

Señores

DIVISION DE NUEVAS CREACIONES

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

Bogotá, D.C.

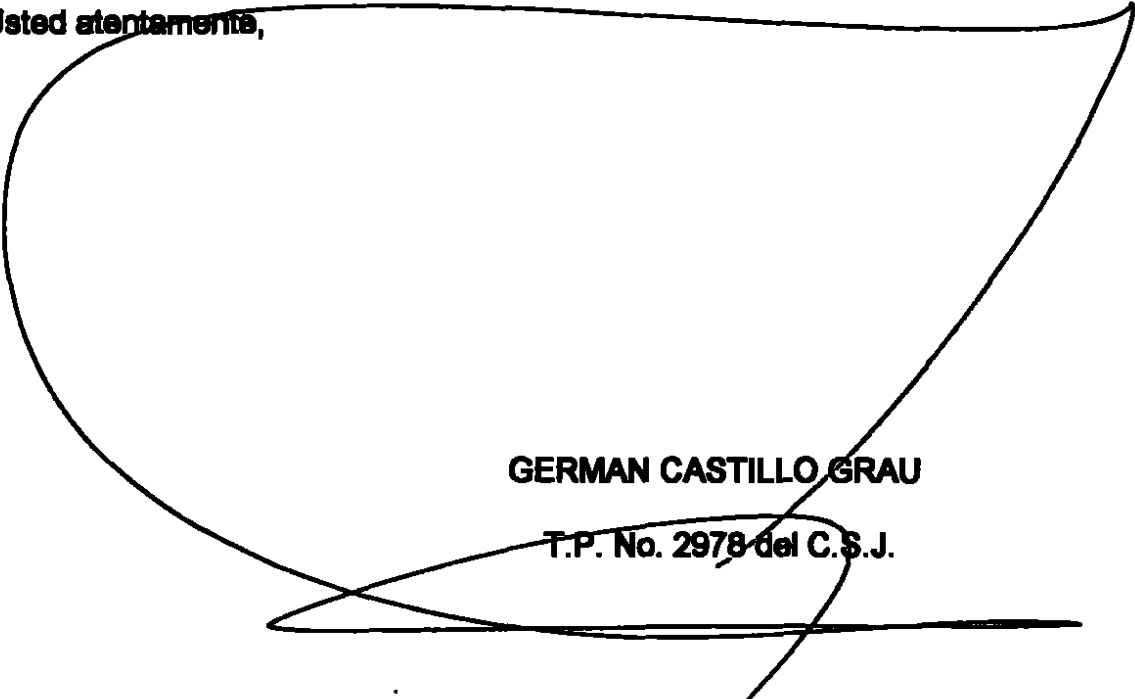
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Solicitud de Patente

Debidamente traducida, adjunto acompaño la copia oficial de la solicitud de patente básica estadounidense No. 09/455.087 la cual le solicito agregar a este expediente para los efectos legales respectivos.

De Usted atentamente,



GERMAN CASTILLO GRAU

T.P. No. 2978 del C.S.J.

ESTADOS UNIDOS DE AMERICA

A TODOS A QUIENES LLEGUE EL PRESENTE:

DEPARTAMENTO DE COMERCIO DE LOS ESTADOS UNIDOS

Oficina de Marcas y Patentes

16 de noviembre del 2000

LA PRESENTE CERTIFICA QUE LA ADJUNTA ES UNA COPIA TOMADA DE LOS REGISTROS DE LA OFICINA DE MARCAS Y PATENTES DE LOS ESTADOS UNIDOS, DE LOS DOCUMENTOS DE LA SOLICITUD DE PATENTE ABAJO IDENTIFICADA Y LA CUAL CUMPLE CON LOS REQUISITOS PARA QUE LE SEA CONFERIDA UNA FECHA DE RADICACIÓN SEGÚN 35 USC 111.

NÚMERO DE SOLICITUD 09/455.087

FECHA DE RADICACIÓN: 06 de diciembre de 1999

Por Autoridad del

COMISIONADO DE MARCAS Y PATENTES

(FIRMA) N. WOODSON

Oficial de Certificaciones

(SELLO DORADO DE OBLEA)

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**MÉTODO APARATO PARA TRANSFORMAR UNA ESTIMACIÓN DE
CANAL**

REIVINDICACIONES:

1. Un aparato para estimar un canal para una señal recibida, en el cual diferentes partes de la señal recibida son moduladas utilizando diferentes tipos de modulación; el aparato comprende:

un estimador de canal para estimar el canal basado en parte de una señal recibida modulada utilizando un primer tipo de modulación; y

un transformador de estimación de canal para transformar la estimación de canal a otra estimación de canal correspondiente al menos a un segundo tipo de modulación.

2. El aparato de la reivindicación 1, en el cual el primer tipo de modulación es utilizado para una primera porción de la señal recibida, y el segundo tipo de modulación es utilizado para una segunda porción de la señal recibida.

3. El aparato de la reivindicación 2, en el cual la primera porción es una secuencia de acondicionamiento, y la segunda porción es una secuencia de información.

4. El aparato según la reivindicación 1, que además comprende:

un primer desrotador para desrotar la parte de la señal recibida modulada utilizando el primer tipo de modulación por una cantidad apropiada para el primer tipo de modulación; y

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al menos un segundo desrotador para desrotar parte de la señal recibida modulada utilizando el segundo tipo de modulación por una cantidad apropiada para el segundo tipo de modulación.

5. El aparato de la reivindicación 1, en el cual el transformador de estimación de canal multiplica la estimación de canal por una matriz.

6. El aparato de la reivindicación 5, en el cual la matriz es precomputada y almacenada en una memoria.

7. El aparato de la reivindicación 5, en el cual la matriz es computada para cada muestra de la señal recibida.

8. El aparato de la reivindicación 1, que además comprende un sincronizador para determinar una posición de inicio de la parte de la señal recibida modulada utilizando el primer tipo de modulación para establecer sincronización.

9. El aparato de la reivindicación 1, que además comprende un ecualizador para ecualizar la estimación de canal transformada y una parte de la señal recibida modulada utilizando el primer tipo de modulación.

10. El aparato de la reivindicación 1, que además comprende una memoria intermedia para almacenar la señal recibida.

11. Un método para estimar un canal en una señal recibida, en el cual diferentes partes de la señal recibida son moduladas utilizando diferentes tipos de modulación; el método consta de los siguientes pasos:

estimar un canal basado en parte de la señal recibida modulada utilizando un primer tipo de modulación; y

transformar la estimación de canal a otra estimación de canal correspondiente al menos a un segundo tipo de modulación.

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12. El método de la reivindicación 11, en el cual el primer tipo de modulación es utilizado para la primera porción de la señal recibida, y el segundo tipo de modulación es utilizado para una segunda porción de la señal recibida.

13. El método de la reivindicación 12, en el cual la primera porción es una secuencia de acondicionamiento, y la segunda porción es una secuencia de información.

14. El método de la reivindicación 11 que además consiste en:

desrotar parte de la señal recibida modulada utilizando un primer tipo de modulación por una cantidad apropiada para el primer tipo de modulación; y

desrotar parte de la señal recibida modulada utilizando al menos un segundo tipo de modulación por una cantidad apropiada para el segundo tipo de modulación.

15. El método de la reivindicación 11, en el cual el paso de transformar la estimación del canal consiste en multiplicar la estimación del canal por una matriz.

16. El método de la reivindicación 15, en el cual la matriz es precomputada y almacenada en una memoria.

17. El método de la reivindicación 15, en el cual la matriz es computada para cada muestra de la señal recibida.

18. El método de la reivindicación 11 que además consiste en:

determinar una posición de inicio de la parte de la señal recibida modulada utilizando el primer tipo de modulación para establecer sincronización.

19. El método de la reivindicación 11 que además consiste en:

ecualizar la estimación de canal transformada y una parte de la señal recibida modulada utilizando el segundo tipo de modulación

20. El método de la reivindicación 11, que además consiste en almacenar la señal recibida.

PA 225016



THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

November 16, 2000

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OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT
APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A
FILING DATE UNDER 35 USC 111

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By Authority of the
COMMISSIONER OF PATENTS AND TRADEMARKS

N WOODSON

Certifying Officer

12-017-44

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Patent

Attorney's Docket No 040070-801

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

UTILITY PATENT
APPLICATION TRANSMITTAL LETTERBox PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D C. 20231

Sir

Enclosed for filing is the utility patent application of Bengt LINDOFF for Method and Apparatus for Transforming a Channel Estimate.

Also enclosed are:

- ☒ 2 sheet(s) of ☐ formal ☒ informal drawing(s);
- ☒ an Assignment document;
- ☒ An ☒ executed ☐ unexecuted declaration of the inventor(s)
- ☒ also is enclosed ☐ will follow
- ☒ A bibliographic data entry sheet is enclosed.

	NO. OF CLAIMS		EXTRA CLAIMS	RATE	FEE
Basic Application Fee (101)					\$ 760.00
Total Claims	20	MINUS 20 =	0	x \$18 = (103)	.00
Independent Claims	2	MINUS 3 =	0	x \$78 = (102)	.00
If multiple dependent claims are presented, add \$260.00 (104)					.00
Total Application Fee					\$760.00
If verified statement claiming small entity status is enclosed, subtract 50% of Total Application Fee					.00
Add Assignment Recording Fee of \$40.00 (581) if Assignment document is enclosed					\$40.00
TOTAL APPLICATION FEE DUE					\$800.00



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- ☐ This application is being filed without a filing fee. Issuance of a Notice to File Missing Parts of Application is respectfully requested.
- ☐ A check in the amount of \$_____ is enclosed for the fee due.
- ☒ Charge \$ 800.00 to Deposit Account No. 02-4800 for the fee due.
- ☒ The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in duplicate.

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Respectfully submitted,

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APPLICATION INFORMATION

Title Line One Method and Apparatus for Transforming a
Title Line Two Channel Estimate
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METHOD AND APPARATUS FOR TRANSFORMING A CHANNEL ESTIMATE

BACKGROUND

This invention relates generally to a method and apparatus for channel estimation. More particularly, this invention relates to a method and apparatus for transforming a channel estimate obtained for one modulation type to the corresponding channel estimate for another modulation type.

In a communication system such as a cellular communication system including a transmitter, e.g., a base station, and a receiver, e.g., a mobile station or a fixed cellular terminal, information exchanged between the transmitter and receiver contains data bits and synchronization bits. The information is modulated for transmission.

In some cellular communication systems it can be an advantage to use one modulation type during a first portion of the transmitted signal, e.g., the portion used for synchronization and channel estimation, and another modulation type for a second portion of the transmitted signal, e.g., the portion containing the data to be transmitted. This allows the modulation types to be chosen for efficient transmitter implementation. For an efficient transmitter architecture, an offset is typically introduced in the modulation format. For instance for an 8-PSK signal, the transmitted signal can be given by

$$x_i = e^{j\frac{\pi}{4}} v_i \quad (1)$$

where

$$v_i = e^{j\frac{\pi}{4}k}, k \in (0,1,...,7) \quad (2)$$

The offset here means that the symbol constellation rotates $\pi/8$ radian between adjacent symbols. This rotation produces a transmitted signal with low peak-to-average ratio and no zero-crossing, which allows for an efficient transmitter architecture.

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On the receiver side, the received signal has to be de-rotated in order to correctly detect the received symbols. However, due to multi-path propagation of the radio waves, the rotation of the received signals results in a radio channel estimate that is a function of the offset rotation.

5 Information in cellular radio systems is typically transmitted in bursts containing a synchronization signal, such as a training sequence, and an information sequence. If the whole burst is transmitted with the same modulation format, there are no negative effects caused by the channel estimate being a function of the offset rotation. However, if one modulation type, with a specific offset, is used for the training sequence and another
10 modulation type, with another offset, is used for the information sequence, the channel estimate obtained for the first modulation type must be transformed to a correct channel estimate for the second modulation type.

There is thus a need for an efficient technique algorithm that transforms a channel estimate obtained for one modulation type to the corresponding channel estimate for
15 another modulation type.

SUMMARY

It is therefore an object of the present invention to provide an accurate channel estimate for a received signal when different parts of the received signal are modulated by
20 more than one modulation type.

According to exemplary embodiments, this and other objects are met by a method and apparatus for estimating a channel in a received signal, wherein different parts of the received signal are modulated by different modulation types. The channel is estimated based on a part of the received signal modulated using a first modulation type. The
25 estimated channel is then transformed into a channel estimate corresponding to at least a second modulation type.

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BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of this invention will become apparent by reading this description in conjunction with the accompanying drawings, in which like reference numerals refer to like elements and in which

5 FIG 1 illustrates an exemplary apparatus for channel estimation and transformation according to an exemplary embodiment of the present invention, and

FIG 2 illustrates an exemplary method for channel estimation and transformation according to an exemplary embodiment of the present invention.

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DETAILED DESCRIPTION

For illustrative purposes, the following description is directed to a cellular radio communication system, but it will be understood that this invention is not so limited and applies to other types of communication systems.

15 FIG 1 illustrates an exemplary apparatus for channel estimation and transformation according to an exemplary embodiment of the present invention. This apparatus can be included in a receiver, e.g., a mobile station or a fixed cellular terminal. A received signal y_n from a transmitter, e.g., a base station, is down converted to a baseband signal, sampled, with a predefined burst length, and stored in a Buffer 100. The received signal y_n can be written as.

$$y_n = h_0 u_n + \dots + h_L u_{n-L} + e_n, n = 1, \dots, K \quad (3)$$

20 where K is the burst length, $h = [h_0, \dots, h_L]$ is the radio channel, e_n represents noise, and u_k is the transmitted symbol at time k , which can be given by the equation.

$$u_k = e^{j\theta_k} v_k^i, i = 1, 2 \quad (4)$$

where v_k^i is a symbol from a specific symbol constellation (for instance a 8-PSK signal), and $\theta_i, i = 1, 2$ is the offset chosen for the present modulation format (for instance $\theta_i = \pi/8$ for $\pi/8$ offset 8-PSK). In the following description, it is assumed that a first modulation type, with offset θ_1 , is used for a first part of the received signal, e.g., the

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training sequence, and a second modulation type, with offset θ_2 , is used for a second part of the received signal, e.g., the information sequence. The first part of the received signal which contains the training sequence is output from the Buffer 100 to a Derotation unit 105 unit that de-rotates the first portion by a factor θ_1 . The output from the Derotation

5 105 unit can then be written as

$$\begin{aligned} y_n^{(1)} &= e^{-j\theta_1 n} y_n \\ &= h_0 v_n^{(1)} + h_1 e^{-j\theta_1} v_{n-1}^{(1)} + \dots + h_L e^{-j\theta_1 L} v_{n-L}^{(1)} + e_n \\ &= H_{\text{mod}_1}^T V_n^{(1)} + e_n, \quad n = n_0 n_0 + 1, \dots, n_1 \end{aligned} \quad (5)$$

where $H_{\text{mod}_1} = [h_0, h_1 e^{-j\theta_1}, \dots, h_L e^{-j\theta_1 L}]^T$, $V_n^{(1)} = [v_n^{(1)}, \dots, v_{n-L}^{(1)}]^T$, and e_n is a rotated version of the noise. The signal $y_n^{(1)}$ is then fed to a Synchronization unit 110 that correlates the signal $y_n^{(1)}$ with the known training sequences $v_i^{(1,TS)}$, $i = 1, \dots, n_{TS}$ of the communication system in order to determine where the training sequence begins within the received burst to establish burst synchronization. The Synchronization unit 110 may be implemented with any type of conventional synchronization device, e.g., that described in J Proakis, Digital Communications, McGraw-Hill Inc., New York, 1995 and WO 96/13910

Information representing the starting or synchronization position of the training sequence, together with the derotated signal $y_n^{(1)}$ and the system training sequence $v_i^{(1,TS)}$, are then input to a Channel Estimator 130 which estimates the received signal with regard to the first modulation type. The Estimator 130 can be implemented with any type of conventional channel estimator, e.g., a Least Squares estimator. The output from the Channel Estimator 130, which is an estimate of the channel for the first modulation type, $H_{\text{mod}_1} = \{\hat{h}_i^{(1)}\}_{i=0,L}$, is fed to a Channel Transformation unit 135, along with the system training sequence $v_i^{(1,TS)}$. The Channel Transformation unit 135 transforms the estimate to a channel estimate that corresponds to the second modulation type, $H_{\text{mod}_2} = \{\hat{h}_i^{(2)}\}_{i=0,L}$. An exemplary transform algorithm is described in more detail below

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A second portion of the received signal y_n , corresponding to, e.g., the information sequence, stored in the Buffer 100 is derotated in a De-rotation unit 120, resulting in a signal $y_n^{(2)}$ which can be given by the equations

$$\begin{aligned} y_n^{(2)} &= e^{-j\theta_2} y_n \\ &= h_0 v_n^{(2)} + h_1 e^{-j\theta_2} v_{n-1}^{(2)} + \dots + h_L e^{-j\theta_2 L} v_{n-L}^{(2)} + e_n \\ &= H_{\text{mod}_2}^T V_n^{(2)} + e_n, \quad n=1, n_s, n_s + n_{TS} + 1, \dots, K \end{aligned} \quad (6)$$

where $H_{\text{mod}_2} = [h_0, h_1 e^{-j\theta_2}, \dots, h_L e^{-j\theta_2 L}]^T$, $V_n^{(2)} = [v_n^{(2)}, \dots, v_{n-L}^{(2)}]^T$, and e_n is a rotated version of the noise

The channel estimate for the second modulation type is then input to an Equalizer 140 together with the derotated information sequence $y_n^{(2)}$. The Equalizer 140 can be of any kind, for instance a Maximum Likelihood Sequence Estimator (MLSE) equalizer as described in J Proakis, Digital Communications. The Equalizer 140 demodulates the received signal. From the received sequence y , the Equalizer tries to find the most likely transmitted symbols v . The output from the Equalizer 140 is the decoded symbol.

According to an exemplary embodiment, the channel transformation can be performed in the following manner. Assume the Channel Estimator 130 is of the Least Squares type. Then, the least squares estimate of H_{mod_1} , can be written as

$$\begin{aligned} \hat{H}_{\text{mod}_1} &= \left(\sum_k V_k^* V_k^T \right)^{-1} \left(\sum_k V_k^* y_k^{(1)} \right) \\ &= \left(\sum_k V_k^* V_k^T \right)^{-1} \left(\sum_k V_k^* \bar{V}_k^T \right) H + \left(\sum_k V_k^* V_k^T \right)^{-1} \left(\sum_k V_k^* \bar{V}_k^T e_k \right) \end{aligned} \quad (7)$$

where V^* is the complex conjugate of V , and $\bar{V}_k = [v_k, v_{k-1} e^{-j\theta_1}, \dots, v_{k-L} e^{-j\theta_1 L}]^T$. As can be seen from Equation 7, $\hat{H}_{\text{mod}_1}$ is an estimate of the channel that corresponds to the first modulation type, since it depends on the offset θ_1 (through the vector $\bar{V}_k$) for this modulation. However, the relationship between $\hat{H}_{\text{mod}_1}$ and H can be written according to

$$\hat{H}_{\text{mod}_1} = AH + e \quad (8)$$

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where ε is the uncertainty in the estimate, and A is given by

$$A = \left(\sum_k V_k^* V_k^T \right)^{-1} \left(\sum_k V_k^* \hat{p}_k^T \right) \quad (9)$$

Since θ and V_k are known in advance from the system training sequence, A can be precomputed. Further, from Equation 6 it can be seen that

$$\begin{aligned} H_{\text{mod}_1} &= BH \\ B &= \text{diag} (1, e^{-jA_1}, \dots, e^{-jA_L}) \end{aligned} \quad (10)$$

where $\text{diag}(X)$ is a diagonal matrix with diagonal element X . Thus, the relationship between $\hat{H}_{\text{mod}_1}$ and $\hat{H}_{\text{mod}_2}$ can be given as

$$\hat{H}_{\text{mod}_2} = C \hat{H}_{\text{mod}_1} = BA^{-1} \hat{H}_{\text{mod}_1} \quad (11)$$

Both the matrices A and B are known in advance. Hence, the $(L+1) \times (L+1)$ matrix $C = BA^{-1}$ can be precomputed and stored in a memory. Alternately, the matrix C can be computed for each burst. In either case, the channel transformation can be performed with a simple matrix multiplication.

FIG 2 illustrates a method for channel estimation and transformation according to an exemplary embodiment. The method begins at step 200 at which a received signal is stored in a buffer. At step 210, a first portion of the received signal, e.g., the training sequence, modulated with a first modulation type is derotated. At step 220, synchronization is established by determining the starting position of the training sequence in the received burst. At step 230, channel estimation is performed using the start position and the derotated training sequence, as well as a known training sequence of the communication system. At step 240, the channel estimate for the first modulation type is transformed into a channel estimate for the second modulation type. At step 250, a second portion of the received signal, e.g., the information sequence, modulated with

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the second modulation type, is derotated. Finally, at step 260, the derotated information sequence is demodulated in an Equalizer using the transformed channel estimate. The output of the Equalizer represents the decided symbol of the second modulation type.

It will be appreciated that the order of steps described is given by way of example only, and the order can be changed as desired. For example, the second portion of the received signal can be derotated at any convenient point before equalization.

For ease of explanation, the description above is based on a signal with one modulation applied to the training sequence and another modulation type applied to the information sequence. However, the invention is not so limited but may apply to any number of modulation types used. For example, assume that a first of the transmitted signal portion, e.g., the training sequence, is modulated with modulation type 1 with phase offset θ_1 , a second portion of the transmitted signal, e.g., a first part of the information sequence, is modulated with modulation type 2 with phase offset θ_2 , and the n th portion of the signal, e.g., the last part of the information sequence, is modulated with modulation type n with phase offset θ_n . Then, the channel estimate H_{mod_1} for the training sequence may be transformed to channel estimates $H_{\text{mod}_1}, \dots, H_{\text{mod}_n}$ for each of the $n-1$ other modulation types.

This invention proposes an efficient method to transform a channel estimate obtained for one modulation type to the corresponding channel estimate for another modulation type. The transform is a function of the offsets used for the different modulation types and the known training sequence, and can therefore be precomputed and stored in memory, which allows for an efficient implementation. The transformed channel estimate is then used in an equalizer for decoding the received data.

It will be appreciated by those of ordinary skill in the art that this invention can be embodied in other specific forms without departing from its essential character. The embodiments described above should therefore be considered in all respects to be illustrative and not restrictive. For example, although described above with reference to

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mobile and base stations in cellular communication systems, the invention is applicable to other types of communication systems.

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WHAT IS CLAIMED IS

- 1 An apparatus for estimating a channel for a received signal, wherein
different parts of the received signal are modulated using different modulation types,
5 comprising.
- a channel estimator for estimating the channel based on part of a received
signal modulated using a first modulation type; and
- a channel estimate transformer for transforming the channel estimate to
another channel estimate corresponding to at least a second modulation type.
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- 2 The apparatus of claim 1, wherein the first modulation type is used for a
first portion of the received signal, and the second modulation type is used for a second
portion of the received signal.
- 15 3 The apparatus of claim 2, wherein the first portion is a training sequence,
and the second portion is an information sequence.
- 4 The apparatus of claim 1, further comprising
- a first derotator for derotating the part of the received signal modulated
20 using the first modulation type by an amount appropriate for the first modulation type;
and
- at least a second derotator for derotating part of the received signal
modulated using the second modulation type by an amount appropriate for the second
modulation type.
25
- 5 The apparatus of claim 1, wherein the channel estimate transformer
multiplies the channel estimate by a matrix

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6. The apparatus of claim 5, wherein the matrix is precomputed and stored in a memory

7 The apparatus of claim 5, wherein the matrix is computed for each sample of the received signal.

8 The apparatus of claim 1, further comprising a synchronizer for determining a starting position of the part of the received signal modulated using the first modulation type to establish synchronization.

9 The apparatus of claim 1, further comprising an equalizer for equalizing the transformed channel estimate and a part of the received signal modulated using the second modulation type.

10 The apparatus of claim 1, further comprising a buffer for storing the received signal.

11 A method for estimating a channel in a received signal, wherein different parts of the received signal are modulated using different modulation types, comprising the steps of

estimating a channel based on part of the received signal modulated using a first modulation type; and

transforming the channel estimate to another channel estimate corresponding to at least a second modulation type.

12 The method of claim 11, wherein the first modulation type is used for a first portion of the received signal, and the second modulation type is used for a second portion of the received signal.

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13 The method of claim 12, wherein the first portion is a training sequence,
and the second portion is an information sequence.

5 14 The method of claim 11, further comprising:
derotating part of the received signal modulated using a first modulation
type by an amount appropriate for the first modulation type; and
derotating part of the received signal modulated using at least a second
modulation type by an amount appropriate for the second modulation type.

10 15 The method of claim 11, wherein the step of transforming the channel
estimate comprises multiplying the channel estimate by a matrix.

15 16. The method of claim 15, wherein the matrix is precomputed and stored in
a memory

17 The method of claim 15, wherein the matrix is computed for each sample
of the received signal.

20 18 The method of claim 11, further comprising:
determining a starting position of the part of the received signal modulated
using the first modulation type to establish synchronization.

25 19 The method of claim 11, further comprising:
equalizing the transformed channel estimate and a part of the received
signal modulated using the second modulation type.

20 The method of claim 11, further comprising storing the received signal

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Attorney Docket No 040070-801

ABSTRACT

Channel estimation is performed for a received signal, wherein different parts of the received signals are modulated using different modulation types. The channel is first estimated based on part of a received signal modulated with a first modulation type. This
5 channel estimate is then transformed into a channel estimate corresponding to at least a second modulation type.

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COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
(Includes Reference to Provisional and PCT International Applications)

ATTORNEY'S DOCKET NUMBER

040070-801

As a below named inventor, I hereby declare that
My residence, post office address and citizenship are as stated below next to my name;
I believe I am the original first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled.

Method and Apparatus for Transforming a Channel Estimate

the specification of which (check only one item below)

☒ is attached hereto

☐ was filed as United States application

Number _____

on _____

and was amended

on _____ (if applicable)

☐ was filed as PCT international application

Number _____

on _____

and was amended under PCT Article 19 and/or PCT Article 34

on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37 Code of Federal Regulations, § 1.56

I hereby claim foreign priority benefits under Title 35 United States Code, §§ 119 (a)-(e) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

COUNTRY (if PCT indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. § 119
			__ Yes __ No
			__ Yes __ No
			__ Yes __ No
			__ Yes __ No
			__ Yes __ No

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below

(Application Number) _____

(Filing Date) _____

(Application Number) _____

(Filing Date) _____

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (CONTINUED)
(Includes Reference to Provisional and PCT International Applications)

ATTORNEY'S DOCKET NO
040070-801

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose to the Office all information known to me to be material to the patentability as defined in Title 37, Code of Federal Regulations § 1.56, which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. § 120:

U.S. APPLICATIONS		STATUS (check one)		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.

PCT APPLICATION NO.	PCT FILING DATE	U.S. APPLICATION NUMBERS ASSIGNED (if any)			

I hereby appoint the following attorneys and agent(s) to prosecute said application and to transact all business in the Patent and Trademark Office connected therewith and to file, prosecute and to transact all business in connection with international applications directed to said invention:

☐ William L. Mathis	17,337	☐ R. Denny Hestingsen	27,903	☐ Gerald F. Swine	30,113
☐ Robert S. Swecker	19,823	☐ Eric H. Weidman	30,505	☐ Michael J. Ure	33,089
☐ Philip N. Mathews	22,124	☐ James W. Peterson	26,037	☐ Charles F. Whitland III	33,096
☐ Dennis S. Duffus, Jr.	22,030	☐ Tereza Smutek Ben	30,437	☐ Bruce T. Windsor	33,815
☐ Norman H. Supina	22,716	☐ Robert E. Krebs	25,825	☐ Todd E. Wilburn	34,040
☐ Ronald L. Grudisfeld	24,970	☐ William C. Rowland	30,838	☐ Russ S. Johnson	31,979
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☐ Samuel C. Miller, III	27,360	☐ William H. Benz	25,932	☐ Brian P. O'Steenhousey	32,747
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☐ George A. Rowman, Jr.	28,223	☐ Richard J. McGrath	29,135		
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Page 2 of 3

(11/99)

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (CONTINUED) (Includes References to Provisional and PCT International Applications)		ATTORNEY'S SOCIETY NO. 040070-801	
FULL NAME OF SOLE OR FIRST INVENTOR Bengt LINDOFF		SIGNATURE <i>Bengt Lindoff</i>	
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FULL NAME OF SECOND JOINT INVENTOR, IF ANY		SIGNATURE	
RESIDENCE		DATE	
POST OFFICE ADDRESS			
FULL NAME OF THIRD JOINT INVENTOR, IF ANY		SIGNATURE	
RESIDENCE		DATE	
POST OFFICE ADDRESS			
FULL NAME OF FOURTH JOINT INVENTOR, IF ANY		SIGNATURE	
RESIDENCE		DATE	
POST OFFICE ADDRESS			
FULL NAME OF FIFTH JOINT INVENTOR, IF ANY		SIGNATURE	
RESIDENCE		DATE	
POST OFFICE ADDRESS			
FULL NAME OF SIXTH JOINT INVENTOR, IF ANY		SIGNATURE	
RESIDENCE		DATE	
POST OFFICE ADDRESS			
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RESIDENCE		DATE	
POST OFFICE ADDRESS			
FULL NAME OF EIGHTH JOINT INVENTOR, IF ANY		SIGNATURE	
RESIDENCE		DATE	
POST OFFICE ADDRESS			
FULL NAME OF NINTH JOINT INVENTOR, IF ANY		SIGNATURE	
RESIDENCE		DATE	
POST OFFICE ADDRESS			

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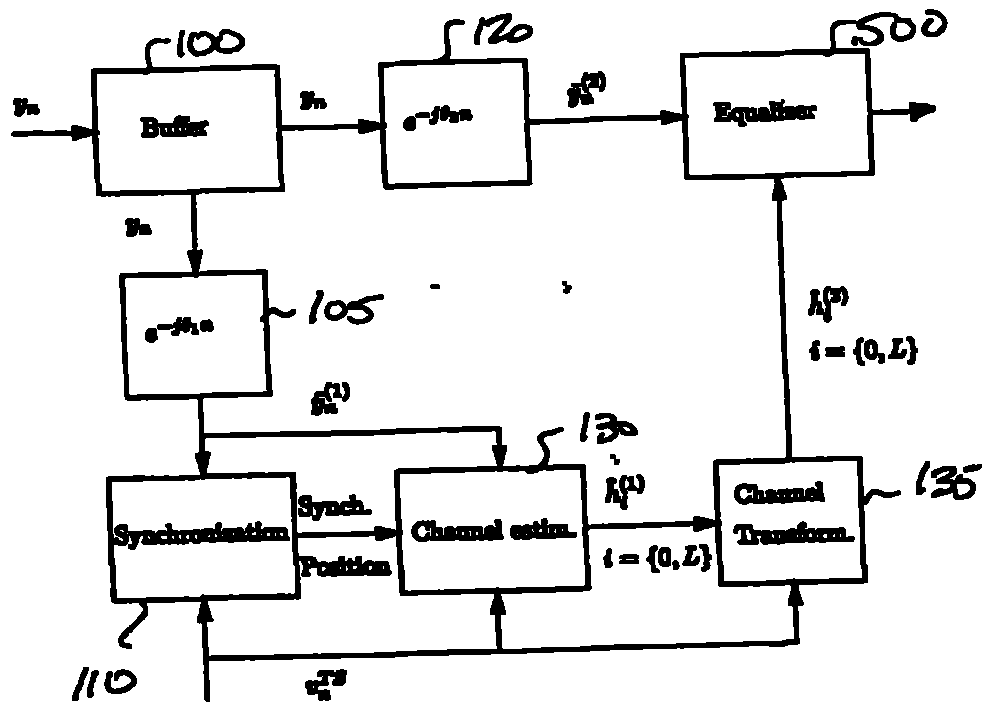


FIG 1

48

27

46

49

28
97

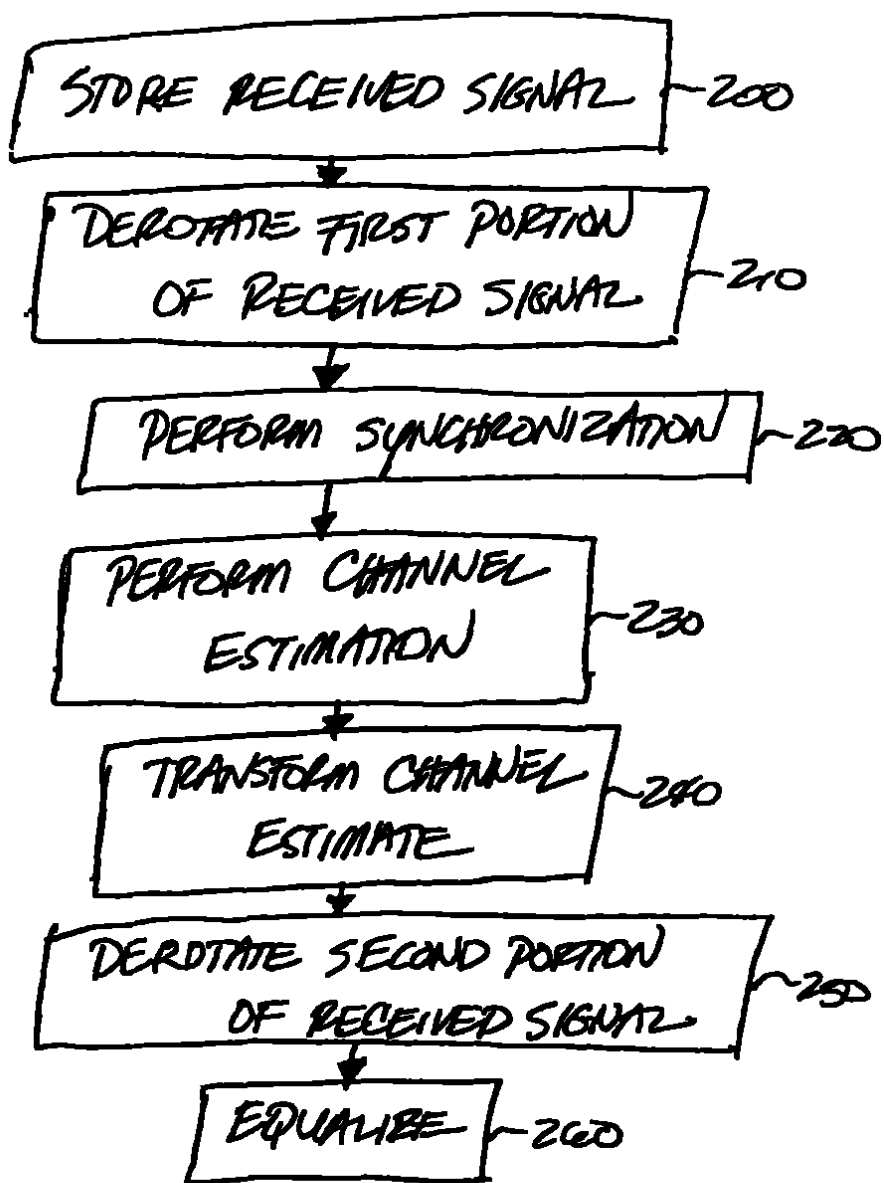


FIG 2

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