PACTOR-2/3/4

Advanced Data Compression:

Huffman/PMC decoder, RLE

PACTOR Advanced Data Compression

P2, P3 and P4 use automatic on-line data compression comprising Huffman and run-length encoding as well as Pseudo-Markov Compression (PMC, see below). The information sending system (ISS) automatically checks, whether one of these compression modes or the original ASCII code leads to the shortest data package, which depends on the probability of occurrence of the characters. Hence, there is no risk of losing throughput capacity. Of course, PACTOR is still capable to transfer any given binary information, e.g. programs or picture and voice files. In case of a binary data transfer, the on-line data compression normally switches off automatically due to the character distribution. An external data compression in the terminal program is usually performed instead.

Huffman compression exploits the "one-dimensional" probability distribution of the characters in plain texts. The more frequently a character occurs, the shorter its Huffman symbol has to be.

Markov compression can be considered as a "double" Huffman compression, since it not only makes use of the simple probability distribution, but of the "two-dimensional" probability. For each preceding character, a probability distribution of the very next character can be calculated. For example, if the actual character is "e", it is very likely that "i" or "s" occurs next, but extremely unlikely that an "X" follows. The resulting probability distributions are much more concentrated than the simple one-dimensional distribution and thus lead to a considerably better compression. Unfortunately, there are two drawbacks: Since for each ASCII character a separate coding table is required, the entire Markov coding table becomes impractically large. Additionally, the two-dimensional distribution and thus the achievable compression factor depends much more on the kind of text than the simple character distribution. We have therefore chosen a slightly modified approach which we called Pseudo-Markov Compression (PMC), because it can be considered as a hybrid between Markov- and Huffman encoding. In PMC, the Markov encoding is limited to the 16 most frequent "preceding" characters. All other characters trigger normal Huffman compression of the very next character. This reduces the Markov coding table to a reasonable size and also makes the character probabilities less critical, since especially the less frequent characters tend to have unstable probability distributions. Nevertheless, for optimum compression, two different tables for English and German texts are defined in the PACTOR-II and -III protocols and automatically chosen. When transferring plain text, PMC yields a compression factor of around 1.9 compared to 8-bit ASCII.

Run-length encoding (RLE) allows the effective compression of longer sequences of identical bytes. The special prefix byte "0x1D" is defined, which initiates a 3 byte run length code. The second byte is called the "code byte" and contains the original code of the transferred byte within the range of the entire ASCII character set. The third byte provides the number of code bytes to be displayed on the receiving side within the range between "0x01" to "0x60". Values between "0x00" and "0x1f" are transferred as "0x60" to "0x7f", values between "0x20" and "0x60" are transferred without any change. For example, the sequence "AAAAAAAA" is transferred using the 3 byte run-length code "0x1D 0x41 0x68".

Example Source Code Routines

```c
#define IDLE 0x1E

/******************************************************************
* printr
*
* generic data output routine
******************************************************************/

void printr(unsigned char outbyte)
{

      // put outbyte to display or whatever output device

      // printf("%c",outbyte);

}


/******************************************************************
 * ascii_decoder
 *
 * rxpackx: pointer to start of original (encoded) data field
 * rxlen: number of bytes contained in original (encoded) data field
 ******************************************************************/

 void ascii_decoder(unsigned char *rxpackx, unsigned int rxlen)
 {
      unsigned int i;

      for(i=0;i<rxlen;i++)
      {
            if (rxpackx[i]!=IDLE)
            {
            printr(rxpackx[i]);

            }
      }
 }
```

```c
/*******************************************************************
 * huffman_decoder
 *
 * rxpackx: pointer to start of original (encoded) data field
 * rxlen: number of bytes contained in original (encoded) data field
 *******************************************************************/

void huffman_decoder(unsigned char *rxpackx,unsigned int rxlen)
{
    unsigned int i,j;
    unsigned short offset;
    unsigned char curbyte,outbyte;

    offset=0;

    for(i=0;i<rxlen;i++)
    {
        curbyte=rxpackx[i];            // next input byte

        for(j=0;j<8;j++)
        {
            if(curbyte&1)
                offset+=2;
            offset=huftab[offset>>1];
            curbyte>>=1;

            if (offset>767)          // data ready?
            {
                outbyte=offset&0xff;
                if(outbyte!=IDLE)
                {
                    printr(outbyte);

                }
                else

                offset=0;          // next output byte

            }

        }

    }
}
```

```c
/******************************************************************
 * pmc_decoder
 *
 * rxpackx: pointer to start of original (encoded) data field
 * rxlen: number of bytes contained in original (encoded) data field
 * english: 0=German data, 1=English data
 ******************************************************************/

 void pmc_decoder(unsigned char *rxpackx,unsigned int rxlen,
                  unsigned char english)
{
    unsigned int i,j;
    unsigned short table_offset=0,offset=0;
    unsigned char curbyte,outbyte;

    for(i=0;i<rxlen;i++)
    {
        curbyte=rxpackx[i];             // next input byte

        for(j=0;j<8;j++)
        {
            if(curbyte&1)
                offset+=2;
            offset=huftab[(table_offset+offset)>>1];
            curbyte>>=1;

            if (offset>767)             // data ready?
            {
                outbyte=offset&0xff;

                table_offset=reftab[outbyte];
                if (table_offset)
                {
                    if(english)
                        table_offset+=8128;

                }

                if(outbyte!=IDLE)
                {
                    printr(outbyte);
                }

                offset=0;               // next output byte

            }

        }

    }
}
```

```
//===================================================================

// Huffman/PMC-Decoding tables

unsigned short huftab[]=
                {
                4,8,12,16,800,20,24,28,32,869,36,40,
                44,48,52,56,60,878,64,873,882,68,884,72,
                76,80,883,84,88,868,865,92,96,100,104,885,
                876,108,872,112,116,871,120,877,781,778,879,867,
                124,128,132,136,140,144,866,870,148,152,887,836,
                156,875,160,164,890,168,814,812,172,176,180,184,
                188,851,192,196,200,204,208,833,837,212,880,886,
                216,816,838,220,224,834,228,835,841,232,852,236,
                847,240,244,248,848,252,256,260,817,264,850,268,
                272,276,280,808,809,844,846,284,858,288,845,292,
                825,296,855,821,889,300,818,819,820,822,823,824,
                840,304,842,853,854,796,888,308,843,831,829,312,
                316,320,881,849,874,839,324,813,328,826,332,336,
                340,344,348,801,815,352,356,360,810,364,802,805,
                807,368,863,372,376,380,384,806,811,830,832,804,
                828,856,388,803,392,396,400,404,408,412,416,420,
                424,428,432,857,436,440,444,448,827,860,452,456,
                460,464,468,472,476,480,484,488,492,496,500,504,
                859,861,895,894,893,892,891,864,862,799,797,795,
                793,792,791,790,789,788,787,786,785,784,798,783,
                782,780,779,777,776,775,774,773,772,771,770,769,
                768,794,

            //   german rx-markov-table follows

                4,8,12,800,16,20,24,28,32,36,868,40,
                44,48,52,56,60,869,64,68,72,76,80,84,
                88,865,92,883,96,100,104,108,887,885,112,116,
                866,890,873,120,836,848,124,851,128,886,833,132,
                877,136,834,140,845,871,144,148,152,837,878,870,
                156,854,160,875,850,164,168,838,172,176,852,180,
                843,184,188,192,844,872,196,200,204,839,840,808,
                208,876,212,835,879,817,216,781,220,224,841,855,
                874,784,228,232,882,236,853,880,240,244,818,867,
                822,248,252,813,858,256,811,820,821,824,847,856,
                859,260,264,884,268,790,819,846,272,825,276,280,
                284,288,881,292,823,842,296,300,304,308,312,316,
                320,324,807,816,888,328,332,336,340,344,348,352,
                356,360,364,368,372,376,380,384,388,392,396,400,
                404,408,412,416,420,424,428,432,436,440,444,448,
                452,456,460,464,468,472,476,480,484,488,492,496,
                500,504,768,769,770,771,772,773,774,775,776,777,
                778,779,780,782,783,785,786,787,788,789,791,792,
                793,794,795,796,797,798,799,801,802,803,804,805,
                806,809,810,812,814,815,826,827,828,829,830,831,
                832,849,857,860,861,862,863,864,889,891,892,893,
                894,895,
                4,8,12,16,882,878,20,873,24,800,28,32,
                36,883,40,44,876,48,884,52,56,877,60,64,
                68,72,76,872,866,80,84,871,870,781,868,88,
                867,885,92,875,96,100,104,812,108,813,888,112,
                881,890,116,814,887,791,120,880,124,869,865,886,
                128,132,136,140,144,148,152,156,160,164,809,879,
                168,172,176,180,184,188,192,196,200,204,208,212,
                216,220,224,228,232,236,240,244,248,252,256,260,
                264,268,272,276,280,284,288,292,296,300,304,308,
                312,316,320,324,328,332,336,340,344,348,352,356,
```

360,364,368,372,376,380,384,388,392,396,400,404,
408,412,416,420,424,428,432,436,440,444,448,452,
456,460,464,468,472,476,480,484,488,492,496,500,
504,768,769,770,771,772,773,774,775,776,777,778,
779,780,782,783,784,785,786,787,788,789,790,792,
793,794,795,796,797,798,799,801,802,803,804,805,
806,807,808,810,811,815,816,817,818,819,820,821,
822,823,824,825,826,827,828,829,830,831,832,833,
834,835,836,837,838,839,840,841,842,843,844,845,
846,847,848,849,850,851,852,853,854,855,856,857,
858,859,860,861,862,863,864,874,889,891,892,893,
894,895,
4,8,12,800,16,20,24,871,28,868,32,869,
36,40,44,884,48,52,878,56,883,60,865,814,
64,885,812,873,68,890,72,781,76,80,84,875,
88,872,879,92,870,96,876,100,813,104,108,112,
866,886,116,783,120,124,887,128,784,880,877,132,
136,140,809,826,882,144,148,152,156,160,164,168,
807,867,172,176,180,184,188,192,196,200,204,208,
212,216,220,224,228,232,236,240,244,248,252,256,
260,264,268,272,276,280,284,288,292,296,300,304,
308,312,316,320,324,328,332,336,340,344,348,352,
356,360,364,368,372,376,380,384,388,392,396,400,
404,408,412,416,420,424,428,432,436,440,444,448,
452,456,460,464,468,472,476,480,484,488,492,496,
500,504,768,769,770,771,772,773,774,775,776,777,
778,779,780,782,785,786,787,788,789,790,791,792,
793,794,795,796,797,798,799,801,802,803,804,805,
806,808,810,811,815,816,817,818,819,820,821,822,
823,824,825,827,828,829,830,831,832,833,834,835,
836,837,838,839,840,841,842,843,844,845,846,847,
848,849,850,851,852,853,854,855,856,857,858,859,
860,861,862,863,864,874,881,888,889,891,892,893,
894,895,
4,8,12,16,869,878,20,24,884,28,32,871,
36,867,883,40,44,879,876,48,877,52,882,56,
886,60,800,64,875,68,72,880,76,865,80,866,
868,84,88,92,872,96,100,781,104,813,890,108,
870,112,116,120,124,791,885,128,132,136,140,144,
148,152,815,873,888,156,160,164,168,172,176,180,
184,188,192,196,200,204,208,212,216,220,224,228,
232,236,240,244,248,252,256,260,264,268,272,276,
280,284,288,292,296,300,304,308,312,316,320,324,
328,332,336,340,344,348,352,356,360,364,368,372,
376,380,384,388,392,396,400,404,408,412,416,420,
424,428,432,436,440,444,448,452,456,460,464,468,
472,476,480,484,488,492,496,500,504,768,769,770,
771,772,773,774,775,776,777,778,779,780,782,783,
784,785,786,787,788,789,790,792,793,794,795,796,
797,798,799,801,802,803,804,805,806,807,808,809,
810,811,812,814,816,817,818,819,820,821,822,823,
824,825,826,827,828,829,830,831,832,833,834,835,
836,837,838,839,840,841,842,843,844,845,846,847,
848,849,850,851,852,853,854,855,856,857,858,859,
860,861,862,863,864,874,881,887,889,891,892,893,
894,895,
4,8,12,800,16,20,24,28,32,869,36,40,
44,48,868,879,873,52,884,56,865,60,883,64,
68,72,885,76,866,870,878,80,84,781,890,871,
88,877,92,867,96,875,887,813,100,876,104,814,
872,783,812,108,112,882,784,116,120,880,124,128,
132,809,136,140,144,148,152,156,160,164,168,172,
176,180,184,188,192,196,200,204,208,212,216,220,

224,228,232,236,240,244,248,252,256,260,264,268,
272,276,280,284,288,292,296,300,304,308,312,316,
320,324,328,332,336,340,344,348,352,356,360,364,
368,372,376,380,384,388,392,396,400,404,408,412,
416,420,424,428,432,436,440,444,448,452,456,460,
464,468,472,476,480,484,488,492,496,500,504,768,
769,770,771,772,773,774,775,776,777,778,779,780,
782,785,786,787,788,789,790,791,792,793,794,795,
796,797,798,799,801,802,803,804,805,806,807,808,
810,811,815,816,817,818,819,820,821,822,823,824,
825,826,827,828,829,830,831,832,833,834,835,836,
837,838,839,840,841,842,843,844,845,846,847,848,
849,850,851,852,853,854,855,856,857,858,859,860,
861,862,863,864,874,881,886,888,889,891,892,893,
894,895,
4,8,12,869,16,800,20,24,28,873,32,36,
882,40,44,865,48,52,56,890,885,814,60,64,
68,884,812,883,813,72,887,76,879,80,781,84,
876,88,92,96,870,100,104,108,880,112,784,872,
116,120,783,124,866,867,871,128,809,878,132,875,
877,886,889,136,140,144,826,148,152,156,160,164,
168,807,172,176,180,184,188,192,196,200,204,208,
212,216,220,224,228,232,236,240,244,248,252,256,
260,264,268,272,276,280,284,288,292,296,300,304,
308,312,316,320,324,328,332,336,340,344,348,352,
356,360,364,368,372,376,380,384,388,392,396,400,
404,408,412,416,420,424,428,432,436,440,444,448,
452,456,460,464,468,472,476,480,484,488,492,496,
500,504,768,769,770,771,772,773,774,775,776,777,
778,779,780,782,785,786,787,788,789,790,791,792,
793,794,795,796,797,798,799,801,802,803,804,805,
806,808,810,811,815,816,817,818,819,820,821,822,
823,824,825,827,828,829,830,831,832,833,834,835,
836,837,838,839,840,841,842,843,844,845,846,847,
848,849,850,851,852,853,854,855,856,857,858,859,
860,861,862,863,864,868,874,881,888,891,892,893,
894,895,
4,8,12,16,20,884,800,24,28,869,32,36,
867,873,883,879,40,44,880,48,52,56,865,60,
64,68,72,76,781,813,80,871,885,84,88,886,
887,92,870,812,96,866,100,814,104,875,108,889,
882,890,112,876,116,120,868,877,124,872,878,128,
132,136,140,807,826,144,148,152,156,160,164,168,
172,176,180,184,188,192,196,200,204,208,212,216,
220,224,228,232,236,240,244,248,252,256,260,264,
268,272,276,280,284,288,292,296,300,304,308,312,
316,320,324,328,332,336,340,344,348,352,356,360,
364,368,372,376,380,384,388,392,396,400,404,408,
412,416,420,424,428,432,436,440,444,448,452,456,
460,464,468,472,476,480,484,488,492,496,500,504,
768,769,770,771,772,773,774,775,776,777,778,779,
780,782,783,784,785,786,787,788,789,790,791,792,
793,794,795,796,797,798,799,801,802,803,804,805,
806,808,809,810,811,815,816,817,818,819,820,821,
822,823,824,825,827,828,829,830,831,832,833,834,
835,836,837,838,839,840,841,842,843,844,845,846,
847,848,849,850,851,852,853,854,855,856,857,858,
859,860,861,862,863,864,874,881,888,891,892,893,
894,895,
4,869,8,12,873,800,16,20,24,865,28,885,
32,876,36,40,882,44,48,781,52,879,56,60,
887,64,812,813,68,814,866,72,76,80,878,883,
84,88,92,889,96,100,104,108,784,872,875,886,

890,112,116,120,124,128,132,136,140,144,148,152,
156,160,164,168,172,176,180,184,188,192,196,200,
204,208,212,216,220,224,228,232,236,240,244,248,
252,256,260,264,268,272,276,280,284,288,292,296,
300,304,308,312,316,320,324,328,332,336,340,344,
348,352,356,360,364,368,372,376,380,384,388,392,
396,400,404,408,412,416,420,424,428,432,436,440,
444,448,452,456,460,464,468,472,476,480,484,488,
492,496,500,504,768,769,770,771,772,773,774,775,
776,777,778,779,780,782,783,785,786,787,788,789,
790,791,792,793,794,795,796,797,798,799,801,802,
803,804,805,806,807,808,809,810,811,815,816,817,
818,819,820,821,822,823,824,825,826,827,828,829,
830,831,832,833,834,835,836,837,838,839,840,841,
842,843,844,845,846,847,848,849,850,851,852,853,
854,855,856,857,858,859,860,861,862,863,864,867,
868,870,871,874,877,880,881,884,888,891,892,893,
894,895,
4,8,12,16,20,878,24,885,876,28,884,32,
882,36,40,44,883,48,867,52,877,56,866,60,
64,800,872,868,68,72,875,871,791,76,80,84,
88,889,888,92,873,890,96,781,870,880,814,100,
104,108,813,112,116,120,124,815,886,128,132,136,
140,144,148,152,156,160,164,168,172,176,180,184,
188,192,196,200,204,208,212,216,220,224,228,232,
236,240,244,248,252,256,260,264,268,272,276,280,
284,288,292,296,300,304,308,312,316,320,324,328,
332,336,340,344,348,352,356,360,364,368,372,376,
380,384,388,392,396,400,404,408,412,416,420,424,
428,432,436,440,444,448,452,456,460,464,468,472,
476,480,484,488,492,496,500,504,768,769,770,771,
772,773,774,775,776,777,778,779,780,782,783,784,
785,786,787,788,789,790,792,793,794,795,796,797,
798,799,801,802,803,804,805,806,807,808,809,810,
811,812,816,817,818,819,820,821,822,823,824,825,
826,827,828,829,830,831,832,833,834,835,836,837,
838,839,840,841,842,843,844,845,846,847,848,849,
850,851,852,853,854,855,856,857,858,859,860,861,
862,863,864,865,869,874,879,881,887,891,892,893,
894,895,
4,878,8,12,16,20,24,883,28,882,870,32,
36,40,800,44,877,48,867,884,869,52,56,876,
791,871,60,813,64,68,880,72,868,76,80,84,
865,875,88,866,872,873,92,96,885,100,104,108,
112,812,890,116,120,124,128,132,136,140,144,148,
152,156,160,164,168,172,176,180,184,188,192,196,
200,204,208,212,216,220,224,228,232,236,240,244,
248,252,256,260,264,268,272,276,280,284,288,292,
296,300,304,308,312,316,320,324,328,332,336,340,
344,348,352,356,360,364,368,372,376,380,384,388,
392,396,400,404,408,412,416,420,424,428,432,436,
440,444,448,452,456,460,464,468,472,476,480,484,
488,492,496,500,504,768,769,770,771,772,773,774,
775,776,777,778,779,780,781,782,783,784,785,786,
787,788,789,790,792,793,794,795,796,797,798,799,
801,802,803,804,805,806,807,808,809,810,811,814,
815,816,817,818,819,820,821,822,823,824,825,826,
827,828,829,830,831,832,833,834,835,836,837,838,
839,840,841,842,843,844,845,846,847,848,849,850,
851,852,853,854,855,856,857,858,859,860,861,862,
863,864,874,879,881,886,887,888,889,891,892,893,
894,895,
4,8,869,12,16,20,876,24,28,873,32,884,

36,40,865,883,44,800,48,879,52,885,56,60,
64,68,867,72,76,80,84,868,88,871,866,92,
781,96,783,812,814,100,104,870,880,813,108,112,
116,120,784,878,882,887,124,128,132,826,875,886,
889,136,140,144,791,809,872,890,148,152,156,160,
164,168,172,176,180,184,188,192,196,200,204,208,
212,216,220,224,228,232,236,240,244,248,252,256,
260,264,268,272,276,280,284,288,292,296,300,304,
308,312,316,320,324,328,332,336,340,344,348,352,
356,360,364,368,372,376,380,384,388,392,396,400,
404,408,412,416,420,424,428,432,436,440,444,448,
452,456,460,464,468,472,476,480,484,488,492,496,
500,504,768,769,770,771,772,773,774,775,776,777,
778,779,780,782,785,786,787,788,789,790,792,793,
794,795,796,797,798,799,801,802,803,804,805,806,
807,808,810,811,815,816,817,818,819,820,821,822,
823,824,825,827,828,829,830,831,832,833,834,835,
836,837,838,839,840,841,842,843,844,845,846,847,
848,849,850,851,852,853,854,855,856,857,858,859,
860,861,862,863,864,874,877,881,888,891,892,893,
894,895,
4,8,12,16,869,800,20,24,28,32,36,882,
865,40,878,884,44,876,48,52,56,873,60,879,
64,68,72,781,883,885,76,887,80,84,783,814,
88,877,870,890,812,813,875,92,866,96,100,104,
871,108,112,784,827,868,116,120,124,128,132,136,
140,144,148,152,156,160,164,168,172,176,180,184,
188,192,196,200,204,208,212,216,220,224,228,232,
236,240,244,248,252,256,260,264,268,272,276,280,
284,288,292,296,300,304,308,312,316,320,324,328,
332,336,340,344,348,352,356,360,364,368,372,376,
380,384,388,392,396,400,404,408,412,416,420,424,
428,432,436,440,444,448,452,456,460,464,468,472,
476,480,484,488,492,496,500,504,768,769,770,771,
772,773,774,775,776,777,778,779,780,782,785,786,
787,788,789,790,791,792,793,794,795,796,797,798,
799,801,802,803,804,805,806,807,808,809,810,811,
815,816,817,818,819,820,821,822,823,824,825,826,
828,829,830,831,832,833,834,835,836,837,838,839,
840,841,842,843,844,845,846,847,848,849,850,851,
852,853,854,855,856,857,858,859,860,861,862,863,
864,867,872,874,880,881,886,888,889,891,892,893,
894,895,
4,8,869,12,800,16,20,24,28,883,32,36,
40,44,884,885,876,873,882,48,865,878,52,56,
814,875,60,781,64,812,68,866,72,813,76,80,
784,84,88,92,877,96,100,104,870,871,879,890,
108,112,116,120,124,128,132,136,140,144,148,152,
156,160,164,168,172,176,180,184,188,192,196,200,
204,208,212,216,220,224,228,232,236,240,244,248,
252,256,260,264,268,272,276,280,284,288,292,296,
300,304,308,312,316,320,324,328,332,336,340,344,
348,352,356,360,364,368,372,376,380,384,388,392,
396,400,404,408,412,416,420,424,428,432,436,440,
444,448,452,456,460,464,468,472,476,480,484,488,
492,496,500,504,768,769,770,771,772,773,774,775,
776,777,778,779,780,782,783,785,786,787,788,789,
790,791,792,793,794,795,796,797,798,799,801,802,
803,804,805,806,807,808,809,810,811,815,816,817,
818,819,820,821,822,823,824,825,826,827,828,829,
830,831,832,833,834,835,836,837,838,839,840,841,
842,843,844,845,846,847,848,849,850,851,852,853,
854,855,856,857,858,859,860,861,862,863,864,867,

868,872,874,880,881,886,887,888,889,891,892,893,
894,895,
4,8,12,800,16,20,24,873,28,865,32,869,
877,36,40,44,48,880,52,885,884,56,781,783,
883,60,64,68,72,76,879,813,80,84,88,866,
784,876,92,870,96,791,812,854,868,886,100,855,
871,104,108,814,826,112,116,120,124,128,132,136,
140,144,148,152,156,160,164,168,172,176,180,184,
188,192,196,200,204,208,212,216,220,224,228,232,
236,240,244,248,252,256,260,264,268,272,276,280,
284,288,292,296,300,304,308,312,316,320,324,328,
332,336,340,344,348,352,356,360,364,368,372,376,
380,384,388,392,396,400,404,408,412,416,420,424,
428,432,436,440,444,448,452,456,460,464,468,472,
476,480,484,488,492,496,500,504,768,769,770,771,
772,773,774,775,776,777,778,779,780,782,785,786,
787,788,789,790,792,793,794,795,796,797,798,799,
801,802,803,804,805,806,807,808,809,810,811,815,
816,817,818,819,820,821,822,823,824,825,827,828,
829,830,831,832,833,834,835,836,837,838,839,840,
841,842,843,844,845,846,847,848,849,850,851,852,
853,856,857,858,859,860,861,862,863,864,867,872,
874,875,878,881,882,887,888,889,890,891,892,893,
894,895,
4,8,12,16,20,878,24,28,882,32,36,40,
877,44,868,876,871,48,867,52,56,884,60,64,
883,800,68,887,890,870,72,872,880,76,80,866,
813,84,88,92,888,96,869,100,791,104,835,875,
886,108,112,781,885,116,120,812,865,879,124,128,
132,136,140,144,148,152,156,160,164,168,172,176,
180,184,188,192,196,200,204,208,212,216,220,224,
228,232,236,240,244,248,252,256,260,264,268,272,
276,280,284,288,292,296,300,304,308,312,316,320,
324,328,332,336,340,344,348,352,356,360,364,368,
372,376,380,384,388,392,396,400,404,408,412,416,
420,424,428,432,436,440,444,448,452,456,460,464,
468,472,476,480,484,488,492,496,500,504,768,769,
770,771,772,773,774,775,776,777,778,779,780,782,
783,784,785,786,787,788,789,790,792,793,794,795,
796,797,798,799,801,802,803,804,805,806,807,808,
809,810,811,814,815,816,817,818,819,820,821,822,
823,824,825,826,827,828,829,830,831,832,833,834,
836,837,838,839,840,841,842,843,844,845,846,847,
848,849,850,851,852,853,854,855,856,857,858,859,
860,861,862,863,864,873,874,881,889,891,892,893,
894,895,
872,4,8,875,12,16,869,20,879,24,28,865,
32,884,36,781,876,40,44,877,48,52,814,889,
56,60,64,68,72,76,80,84,88,92,96,100,
104,108,112,116,120,124,128,132,136,140,144,148,
152,156,160,164,168,172,176,180,184,188,192,196,
200,204,208,212,216,220,224,228,232,236,240,244,
248,252,256,260,264,268,272,276,280,284,288,292,
296,300,304,308,312,316,320,324,328,332,336,340,
344,348,352,356,360,364,368,372,376,380,384,388,
392,396,400,404,408,412,416,420,424,428,432,436,
440,444,448,452,456,460,464,468,472,476,480,484,
488,492,496,500,504,768,769,770,771,772,773,774,
775,776,777,778,779,780,782,783,784,785,786,787,
788,789,790,791,792,793,794,795,796,797,798,799,
800,801,802,803,804,805,806,807,808,809,810,811,
812,813,815,816,817,818,819,820,821,822,823,824,
825,826,827,828,829,830,831,832,833,834,835,836,

```
837,838,839,840,841,842,843,844,845,846,847,848,
849,850,851,852,853,854,855,856,857,858,859,860,
861,862,863,864,866,867,868,870,871,873,874,878,
880,881,882,883,885,886,887,888,890,891,892,893,
894,895,

// english markov table follows

4,8,12,16,800,20,24,28,32,884,36,40,
44,48,865,52,56,60,64,879,68,873,72,883,
867,76,80,84,866,88,887,92,96,880,877,100,
868,104,108,870,781,112,882,116,869,120,124,876,
128,848,878,872,885,132,833,136,140,144,852,148,
152,156,160,164,836,817,840,168,172,838,176,180,
851,184,808,850,886,188,835,871,192,841,845,196,
200,204,818,208,834,212,807,216,220,224,821,839,
875,228,837,874,881,232,236,240,854,244,824,843,
889,248,252,819,846,849,256,820,855,822,825,844,
847,853,260,264,268,272,276,842,280,813,284,288,
292,296,300,304,308,312,816,858,890,316,320,324,
328,332,336,340,344,348,352,356,360,364,368,372,
376,810,811,380,384,388,392,396,400,404,408,412,
416,420,424,428,432,436,440,444,448,452,456,460,
464,468,472,476,480,484,488,492,496,500,504,768,
769,770,771,772,773,774,775,776,777,778,779,780,
782,783,784,785,786,787,788,789,790,791,792,793,
794,795,796,797,798,799,801,802,803,804,805,806,
809,812,814,815,823,826,827,828,829,830,831,832,
856,857,859,860,861,862,863,864,888,891,892,893,
894,895,
4,8,800,12,16,20,24,882,28,32,883,36,
878,40,868,44,48,52,56,865,60,867,877,64,
884,68,876,72,76,886,80,869,84,88,881,814,
92,781,870,812,888,96,813,873,889,880,887,100,
104,108,885,112,116,120,124,128,871,132,136,140,
866,872,879,144,807,148,152,156,160,164,168,809,
826,172,176,180,184,188,192,196,200,204,208,212,
216,831,220,224,228,232,236,240,244,248,252,256,
260,264,268,272,276,280,284,288,292,296,300,304,
308,312,316,320,324,328,332,336,340,344,348,352,
356,360,364,368,372,376,380,384,388,392,396,400,
404,408,412,416,420,424,428,432,436,440,444,448,
452,456,460,464,468,472,476,480,484,488,492,496,
500,504,768,769,770,771,772,773,774,775,776,777,
778,779,780,782,783,784,785,786,787,788,789,790,
791,792,793,794,795,796,797,798,799,801,802,803,
804,805,806,808,810,811,815,816,817,818,819,820,
821,822,823,824,825,827,828,829,830,832,833,834,
835,836,837,838,839,840,841,842,843,844,845,846,
847,848,849,850,851,852,853,854,855,856,857,858,
859,860,861,862,863,864,874,875,890,891,892,893,
894,895,
4,8,12,16,800,20,24,28,32,868,871,36,
884,40,865,869,883,44,867,48,879,52,56,60,
64,876,68,72,873,870,76,889,813,878,781,80,
812,885,886,875,814,84,88,92,96,100,104,108,
112,116,120,124,128,132,880,136,140,144,148,152,
156,160,164,168,172,176,180,184,188,192,196,200,
204,208,212,216,220,224,228,232,236,240,244,248,
252,256,260,264,268,272,276,280,284,288,292,296,
300,304,308,312,316,320,324,328,332,336,340,344,
348,352,356,360,364,368,372,376,380,384,388,392,
396,400,404,408,412,416,420,424,428,432,436,440,
```

444,448,452,456,460,464,468,472,476,480,484,488,
492,496,500,504,768,769,770,771,772,773,774,775,
776,777,778,779,780,782,783,784,785,786,787,788,
789,790,791,792,793,794,795,796,797,798,799,801,
802,803,804,805,806,807,808,809,810,811,815,816,
817,818,819,820,821,822,823,824,825,826,827,828,
829,830,831,832,833,834,835,836,837,838,839,840,
841,842,843,844,845,846,847,848,849,850,851,852,
853,854,855,856,857,858,859,860,861,862,863,864,
866,872,874,877,881,882,887,888,890,891,892,893,
894,895,
4,8,12,16,878,20,24,884,28,883,32,879,
36,40,44,871,48,867,877,52,868,876,870,56,
882,869,60,886,64,865,68,866,880,72,813,76,
875,80,84,890,88,92,814,96,100,104,888,108,
112,116,120,124,128,132,872,136,140,144,148,152,
156,160,164,168,172,176,180,184,188,192,196,200,
204,208,212,216,220,224,228,232,236,240,244,248,
252,256,260,264,268,272,276,280,284,288,292,296,
300,304,308,312,316,320,324,328,332,336,340,344,
348,352,356,360,364,368,372,376,380,384,388,392,
396,400,404,408,412,416,420,424,428,432,436,440,
444,448,452,456,460,464,468,472,476,480,484,488,
492,496,500,504,768,769,770,771,772,773,774,775,
776,777,778,779,780,781,782,783,784,785,786,787,
788,789,790,791,792,793,794,795,796,797,798,799,
800,801,802,803,804,805,806,807,808,809,810,811,
812,815,816,817,818,819,820,821,822,823,824,825,
826,827,828,829,830,831,832,833,834,835,836,837,
838,839,840,841,842,843,844,845,846,847,848,849,
850,851,852,853,854,855,856,857,858,859,860,861,
862,863,864,873,874,881,885,887,889,891,892,893,
894,895,
4,8,12,869,16,20,800,24,28,879,865,32,
36,40,44,48,884,52,873,868,889,877,882,56,
883,60,64,68,72,812,76,870,80,814,885,84,
88,876,781,875,92,96,866,100,813,878,104,108,
867,886,887,112,871,116,120,124,880,128,132,136,
140,144,148,807,152,156,160,164,168,172,176,180,
184,188,192,196,200,204,208,212,216,220,224,228,
232,236,240,244,248,252,256,260,264,268,272,276,
280,284,288,292,296,300,304,308,312,316,320,324,
328,332,336,340,344,348,352,356,360,364,368,372,
376,380,384,388,392,396,400,404,408,412,416,420,
424,428,432,436,440,444,448,452,456,460,464,468,
472,476,480,484,488,492,496,500,504,768,769,770,
771,772,773,774,775,776,777,778,779,780,782,783,
784,785,786,787,788,789,790,791,792,793,794,795,
796,797,798,799,801,802,803,804,805,806,808,809,
810,811,815,816,817,818,819,820,821,822,823,824,
825,826,827,828,829,830,831,832,833,834,835,836,
837,838,839,840,841,842,843,844,845,846,847,848,
849,850,851,852,853,854,855,856,857,858,859,860,
861,862,863,864,872,874,881,888,890,891,892,893,
894,895,
4,8,872,12,16,800,20,873,24,869,28,879,
32,36,865,882,40,883,44,48,52,885,56,887,
889,60,64,812,68,72,867,884,76,814,781,80,
878,813,876,84,88,92,96,100,104,108,112,116,
120,124,128,132,136,140,815,868,877,880,890,144,
148,152,156,160,164,168,172,176,180,184,188,192,
196,200,204,208,212,216,220,224,228,232,236,240,
244,248,252,256,260,264,268,272,276,280,284,288,

292,296,300,304,308,312,316,320,324,328,332,336,
340,344,348,352,356,360,364,368,372,376,380,384,
388,392,396,400,404,408,412,416,420,424,428,432,
436,440,444,448,452,456,460,464,468,472,476,480,
484,488,492,496,500,504,768,769,770,771,772,773,
774,775,776,777,778,779,780,782,783,784,785,786,
787,788,789,790,791,792,793,794,795,796,797,798,
799,801,802,803,804,805,806,807,808,809,810,811,
816,817,818,819,820,821,822,823,824,825,826,827,
828,829,830,831,832,833,834,835,836,837,838,839,
840,841,842,843,844,845,846,847,848,849,850,851,
852,853,854,855,856,857,858,859,860,861,862,863,
864,866,870,871,874,875,881,886,888,891,892,893,
894,895,
4,8,800,12,16,20,24,28,884,873,869,32,
36,40,44,48,52,883,872,56,812,879,889,880,
60,885,814,64,68,781,72,865,877,76,867,870,
80,813,84,887,88,876,92,807,96,815,100,104,
108,809,112,116,120,124,128,132,136,140,144,148,
152,156,160,164,168,172,176,180,184,188,192,196,
200,204,208,212,216,220,224,228,232,236,240,244,
248,252,256,260,264,268,272,276,280,284,288,292,
296,300,304,308,312,316,320,324,328,332,336,340,
344,348,352,356,360,364,368,372,376,380,384,388,
392,396,400,404,408,412,416,420,424,428,432,436,
440,444,448,452,456,460,464,468,472,476,480,484,
488,492,496,500,504,768,769,770,771,772,773,774,
775,776,777,778,779,780,782,783,784,785,786,787,
788,789,790,791,792,793,794,795,796,797,798,799,
801,802,803,804,805,806,808,810,811,816,817,818,
819,820,821,822,823,824,825,826,827,828,829,830,
831,832,833,834,835,836,837,838,839,840,841,842,
843,844,845,846,847,848,849,850,851,852,853,854,
855,856,857,858,859,860,861,862,863,864,866,868,
871,874,875,878,881,882,886,888,890,891,892,893,
894,895,
4,8,800,12,869,16,873,20,24,28,32,36,
885,40,44,48,865,52,883,56,879,60,887,812,
814,64,68,884,889,868,72,781,834,76,813,882,
80,886,84,88,92,876,96,100,826,874,104,108,
112,116,809,871,872,120,124,128,132,136,140,144,
148,152,156,160,164,168,172,176,180,184,188,192,
196,200,204,208,212,216,220,224,228,232,236,240,
244,248,252,256,260,264,268,272,276,280,284,288,
292,296,300,304,308,312,316,320,324,328,332,336,
340,344,348,352,356,360,364,368,372,376,380,384,
388,392,396,400,404,408,412,416,420,424,428,432,
436,440,444,448,452,456,460,464,468,472,476,480,
484,488,492,496,500,504,768,769,770,771,772,773,
774,775,776,777,778,779,780,782,783,784,785,786,
787,788,789,790,791,792,793,794,795,796,797,798,
799,801,802,803,804,805,806,807,808,810,811,815,
816,817,818,819,820,821,822,823,824,825,827,828,
829,830,831,832,833,835,836,837,838,839,840,841,
842,843,844,845,846,847,848,849,850,851,852,853,
854,855,856,857,858,859,860,861,862,863,864,866,
867,870,875,877,878,880,881,888,890,891,892,893,
894,895,
4,8,12,16,20,878,24,28,876,884,32,882,
36,800,40,883,44,48,52,867,868,56,60,873,
886,866,64,877,880,885,68,871,889,72,76,875,
80,781,888,84,813,88,92,96,870,100,104,108,
112,874,116,120,124,128,132,136,140,812,887,144,

148,152,156,160,164,168,172,176,180,184,188,192,
196,200,204,208,212,216,220,224,228,232,236,240,
244,248,252,256,260,264,268,272,276,280,284,288,
292,296,300,304,308,312,316,320,324,328,332,336,
340,344,348,352,356,360,364,368,372,376,380,384,
388,392,396,400,404,408,412,416,420,424,428,432,
436,440,444,448,452,456,460,464,468,472,476,480,
484,488,492,496,500,504,768,769,770,771,772,773,
774,775,776,777,778,779,780,782,783,784,785,786,
787,788,789,790,791,792,793,794,795,796,797,798,
799,801,802,803,804,805,806,807,808,809,810,811,
814,815,816,817,818,819,820,821,822,823,824,825,
826,827,828,829,830,831,832,833,834,835,836,837,
838,839,840,841,842,843,844,845,846,847,848,849,
850,851,852,853,854,855,856,857,858,859,860,861,
862,863,864,865,869,872,879,881,890,891,892,893,
894,895,
4,8,12,16,20,24,883,28,876,32,884,36,
40,882,877,44,873,878,48,868,869,867,871,52,
865,880,56,60,870,64,800,866,813,68,72,76,
80,84,88,92,96,100,104,108,112,116,120,124,
128,132,136,140,144,148,152,156,160,164,168,172,
176,180,184,188,192,196,200,204,208,212,216,220,
224,228,232,236,240,244,248,252,256,260,264,268,
272,276,280,284,288,292,296,300,304,308,312,316,
320,324,328,332,336,340,344,348,352,356,360,364,
368,372,376,380,384,388,392,396,400,404,408,412,
416,420,424,428,432,436,440,444,448,452,456,460,
464,468,472,476,480,484,488,492,496,500,504,768,
769,770,771,772,773,774,775,776,777,778,779,780,
781,782,783,784,785,786,787,788,789,790,791,792,
793,794,795,796,797,798,799,801,802,803,804,805,
806,807,808,809,810,811,812,814,815,816,817,818,
819,820,821,822,823,824,825,826,827,828,829,830,
831,832,833,834,835,836,837,838,839,840,841,842,
843,844,845,846,847,848,849,850,851,852,853,854,
855,856,857,858,859,860,861,862,863,864,872,874,
875,879,881,885,886,887,888,889,890,891,892,893,
894,895,
4,8,12,16,20,800,24,869,28,32,876,889,
873,36,879,865,40,883,44,48,885,52,56,884,
60,64,868,68,812,781,882,72,814,76,813,80,
84,88,866,807,887,92,870,871,877,96,100,104,
108,112,116,867,886,120,124,128,132,136,140,144,
148,152,156,160,164,168,172,176,180,184,188,192,
196,200,204,208,212,216,220,224,228,232,236,240,
244,248,252,256,260,264,268,272,276,280,284,288,
292,296,300,304,308,312,316,320,324,328,332,336,
340,344,348,352,356,360,364,368,372,376,380,384,
388,392,396,400,404,408,412,416,420,424,428,432,
436,440,444,448,452,456,460,464,468,472,476,480,
484,488,492,496,500,504,768,769,770,771,772,773,
774,775,776,777,778,779,780,782,783,784,785,786,
787,788,789,790,791,792,793,794,795,796,797,798,
799,801,802,803,804,805,806,808,809,810,811,815,
816,817,818,819,820,821,822,823,824,825,826,827,
828,829,830,831,832,833,834,835,836,837,838,839,
840,841,842,843,844,845,846,847,848,849,850,851,
852,853,854,855,856,857,858,859,860,861,862,863,
864,872,874,875,878,880,881,888,890,891,892,893,
894,895,
4,869,8,12,16,865,800,873,20,879,24,28,
32,882,36,880,885,40,44,48,52,56,60,781,

814,64,812,68,877,878,884,72,813,883,76,80,
84,88,92,867,889,96,100,104,108,112,116,120,
124,128,132,136,140,144,148,152,156,160,164,168,
172,176,180,184,188,192,196,200,204,208,212,216,
220,224,228,232,236,240,244,248,252,256,260,264,
268,272,276,280,284,288,292,296,300,304,308,312,
316,320,324,328,332,336,340,344,348,352,356,360,
364,368,372,376,380,384,388,392,396,400,404,408,
412,416,420,424,428,432,436,440,444,448,452,456,
460,464,468,472,476,480,484,488,492,496,500,504,
768,769,770,771,772,773,774,775,776,777,778,779,
780,782,783,784,785,786,787,788,789,790,791,792,
793,794,795,796,797,798,799,801,802,803,804,805,
806,807,808,809,810,811,815,816,817,818,819,820,
821,822,823,824,825,826,827,828,829,830,831,832,
833,834,835,836,837,838,839,840,841,842,843,844,
845,846,847,848,849,850,851,852,853,854,855,856,
857,858,859,860,861,862,863,864,866,868,870,871,
872,874,875,876,881,886,887,888,890,891,892,893,
894,895,
4,8,800,12,16,20,24,878,872,28,869,32,
873,36,865,40,44,885,48,52,781,814,879,884,
882,56,60,876,64,812,871,889,68,72,76,80,
807,813,883,84,88,92,96,100,104,108,112,116,
120,124,128,132,136,140,144,148,152,156,160,164,
168,172,176,180,184,188,192,196,200,204,208,212,
216,220,224,228,232,236,240,244,248,252,256,260,
264,268,272,276,280,284,288,292,296,300,304,308,
312,316,320,324,328,332,336,340,344,348,352,356,
360,364,368,372,376,380,384,388,392,396,400,404,
408,412,416,420,424,428,432,436,440,444,448,452,
456,460,464,468,472,476,480,484,488,492,496,500,
504,768,769,770,771,772,773,774,775,776,777,778,
779,780,782,783,784,785,786,787,788,789,790,791,
792,793,794,795,796,797,798,799,801,802,803,804,
805,806,808,809,810,811,815,816,817,818,819,820,
821,822,823,824,825,826,827,828,829,830,831,832,
833,834,835,836,837,838,839,840,841,842,843,844,
845,846,847,848,849,850,851,852,853,854,855,856,
857,858,859,860,861,862,863,864,866,867,868,870,
874,875,877,880,881,886,887,888,890,891,892,893,
894,895,
4,8,12,16,20,865,869,879,24,28,880,800,
32,873,36,885,866,883,40,44,814,877,48,52,
56,60,812,64,68,878,887,72,813,870,76,80,
781,854,84,88,92,96,100,104,108,112,116,120,
124,128,132,136,140,144,148,152,156,160,164,168,
172,176,180,184,188,192,196,200,204,208,212,216,
220,224,228,232,236,240,244,248,252,256,260,264,
268,272,276,280,284,288,292,296,300,304,308,312,
316,320,324,328,332,336,340,344,348,352,356,360,
364,368,372,376,380,384,388,392,396,400,404,408,
412,416,420,424,428,432,436,440,444,448,452,456,
460,464,468,472,476,480,484,488,492,496,500,504,
768,769,770,771,772,773,774,775,776,777,778,779,
780,782,783,784,785,786,787,788,789,790,791,792,
793,794,795,796,797,798,799,801,802,803,804,805,
806,807,808,809,810,811,815,816,817,818,819,820,
821,822,823,824,825,826,827,828,829,830,831,832,
833,834,835,836,837,838,839,840,841,842,843,844,
845,846,847,848,849,850,851,852,853,855,856,857,
858,859,860,861,862,863,864,867,868,871,872,874,
875,876,881,882,884,886,888,889,890,891,892,893,

```c
            894,895,
            4,8,12,16,878,20,24,882,28,32,870,800,
            36,40,868,44,48,52,877,885,56,887,60,884,
            876,64,880,886,883,68,867,72,866,76,80,84,
            88,871,869,879,92,813,96,873,888,100,104,108,
            814,865,112,812,116,781,889,120,124,128,875,132,
            136,140,144,148,152,872,156,160,164,168,172,176,
            180,184,188,192,196,200,204,208,212,216,220,224,
            228,232,236,240,244,248,252,256,260,264,268,272,
            276,280,284,288,292,296,300,304,308,312,316,320,
            324,328,332,336,340,344,348,352,356,360,364,368,
            372,376,380,384,388,392,396,400,404,408,412,416,
            420,424,428,432,436,440,444,448,452,456,460,464,
            468,472,476,480,484,488,492,496,500,504,768,769,
            770,771,772,773,774,775,776,777,778,779,780,782,
            783,784,785,786,787,788,789,790,791,792,793,794,
            795,796,797,798,799,801,802,803,804,805,806,807,
            808,809,810,811,815,816,817,818,819,820,821,822,
            823,824,825,826,827,828,829,830,831,832,833,834,
            835,836,837,838,839,840,841,842,843,844,845,846,
            847,848,849,850,851,852,853,854,855,856,857,858,
            859,860,861,862,863,864,874,881,890,891,892,893,
            894,895,
            4,8,12,879,16,20,24,872,865,869,28,884,
            32,36,40,44,873,875,48,882,889,52,876,885,
            800,867,56,781,814,60,64,68,813,72,76,80,
            84,88,92,96,100,104,108,112,116,120,124,128,
            132,136,140,144,148,152,156,160,164,168,172,176,
            180,184,188,192,196,200,204,208,212,216,220,224,
            228,232,236,240,244,248,252,256,260,264,268,272,
            276,280,284,288,292,296,300,304,308,312,316,320,
            324,328,332,336,340,344,348,352,356,360,364,368,
            372,376,380,384,388,392,396,400,404,408,412,416,
            420,424,428,432,436,440,444,448,452,456,460,464,
            468,472,476,480,484,488,492,496,500,504,768,769,
            770,771,772,773,774,775,776,777,778,779,780,782,
            783,784,785,786,787,788,789,790,791,792,793,794,
            795,796,797,798,799,801,802,803,804,805,806,807,
            808,809,810,811,812,815,816,817,818,819,820,821,
            822,823,824,825,826,827,828,829,830,831,832,833,
            834,835,836,837,838,839,840,841,842,843,844,845,
            846,847,848,849,850,851,852,853,854,855,856,857,
            858,859,860,861,862,863,864,866,868,870,871,874,
            877,878,880,881,883,886,887,888,890,891,892,893,
            894,895
            };

    unsigned short reftab[]=
                {
            0,0,0,0,0,0,0,0,0,0,0,      // 0-10
            0,0,0,0,0,0,0,0,0,0,
            0,0,0,0,0,0,0,0,0,0,
            0,508,0,0,0,0,0,0,0,0,      // 31-40
            0,0,0,0,0,0,0,0,0,0,
            0,0,0,0,0,0,0,0,0,0,
            0,0,0,0,0,0,0,0,0,0,
            0,0,0,0,0,0,0,0,0,0,
            0,0,0,0,0,0,0,0,0,0,
            0,0,0,0,0,0,4572,0,8128,4064,      // 91-100
            1016,0,6604,6096,2032,0,0,5588,7112,1524,      // 101-110
            7620,0,0,2540,3556,3048,5080,0,0,0,      // 111-120
            0,0,0,0,0,0,0                  //121-127
            };
```

SCS

Spezielle Communications Systeme GmbH & Co. KG
Röntgenstraße 36
63454 Hanau
GERMANY
Internet: www.p4dragon.com
E-Mail: info@p4dragon.com

Tel.:   +49(0)618185 00 00
Fax.:   +49(0)618199 02 38