression is the protocol type, 1 bit indicating if the data is compressed or not, 15 bits of the uncompressed data length in octets, compressed data, and uncompressed CRC-16 of the two octets of unsigned length in network byte order, followed by the original, uncompressed data packet.



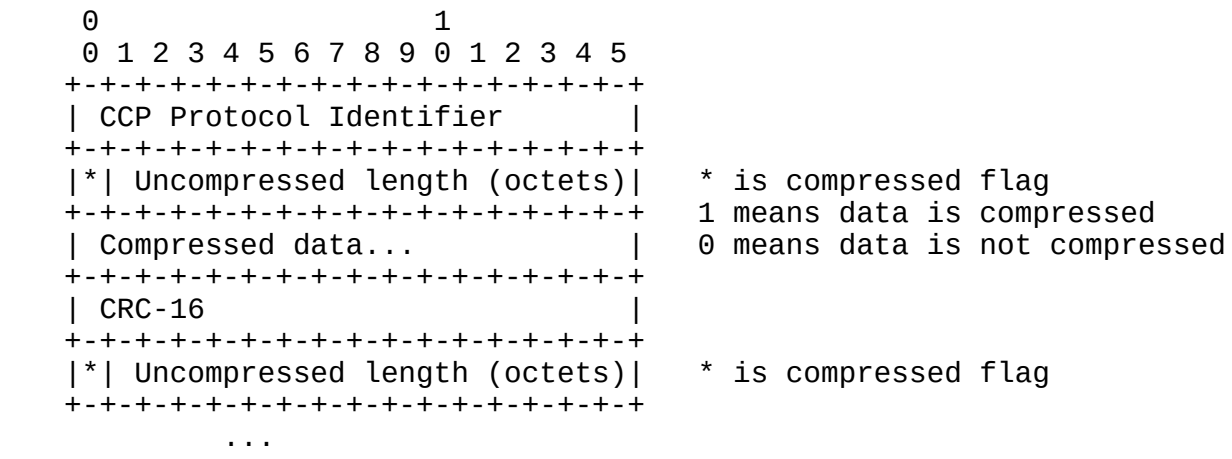
The CCP Protocol Identifier that starts the packet is always 0xfd. If PPP Protocol field compression has not be negotiated, it MUST be a 16-bit field.

The Compressed data is the Protocol Identifier and the Info fields of the original PPP packet described in [1], but not the Address, Control, FCS, or Flag. The CCP Protocol field MAY be compressed as described in [1], regardless of whether the Protocol field of the CCP Protocol Identifier is compressed or whether PPP Protocol field compression has been negotiated.

It is not required that any of the fields land on an even word boundary - the compressed data may be of any length. If during the decode procedure, the CRC-16 does not match the decoded frame, it means that the compress or decompress process has become desyncronized. This will happen as a result of a frame being lost in transit if LAPB is not used. In this case, a new configure-request must be sent, and the CCP will drop out of the open state. Upon receipt of the configure-ack, the predictor tables are cleared to zero, and compression can be resumed without data loss.

3.3. Encapsulation for Predictor type 2

The correct encapsulation for type 2 compression is the protocol type, followed by the data stream. Within the data stream is the current frame length (uncompressed), compressed data, and uncompressed CRC-16 of the two octets of unsigned length in network byte order, followed by the original, uncompressed data. The data stream may be broken at any convenient place for encapsulation purposes. With type 2 encapsulation, LAPB is almost essential for correct delivery.



The CCP Protocol Identifier that starts the packet is always 0xfd. If PPP Protocol field compression has not be negotiated, it MUST be a 16-bit field.

The Compressed data is the Protocol Identifier and the Info fields of the original PPP packet described in [1], but not the Address, Control, FCS, or Flag. The CCP Protocol field MAY be compressed as described in [1], regardless of whether the Protocol field of the CCP Protocol Identifier is compressed or whether PPP Protocol field compression

It is not required that any field land on an even word boundary - the compressed data may be of any length. If during the decode procedure, the CRC-16 does not match the decoded frame, it means that the compress or decompress process has become desyncronized. This will happen as a result of a frame being lost in transit if LAPB is not used. In this case, a new configure-request must be sent, and the CCP will drop out of the open state. Upon receipt of the configure-ack, the predictor tables are cleared to zero, and compression can be resumed without data loss.

4. Configuration Option Format

There are no options for Predictor type one or two.

Security Considerations

Security issues are not discussed in this memo.

References

[1] Simpson, W., "The Point-to-Point Protocol", STD 51, RFC 1661, July 1994.

[2] Rand, D., "The PPP Compression Control Protocol (CCP)", RFC 1962, June 1996.

[3] Rand, D., "PPP Reliable Transmission", RFC 1663, July 1994.

Acknowledgments

The predictor algorithm was originally implemented by Timo Raita, at the ACM SIG Conference, New Orleans, 1987.

Bill Simpson helped with the document formatting.

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