

Technical Specification Group Services and System Aspects
Meeting #28, Quebec, Canada
6-9 June 2005

TSGS#28(05)0247

Source: TSG-SA WG4

Title: CR TS 26.190 on Correction to text and some equations (Release 6)

Document for: Approval

Agenda Item: 7.4.3

The following CR, agreed at the TSG-SA WG4 meeting #35, is presented to TSG SA #28 for approval.

| Spec | CR | Rev | Phase | Subject | Cat | Vers | WG | Meeting | S4 doc |
|--------|-----|-----|-------|---------------------------------------|-----|-------|----|---------------|-----------|
| 26.190 | 002 | | Rel-6 | Correction to text and some equations | F | 6.0.0 | S4 | TSG-SA WG4#35 | S4-050315 |

CHANGE REQUEST

№ 26.190 CR 002 № rev - № Current version: 6.0.0 №

For **HELP** on using this form, see bottom of this page or look at the pop-up text over the № symbols.

Proposed change affects: UICC apps № ☐ ME ☒ Radio Access Network ☐ Core Network ☒

| | | |
|------------------------|---|---|
| Title: | № Correction to text and some equations. | |
| Source: | № TSG SA WG4 Codec | |
| Work item code: | № AMR-WB | Date: № 06/06/2005 |
| Category: | № F Use <u>one</u> of the following categories: F (correction) A (corresponds to a correction in an earlier release) B (addition of feature), C (functional modification of feature) D (editorial modification) Detailed explanations of the above categories can be found in 3GPP TR 21.900 . | Release: № Rel-6 Use <u>one</u> of the following releases: Ph2 (GSM Phase 2) R96 (Release 1996) R97 (Release 1997) R98 (Release 1998) R99 (Release 1999) Rel-4 (Release 4) Rel-5 (Release 5) Rel-6 (Release 6) Rel-7 (Release 7) |

| | |
|--------------------------------------|--|
| Reason for change: | № There are few errors in the text and in some equations. |
| Summary of change: | № Correct the text to conform with the C code. |
| Consequences if not approved: | № May result in some confusion if the algorithmic description differs from the C code. |

| | | | | | | | | | | |
|------------------------------|---|---|---|---|-------------------------------------|--|-------------------------------------|--|-------------------------------------|--|
| Clauses affected: | № 5.7, 5.8.3, 6.1 | | | | | | | | | |
| Other specs affected: | <table><tr><td>Y</td><td>N</td></tr><tr><td>№</td><td><input checked="" type="checkbox"/></td></tr><tr><td></td><td><input checked="" type="checkbox"/></td></tr><tr><td></td><td><input checked="" type="checkbox"/></td></tr></table> | Y | N | № | <input checked="" type="checkbox"/> | | <input checked="" type="checkbox"/> | | <input checked="" type="checkbox"/> | Other core specifications № Test specifications № O&M Specifications № |
| Y | N | | | | | | | | | |
| № | <input checked="" type="checkbox"/> | | | | | | | | | |
| | <input checked="" type="checkbox"/> | | | | | | | | | |
| | <input checked="" type="checkbox"/> | | | | | | | | | |
| Other comments: | № | | | | | | | | | |

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at <http://www.3gpp.org/specs/CR.htm>. Below is a brief summary:

- 1) Fill out the above form. The symbols above marked № contain pop-up help information about the field that they are closest to.
- 2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under <ftp://ftp.3gpp.org/specs/>. For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

- 3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

5.7 Adaptive codebook

Adaptive codebook search is performed on a subframe basis. It consists of performing closed loop pitch search, and then computing the adaptive codevector by interpolating the past excitation at the selected fractional pitch lag.

... <cut text>

Thus, for ~~8.85~~, 12.65, 14.25, 15.85, 18.25, 19.85, 23.05 or 23.85 kbit/s modes, there are two possibilities to generate the

adaptive codebook $v(n)$, $v(n) = v'(n)$ in the first path, or $v(n) = \sum_{i=-1}^1 b_{LP}(i+1)v'(n+i)$ in the second path, where

$b_{LP}=[0.18,0.64,0.18]$. The path which results in minimum energy of the target signal $x_2(n)$ defined in Equation (40) is selected for the filtered adaptive codebook vector. For 6.60 and 8.85 kbit/s modes, $v(n)$ is always

$$v(n) = \sum_{i=-1}^1 b_{LP}(i+1)v'(n+i).$$

... <cut text>

5.8.3 Codebook search

The algebraic codebook is searched by minimizing the mean square error between the weighted input speech and the weighted synthesis speech. The target signal used in the closed-loop pitch search is updated by subtracting the adaptive codebook contribution. That is

$$x_2(n) = x(n) - g_p y(n), \quad n = 0, K, 63, \quad (1)$$

where $y(n) = v(n)*h(n)$ is the filtered adaptive codebook vector and g_p is the unquantized adaptive codebook gain.

The matrix \mathbf{H} is defined as the lower triangular Toeplitz convolution matrix with diagonal $h(0)$ and lower diagonals $h(1), \dots, h(63)$, and $\mathbf{d} = \mathbf{H}'\mathbf{x}_2$ is the correlation between the target signal $x_2(n)$ and the impulse response $h(n)$ (also known as the backward filtered target vector), and $\Phi = \mathbf{H}'\mathbf{H}$ is the matrix of correlations of $h(n)$.

... <cut text>

To simplify the search the signal $d(n)$ and matrix Φ are modified to incorporate the pre-selected signs. Let $s_b(n)$ denote the vector containing the signs of $b(n)$. The modified signal $d'(n)$ is given by

$$d'(n) = s_b(n)d(n) \quad n=0, \dots, N-1$$

and the modified autocorrelation matrix Φ' is given by

$$\phi'(i, j) = s_b(i)s_b(j)\phi(i, j), \quad i=0, \dots, N-1; \quad j=i, \dots, N-1.$$

The correlation at the numerator of the search criterion Q_k is now given by

$$\cancel{R} = \sum_{i=0}^{N_p-1} \cancel{d'(i)} \quad R = \sum_{i=0}^{N_p-1} d'(m_i)$$

and the energy at the denominator of the search criterion Q_k is given by

$$E = \sum_{i=0}^{N_p-1} \phi'(m_i, m_i) + 2 \sum_{i=0}^{N_p-2} \sum_{j=i+1}^{N_p-1} \phi'(m_i, m_j)$$

... <cut text>

6.1 Decoding and speech synthesis

The decoding process is performed in the following order:

Decoding of LP filter parameters: The received indices of ISP quantization are used to reconstruct the quantized ISP vector. The interpolation described in Section 5.2.6 is performed to obtain 4 interpolated ISP vectors (corresponding to 4 subframes). For each subframe, the interpolated ISP vector is converted to LP filter coefficient domain a_k , which is used for synthesizing the reconstructed speech in the subframe.

The following steps are repeated for each subframe:

1. **Decoding of the adaptive codebook vector:** The received pitch index (adaptive codebook index) is used to find the integer and fractional parts of the pitch lag. The adaptive codebook vector $v(n)$ is found by interpolating the past excitation $u(n)$ (at the pitch delay) using the FIR filter described in Section 5.6.5.7. The received adaptive filter index is used to find out whether the filtered adaptive codebook is $v_1(n) = v(n)$ or $v_2(n) = 0.18v(n) + 0.64v(n-1) + 0.18v(n-2)$.

... <cut text>

6. **Noise enhancer:** A nonlinear gain smoothing technique is applied to the fixed codebook gain \hat{g}_c in order to enhance excitation in noise. Based on the stability and voicing of the speech segment, the gain of the fixed codebook is smoothed in order to reduce fluctuation in the energy of the excitation in case of stationary signals. This improves the performance in case of stationary background noise.

The voicing factor is given by $\lambda = 0.5(1-r_v)$ with $r_v = (E_v - E_c)/(E_v + E_c)$, where E_v and E_c are the energies of the scaled pitch codevector and scaled innovation codevector, respectively. Note that since the value of r_v is between -1 and 1 , the value of λ is between 0 and 1 . Note that the factor λ is related to the amount of unvoicing with a value of 0 for purely voiced segments and a value of 1 for purely unvoiced segments.

A stability factor θ is computed based on a distance measure between the adjacent LP filters. Here, the factor θ is related to the ISP distance measure and it is bounded by $0 \leq \theta \leq 1$, with larger values of θ corresponding to more stable signals.

Finally, a gain smoothing factor S_m is given by

$$S_m = \lambda \theta \tag{64}$$

The value of S_m approaches 1 for unvoiced and stable signals, which is the case of stationary background noise signals. For purely voiced signals or for unstable signals, the value of S_m approaches 0 .

An initial modified gain g_0 is computed by comparing the fixed codebook gain \hat{g}_c to a threshold given by the initial modified gain from the previous subframe, g_{-1} . If \hat{g}_c is larger or equal to g_{-1} ,

then g_0 is computed by decrementing \hat{g}_c by 1.5 dB bounded by $g_0 \geq g_{-1}$. If \hat{g}_c is smaller than g_{-1} , then g_0 is computed by incrementing \hat{g}_c by 1.5 dB bounded by $g_0 \leq g_{-1}$.

Finally, the gain is update with the value of the smoothed gain as follows

$$\hat{g}_c = \theta g_0 + (1 - \theta) \hat{g}_c = S_m g_0 + (1 - S_m) \hat{g}_c, \quad (65)$$

7. **Pitch enhancer:** A pitch enhancer procedure modifies the total excitation $u(n)$ by filtering the fixed codebook excitation through an innovation filter whose frequency response emphasizes the higher frequencies more than lower frequencies, and whose coefficients are related to the periodicity in the signal. A filter of the form

$$F_{inno}(z) = -c_{pe}z + 1 - c_{pe}z^{-1}, \quad (66)$$

where $c_{pe} = 0.125(1 - r_v)$, $c_{pe} = 0.125(1 + r_v)$, with $r_v = (E_v - E_c)/(E_v + E_c)$ as described above. The filtered fixed codevector is given by

$$c'(n) = c(n) - c_{pe}(c(n+1) + c(n-1)). \quad (67)$$

and the updated excitation is given by

$$u(n) = \hat{g}_p v(n) + \hat{g}_c c'(n). \quad (68)$$

The above procedure can be done in one step by updating the excitation as follows

$$u(n) = u(n) - \hat{g}_c c_{pe}(c(n+1) + c(n-1)). \quad (69)$$