3GPP TSG RAN Meeting #19 **RP-030132**
Birmingham, United Kingdom, 11 - 14 March 2003

Title: **CRs (R'99 and Rel4/Rel5 category A) to TS 25.214**

Source: **TSG-RAN WG1**

Agenda item: **8.1.3**

1. ***TS 25.214*** **(RP-030132)**

Doc-1st-	Doc-2nd-	Spec	CR	Rev	Subject	Phase	Ca	Versio	Versio	Workitem
RP-030132	R1-030356	25.214	316	-	Correction on verification algorithm in Annex 1	R99	F	3.11.0	3.12.0	TEI
RP-030132	R1-030356	25.214	317	-	Correction on verification algorithm in Annex 1	Rel-4	A	4.5.0	4.6.0	TEI
RP-030132	R1-030356	25.214	318	-	Correction on verification algorithm in Annex 1	Rel-5	A	5.3.0	5.4.0	TEI

3GPP TSG-RAN WG1 Meeting #31
Tokyo, Japan, February 18 – 21, 2003

Tdoc R1-030356

CR-Form-v7

CHANGE REQUEST

⌘	**25.214**	**CR 316**	⌘ **rev**	**-**	⌘ Current version:	**3.11.0** ⌘

*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 [X] Radio Access Network [ ] Core Network [ ]

Title:	⌘	Correction on verification algorithm in Annex 1		
Source:	⌘	TSG RAN WG1		
Work item code:	⌘		***Date:*** ⌘	20/02/2003
Category:	⌘	**F**	***Release:*** ⌘	R99
		Use one 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.		*Use one of the following releases:* *2 (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)*

Reason for change:	⌘	Corrects a sign error in the specification.
Summary of change:	⌘	Corrects a sign error on one formula in TxAA mode 1 antenna verification description. Corrects the derivation of x_i values.
Consequences if not approved:	⌘	A sign mistake in the second formula of Annex A.1 will cause harm for understanding the verification algorithm.

Clauses affected:	⌘	A.1			
		Y	**N**		
Other specs affected:	⌘		**X**	Other core specifications	⌘
			X	Test specifications	
			X	O&M Specifications	
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.

Annex A (informative):

A.1 Antenna verification

In closed loop mode 1, if channel estimates are taken from the Primary CPICH, the performance will also suffer if the UE can-not detect errors since the channel estimates will be taken for the incorrect phase settings. To mitigate this problem, antenna verification can be done, which can make use of antenna specific pilot patterns of the dedicated physical channel. The antenna verification can be implemented with several different algorithms. A straightforward algorithm can use a 4-hypothesis test per slot. Alternatively, a simplified beam former verification (SBV) requiring only a 2-hypothesis test per slot can be used. If we have orthogonal pilot patterns on the downlink DPCCH we can apply the SBV as follows:

Consider:

$$2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Re}(\gamma h_{2,i}^{(d)}h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=\pi)}{\bar{p}(\phi_{Rx}=0)}\right)$$

then define the variable x_0 as, $x_0 = 0$ if the above inequality holds good and $x_0 = \pi$ otherwise.

Similarly consider:

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)}h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=-\pi/2)}{\bar{p}(\phi_{Rx}=\pi/2)}\right)$$

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)}h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\bar{p}(\phi_{Rx}=\pi/2)}{\bar{p}(\phi_{Rx}=-\pi/2)}\right)$$

then define the variable x_1 as, $x_1 = -\pi/2$ if the above inequality holds good and $x_1 = \pi/2$ oherwise.

Whether x_0 or x_1 is to be calculated for each slot is given by the following table:

Slot	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0

The estimate for the transmitted phase is now obtained as:

$$\sin(\phi_{Tx}) + j\cos(\phi_{Tx}) = \frac{\sum_{i=0}^{1}\sin(x_i)}{\sqrt{2}} + j\frac{\sum_{i=0}^{1}\cos(x_i)}{\sqrt{2}}$$

where:

- the x_i values are used corresponding to the current slot and the nextprevious slot taking into account the end-of-frame adjustment and the used CL timing adjustment delay, except in the case of slot 14 wherein the slot 14 and slot 1 of the next frame values are used;
- $h_{2,i}^{(p)}$ is the *i*'th estimated channel tap of antenna 2 using the CPICH;
- $h_{2,i}^{(d)}$ is the *i*'th estimated channel tap of antenna 2 using the DPCCH;
- γ^2 is the DPCH Pilot SNIR/ CPICH SNIR;
- σ_i^2 is the noise plus interference power on the *i*'th path.

In normal operation the *a priori* probability for selected pilot pattern is assumed to be 96% (assuming there are 4% of errors in the feedback channel for power control and antenna selection).

For closed loop mode 2, if channel estimates are taken from the Primary CPICH, antenna verification can also be performed, for example using a 16-hypothesis test per slot. For closed loop mode 2, the same pilot sequence is transmitted on both antennas for DPCCH. Therefore, we obtain channel estimates from the DPCCH that correspond to the combined channel from both transmitting antennas:

$$\vec{h}^{(d)} = \gamma(\beta_1 \vec{h}_1 + \beta_2 \vec{h}_2) + \vec{b}^{(d)}$$

where β_1, β_2 are the applied coefficients on the antennas at the UTRAN, γ is as defined above for mode 1 verification, $\vec{h}_i$ is the actual channel vector from the *i-th* antenna, and $\vec{b}^{(d)}$ is the noise vector for the DPCCH channel estimate. Furthermore we have channel estimates made on the CPICH Pilots for each antenna:

$$\vec{h}_1^{(p)} = \vec{h}_1 + \vec{b}_1^{p}$$

$$\vec{h}_2^{(p)} = \vec{h}_2 + \vec{b}_2^{p}$$

where $\vec{h}_i^{(p)}$ is the estimated channel vector using the CPICH, and $\vec{b}_i^{p}$ is the noise vector for the CPICH channel estimate, from the *i-th* antenna.

At the receiver, verification consists in choosing a pair of applied coefficients, $(\hat{\beta}_1, \hat{\beta}_2)$, which results in a combined channel estimate from CPICH which best fits the channel estimate obtained from the DPCCH, taking into account the *a priori* probability of error on the FBI bits.

One possible way of implementing verification for mode 2 is by choosing $(\hat{\beta}_1, \hat{\beta}_2)$ from the whole set of possibilities $T = \{\alpha_1, \alpha_2\}$, using the logarithmic form of the following decision rule:

$$(\hat{\beta}_1, \hat{\beta}_2) = \arg\left\langle \max_{\alpha_1,\alpha_2 \in T} \left\{ \ln(\hat{p}(\alpha_1,\alpha_2)) + \ln(\overline{p}(\alpha_1,\alpha_2)) \right\} \right\rangle$$

where the *a priori* probability $\overline{p}(\alpha_1,\alpha_2)$ for each candidate antenna coefficient pair is determined from the antenna coefficient pair asked for by the mobile, combined with the *a priori* probability of each FSM bit used to represent the antenna coefficient pair. The *a priori* probability of each FSM bit is assumed to be 96% (assuming there are 4% of errors in the feedback channel). Also

$$\ln(\hat{p}(\alpha_1,\alpha_2)) = -\left(\sum_{i=1}^{Npath} \frac{\left| h_i^{(d)} - \gamma\left(\alpha_1 h_{1,i}^{(p)} + \alpha_2 h_{2,i}^{(p)}\right) \right|^2}{\sigma_i^2 \left(1 + \gamma^2 \left(|\alpha_1|^2 + |\alpha_2|^2\right)\right)} \right)$$

where σ_i^2 is as defined above for mode 1 verification.

Tdoc R1-030356

CR-Form-v7

CHANGE REQUEST

⌘	**25.214**	**CR**	**317**	⌘ **rev**	**-**	⌘	Current version:	**4.5.0** ⌘

*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 [X] Radio Access Network [ ] Core Network [ ]

Title:	⌘	Correction on verification algorithm in Annex 1	
Source:	⌘	TSG RAN WG1	
Work item code:	⌘		***Date:*** ⌘ 20/02/2003
Category:	⌘	**A**	***Release:*** ⌘ Rel-4
		Use one 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.	*Use one of the following releases:* *2 (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)*

Reason for change:	⌘	Corrects a sign error in the specification.
Summary of change:	⌘	Corrects a sign error on one formula in TxAA mode 1 antenna verification description. Corrects the derivation of x_i values.
Consequences if not approved:	⌘	A sign mistake in the second formula of Annex A.1 will cause harm for understanding the verification algorithm.

Clauses affected:	⌘	A.1				
		Y	**N**			
Other specs affected:	⌘		**X**	Other core specifications	⌘	
			X	Test specifications		
			X	O&M Specifications		
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.

Annex A (informative):

A.1 Antenna verification

In closed loop mode 1, if channel estimates are taken from the Primary CPICH, the performance will also suffer if the UE can-not detect errors since the channel estimates will be taken for the incorrect phase settings. To mitigate this problem, antenna verification can be done, which can make use of antenna specific pilot patterns of the dedicated physical channel. The antenna verification can be implemented with several different algorithms. A straightforward algorithm can use a 4-hypothesis test per slot. Alternatively, a simplified beam former verification (SBV) requiring only a 2-hypothesis test per slot can be used. If we have orthogonal pilot patterns on the downlink DPCCH we can apply the SBV as follows:

Consider:

$$2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Re}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\overline{p}(\phi_{Rx}=\pi)}{\overline{p}(\phi_{Rx}=0)}\right)$$

then define the variable x_0 as, $x_0 = 0$ if the above inequality holds good and $x_0 = \pi$ otherwise.

Similarly consider:

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\overline{p}(\phi_{Rx}=-\pi/2)}{\overline{p}(\phi_{Rx}=\pi/2)}\right)$$

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\overline{p}(\phi_{Rx}=\pi/2)}{\overline{p}(\phi_{Rx}=-\pi/2)}\right)$$

then define the variable x_1 as, $x_1 = -\pi/2$ if the above inequality holds good and $x_1 = \pi/2$ oherwise.

Whether x_0 or x_1 is to be calculated for each slot is given by the following table:

Slot	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0

The estimate for the transmitted phase is now obtained as:

$$\sin(\phi_{Tx}) + j\cos(\phi_{Tx}) = \frac{\sum_{i=0}^{1}\sin(x_i)}{\sqrt{2}} + j\frac{\sum_{i=0}^{1}\cos(x_i)}{\sqrt{2}}$$

where:

- the x_i values are used corresponding to the current slot and the nextprevious slot taking into account the end-of-frame adjustment and the used CL timing adjustment delay, except in the case of slot 14 wherein the slot 14 and slot 1 of the next frame values are used;
- $h_{2,i}^{(p)}$ is the *i*'th estimated channel tap of antenna 2 using the CPICH;
- $h_{2,i}^{(d)}$ is the *i*'th estimated channel tap of antenna 2 using the DPCCH;
- γ^2 is the DPCH Pilot SNIR/ CPICH SNIR;
- σ_i^2 is the noise plus interference power on the *i*'th path.

In normal operation the *a priori* probability for selected pilot pattern is assumed to be 96% (assuming there are 4% of errors in the feedback channel for power control and antenna selection).

For closed loop mode 2, if channel estimates are taken from the Primary CPICH, antenna verification can also be performed, for example using a 16-hypothesis test per slot. For closed loop mode 2, the same pilot sequence is transmitted on both antennas for DPCCH. Therefore, we obtain channel estimates from the DPCCH that correspond to the combined channel from both transmitting antennas:

$$\vec{h}^{(d)} = \gamma(\beta_1\vec{h}_1 + \beta_2\vec{h}_2) + \vec{b}^{(d)}$$

where β_1, β_2 are the applied coefficients on the antennas at the UTRAN, γ is as defined above for mode 1 verification, $\vec{h}_i$ is the actual channel vector from the *i-th* antenna, and $\vec{b}^{(d)}$ is the noise vector for the DPCCH channel estimate. Furthermore we have channel estimates made on the CPICH Pilots for each antenna:

$$\vec{h}_1^{(p)} = \vec{h}_1 + \vec{b}_1^p$$

$$\vec{h}_2^{(p)} = \vec{h}_2 + \vec{b}_2^p$$

where $\vec{h}_i^{(p)}$ is the estimated channel vector using the CPICH, and $\vec{b}_i^p$ is the noise vector for the CPICH channel estimate, from the *i-th* antenna.

At the receiver, verification consists in choosing a pair of applied coefficients, $(\hat{\beta}_1, \hat{\beta}_2)$, which results in a combined channel estimate from CPICH which best fits the channel estimate obtained from the DPCCH, taking into account the *a priori* probability of error on the FBI bits.

One possible way of implementing verification for mode 2 is by choosing $(\hat{\beta}_1, \hat{\beta}_2)$ from the whole set of possibilities $T = \{\alpha_1, \alpha_2\}$, using the logarithmic form of the following decision rule:

$$(\hat{\beta}_1, \hat{\beta}_2) = \arg\left\langle \max_{\alpha_1,\alpha_2 \in T} \left\{ \ln(\hat{p}(\alpha_1, \alpha_2)) + \ln(\overline{p}(\alpha_1, \alpha_2)) \right\} \right\rangle$$

where the *a priori* probability $\overline{p}(\alpha_1, \alpha_2)$ for each candidate antenna coefficient pair is determined from the antenna coefficient pair asked for by the mobile, combined with the *a priori* probability of each FSM bit used to represent the antenna coefficient pair. The *a priori* probability of each FSM bit is assumed to be 96% (assuming there are 4% of errors in the feedback channel). Also

$$\ln(\hat{p}(\alpha_1, \alpha_2)) = -\left(\sum_{i=1}^{Npath} \frac{\left| h_i^{(d)} - \gamma\left(\alpha_1 h_{1,i}^{(p)} + \alpha_2 h_{2,i}^{(p)}\right) \right|^2}{\sigma_i^2 \left(1 + \gamma^2 \left(\left|\alpha_1\right|^2 + \left|\alpha_2\right|^2\right)\right)} \right)$$

where σ_i^2 is as defined above for mode 1 verification.

3GPP TSG-RAN WG1 Meeting #31
Tokyo, Japan, February 18 – 21, 2003

Tdoc R1-030356

CR-Form-v7

CHANGE REQUEST

⌘	**25.214**	**CR**	**318**	⌘ **rev**	**-**	⌘ Current version: **5.3.0** ⌘

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 [X] Radio Access Network [ ] Core Network [ ]

Title:	⌘	Correction on verification algorithm in Annex 1		
Source:	⌘	TSG RAN WG1		
Work item code:	⌘		***Date:*** ⌘	20/02/2003
Category:	⌘	**A**	***Release:*** ⌘	Rel-5
		Use one 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.		*Use one of the following releases:* *2 (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)*

Reason for change:	⌘	Corrects a sign error in the specification.
Summary of change:	⌘	Corrects a sign error on one formula in TxAA mode 1 antenna verification description. Corrects the derivation of x_i values.
Consequences if not approved:	⌘	A sign mistake in the second formula of Annex A.1 will cause harm for understanding the verification algorithm.

Clauses affected:	⌘	A.1				
		Y	**N**			
Other specs affected:	⌘		**X**	Other core specifications	⌘	
			X	Test specifications		
			X	O&M Specifications		
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.

Annex A (informative):

A.1 Antenna verification

In closed loop mode 1, if channel estimates are taken from the Primary CPICH, the performance will also suffer if the UE can-not detect errors since the channel estimates will be taken for the incorrect phase settings. To mitigate this problem, antenna verification can be done, which can make use of antenna specific pilot patterns of the dedicated physical channel. The antenna verification can be implemented with several different algorithms. A straightforward algorithm can use a 4-hypothesis test per slot. Alternatively, a simplified beam former verification (SBV) requiring only a 2-hypothesis test per slot can be used. If we have orthogonal pilot patterns on the downlink DPCCH we can apply the SBV as follows:

Consider:

$$2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Re}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\overline{p}(\phi_{Rx}=\pi)}{\overline{p}(\phi_{Rx}=0)}\right)$$

then define the variable x_0 as, $x_0 = 0$ if the above inequality holds good and $x_0 = \pi$ otherwise.

Similarly consider:

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\overline{p}(\phi_{Rx}=-\pi/2)}{\overline{p}(\phi_{Rx}=\pi/2)}\right)$$

$$-2\sum_{i=1}^{Npath}\frac{1}{\sigma_i^2}\left\{\sqrt{2}\,\mathrm{Im}(\gamma h_{2,i}^{(d)} h_{2,i}^{(p)^*})\right\} > \ln\left(\frac{\overline{p}(\phi_{Rx}=\pi/2)}{\overline{p}(\phi_{Rx}=-\pi/2)}\right)$$

then define the variable x_1 as, $x_1 = -\pi/2$ if the above inequality holds good and $x_1 = \pi/2$ oherwise.

Whether x_0 or x_1 is to be calculated for each slot is given by the following table:

Slot	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0	x_1	x_0

The estimate for the transmitted phase is now obtained as:

$$\sin(\phi_{Tx}) + j\cos(\phi_{Tx}) = \frac{\sum_{i=0}^{1}\sin(x_i)}{\sqrt{2}} + j\frac{\sum_{i=0}^{1}\cos(x_i)}{\sqrt{2}}$$

where:

- the x_i values are used corresponding to the current slot and the nextprevious slot taking into account the end-of-frame adjustment and the used CL timing adjustment delay, except in the case of slot 14 wherein the slot 14 and slot 1 of the next frame values are used;
- $h_{2,i}^{(p)}$ is the *i*'th estimated channel tap of antenna 2 using the CPICH;
- $h_{2,i}^{(d)}$ is the *i*'th estimated channel tap of antenna 2 using the DPCCH;
- γ^2 is the DPCH Pilot SNIR/ CPICH SNIR;
- σ_i^2 is the noise plus interference power on the *i*'th path.

In normal operation the *a priori* probability for selected pilot pattern is assumed to be 96% (assuming there are 4% of errors in the feedback channel for power control and antenna selection).

For closed loop mode 2, if channel estimates are taken from the Primary CPICH, antenna verification can also be performed, for example using a 16-hypothesis test per slot. For closed loop mode 2, the same pilot sequence is transmitted on both antennas for DPCCH. Therefore, we obtain channel estimates from the DPCCH that correspond to the combined channel from both transmitting antennas:

$$\vec{h}^{(d)} = \gamma(\beta_1 \vec{h}_1 + \beta_2 \vec{h}_2) + \vec{b}^{(d)}$$

where β_1, β_2 are the applied coefficients on the antennas at the UTRAN, γ is as defined above for mode 1 verification, $\vec{h}_i$ is the actual channel vector from the *i-th* antenna, and $\vec{b}^{(d)}$ is the noise vector for the DPCCH channel estimate. Furthermore we have channel estimates made on the CPICH Pilots for each antenna:

$$\vec{h}_1^{(p)} = \vec{h}_1 + \vec{b}_1^{p}$$

$$\vec{h}_2^{(p)} = \vec{h}_2 + \vec{b}_2^{p}$$

where $\vec{h}_i^{(p)}$ is the estimated channel vector using the CPICH, and $\vec{b}_i^{p}$ is the noise vector for the CPICH channel estimate, from the *i-th* antenna.

At the receiver, verification consists in choosing a pair of applied coefficients, $(\hat{\beta}_1, \hat{\beta}_2)$, which results in a combined channel estimate from CPICH which best fits the channel estimate obtained from the DPCCH, taking into account the *a priori* probability of error on the FBI bits.

One possible way of implementing verification for mode 2 is by choosing $(\hat{\beta}_1, \hat{\beta}_2)$ from the whole set of possibilities $T = \{\alpha_1, \alpha_2\}$, using the logarithmic form of the following decision rule:

$$(\hat{\beta}_1, \hat{\beta}_2) = \arg\left\langle \max_{\alpha_1, \alpha_2 \in T} \left\{ \ln(\hat{p}(\alpha_1, \alpha_2)) + \ln(\overline{p}(\alpha_1, \alpha_2)) \right\} \right\rangle$$

where the *a priori* probability $\overline{p}(\alpha_1, \alpha_2)$ for each candidate antenna coefficient pair is determined from the antenna coefficient pair asked for by the mobile, combined with the *a priori* probability of each FSM bit used to represent the antenna coefficient pair. The *a priori* probability of each FSM bit is assumed to be 96% (assuming there are 4% of errors in the feedback channel). Also

$$\ln(\hat{p}(\alpha_1, \alpha_2)) = -\left(\sum_{i=1}^{Npath} \frac{\left| h_i^{(d)} - \gamma\left(\alpha_1 h_{1,i}^{(p)} + \alpha_2 h_{2,i}^{(p)}\right) \right|^2}{\sigma_i^2 \left(1 + \gamma^2 \left(|\alpha_1|^2 + |\alpha_2|^2\right)\right)} \right)$$

where σ_i^2 is as defined above for mode 1 verification.