TSG-RAN Working Group1 meeting #5
Cheju, Korea 1-4, June 1999

TSGR1#5(99)540

Agenda Item:

Source: **NTT DoCoMo and Nortel Networks**

Title: **Updated text for Turbo code internal interleaver of 25.212, 25.222**

Document for: **Decision**

This document proposes an updated text for the Turbo code internal interleaver of documents S1.12 and S1.22. In this update, the editorial changes are made to eliminate the possibility of misinterpretation and to provide more accurate specification. The following text is an updated version of TSGR1#4(99)471 and the revision marks indicate the part of the modifications from TSGR1#4(99)471.

4.2.2.2.2 Turbo code internal interleaver

<Editor's note: The following is a working assumption of Ad Hoc 5>

Figure 4-xx depicts the overall 8 State PCCC Turbo coding scheme including Turbo code internal interleaver. The Turbo code internal interleaver consists of mother interleaver generation and pruning. For arbitrary given block length K, one mother interleaver is selected from the ~~224~~207 mother interleavers set. The generation scheme of mother interleavre is described in section 4.2.2.2.2.1. After the mother interleaver generation, *l*-bits are pruned in order to adjust the mother interleaver to the block length K. The definition of *l* is shown in section 4.2.2.2.2.2.~~Figure 4-xx.~~

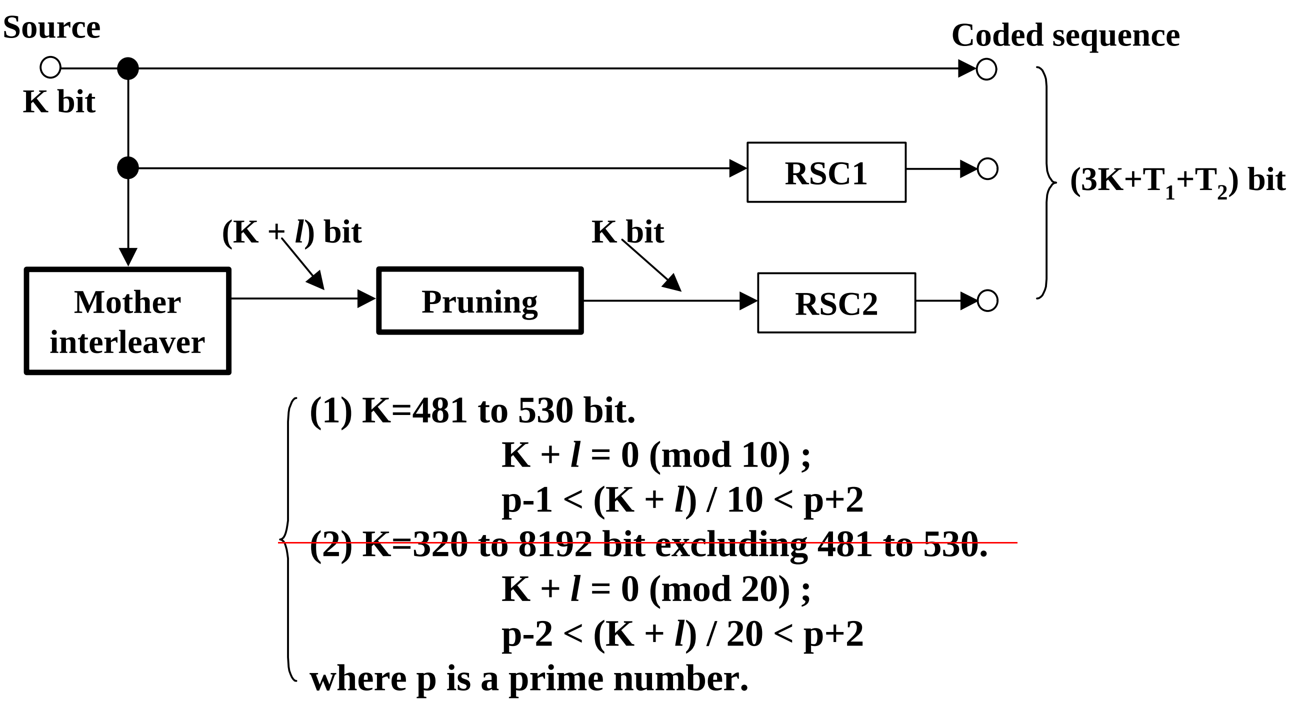

Figure 4-xx. Overall 8 State PCCC Turbo Coding

4.2.2.2.2.1 Mother interleaver generation

The interleaving consists of three stages. In first stage, the input sequence is written into the rectangular matrix row by row. The second stage is intra-row permutation. The third stage is inter-row permutation. The three-stage permutations are described as follows, the input block length is assumed to be K (320 to 8192 bits).

First Stage:

(1) Determine a row number R such that

R=10 (K = 481 to 530 bits; Case-1)

R=20 (K = any other block length except 481 to 530 bits; Case-2)

(2) Determine a column number C such that

Case-1; ~~C = 53~~C = p = 53

Csae-2;

(i) Find minimum prime p such that,

0 =< (p+1)-K/R.

(ii) If (0 =< p-K/R) then go to (iii),

else C = p+1.

(iii) If (0 =< p-1-K/R) then C=p-1~~.~~,

else C = p.

(3) The input sequence of the interleaver is written into the R $\times$ C rectangular matrix row by row.

Second Stage:

A. If C = p

~~(1)~~(A-1) Select a primitive root g_0 from Table 4-yy.

~~(2)~~(A-2) ~~Perform~~Construct the base sequence c(i) for~~first (0-th)~~ intra-row permutation as:

$c(i) = [g_0 \times c(i-1)] \bmod p$, i =1,2,…, (p~~C~~-2)., $c(0)$ = 1~~., and c(C-1) = 0,~~

~~where $c(i)$ is the input bit position of i-th output after the permutation.~~

~~(3)~~(A-3) Select the minimum prime integer set {q~~p~~$_j$ } (j=1,2,…R-1) such that

g.c.d{q~~p~~$_j$, p-1} =1

q~~p~~$_j$ > 6

q~~p~~$_j$ > q~~p~~$_{(j-1)}$

where g.c.d. is greatest common divider. And q_0 = 1.

(A-4) The set {q_j} is permuted to make a new set {p_j} such that

$p_{P(j)} = q_j$, j = 0, 1, …. R-1,

where P(j) is the inter-row permutation pattern defined in the third stage.

~~(4)~~(A-5) Perform the j-th (j = 0, 1, 2, …, R~~C~~-1) intra-row permutation as:

$c_j(i) = c([i \times p_j] \bmod (p-1))$, i =0, 1,2,…, (p~~C~~-2)., ~~$c_j(0) = 1$,~~ and c_j(~~C~~p-1) = 0,

where $c_j(i)$ is the input bit position of i-th output after the permutation of j-th row.

B. If C = p+1

~~(1)~~(B-1) Same as case A-1.

~~(2)~~(B-2) Same as case A-2.~~Perform the first (0-th) intra-row permutation as:~~

~~$c(i) = [g_0 \times c(i-1)] \bmod p$, i =1,2,…, (C-2)., $c(0)$ = 1, c(C-1) = 0, and c(C) = p,~~

~~where $c(i)$ is the input bit position of i-th output after the permutation.~~

~~(3)~~(B-3) Same as case A-3.

(B-4) Same as case A-4.

~~(4)~~(B-5) Perform the j-th (j = 0,1, 2, …, R~~C~~-1) intra-row permutation as:

$c_j(i) = c([i \times p_j] \bmod (p-1))$, i =0,1,2,…, (~~C~~p-2)., ~~$c_j(0) = 1$,~~ c_j(~~C~~p-1) = 0, and c_j(~~C~~p) = p,

where $c_j(i)$ is the input bit position of i-th output after the permutation of j-th row.

C. If C = p-1

~~(1)~~(C-1) Same as case A-1.

~~(2)~~(C-2) Same as case A-2.~~Perform the first (0-th) intra-row permutation as:~~

~~$c(i) = [g_0 \times c(i-1)] \bmod p$, i =1,2,…,(C-2)., and $c(0)$ = 1,~~

~~where $c(i)$ is the input bit position of i-th output after the permutation.~~

~~(3)~~(C-3) Same as case A-3.

(C-4) Same as case A-4.

~~(4)~~(C-5) Perform the j-th (j = 0,1, 2, …, R~~C~~-1) intra-row permutation as:

$$c_j(i) = c([i \times p_j] \bmod (p-1)) \; -1, \quad i = 0,1,2,\ldots,(\cancel{C}p-2), \; \cancel{\text{and } c_j(0) = 1,}$$

where $c_j(i)$ is the input bit position of i-th output after the permutation of j-th row.

Third Stage:

(1) Perform the inter-row permutation based on the following P(j) (j=0,1, ..., R-1) patterns, where P(j) is the original row position of the j-th permuted row.

~~A~~P_A: {19, 9, 14, 4, 0, 2, 5, 7, 12, 18, 10, 8, 13, 17, 3, 1, 16, 6, 15, 11} for R=20
~~B~~P_B: {19, 9, 14, 4, 0, 2, 5, 7, 12, 18, 16, 13, 17, 15, 3, 1, 6, 11, 8, 10} for R=20
~~C~~P_C: {9, 8, 7, 6, 5, 4, 3, 2, 1, 0} for R=10

The usage of these patterns is as follows:

Block length K: ~~Pattern~~P(j)
320 to 480-bit: ~~A~~P_A
481 to 530-bit: ~~C~~P_C
531 to 2280-bit: ~~A~~P_A
2281 to 2480-bit: ~~B~~P_B
2481 to 3160-bit: ~~A~~P_A
3161 to 3210-bit: ~~B~~P_B
3211 to 8192-bit: ~~A~~P_A

(2) The output of the mother interleaver is the sequence read out column by column from the permuted R × C matrix.

Table 4-yy. Table of prime p and associated primitive root

p	g_o	p	g_o	~~P~~p	g_o	p	g_o	p	g_o	p	g_o	p	g_o	p	g_o
17	3	59	2	103	5	157	5	211	2	269	2	331	3	389	2
19	2	61	2	107	2	163	2	223	3	271	6	337	10	397	5
23	5	67	2	109	6	167	5	227	2	277	5	347	2	401	3
29	2	71	7	113	3	173	2	229	6	281	3	349	2	409	21
31	3	73	5	127	3	179	2	233	3	283	3	353	3		
37	2	79	3	131	2	181	2	239	7	293	2	359	7		
41	6	83	2	137	3	191	19	241	7	307	5	367	6		
43	3	89	3	139	2	193	5	251	6	311	17	373	2		
47	5	97	5	149	2	197	2	257	3	313	10	379	2		
53	2	101	2	151	6	199	3	263	5	317	2	383	5		

4.2.2.2.2.2 Definition of number of pruning bits

The output of the mother interleaver is pruned by deleting the l-bits in order to adjust the mother interleaver to the block length K, where the deleted bits are non-existent bits in the input sequence. The pruning bits number l is defined as:

$$l = R \times C - K,$$

where R is the row number and C is the column number defined in section 4.2.2.2.2.1.