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**Datasheet for the decision
of 14 November 2014**

Case Number: T 0851/10 - 3.5.05
Application Number: 99966908.8
Publication Number: 1236326
IPC: H04L27/26, H04L25/03, H04B7/08,
H04L1/06
Language of the proceedings: EN

Title of invention:

METHOD FOR CO-CHANNEL INTERFERENCE CANCELLATION IN A
MULTICARRIER COMMUNICATION SYSTEM

Applicant:

Deutsche Telekom AG

Headword:

OFDM co-channel interference cancellation/DEUTSCHE TELEKOM

Relevant legal provisions:

EPC Art. 54, 56

Keyword:

Decisions cited:

Catchword:



**Beschwerdekammern
Boards of Appeal
Chambres de recours**

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Case Number: T 0851/10 - 3.5.05

D E C I S I O N
of Technical Board of Appeal 3.5.05
of 14 November 2014

Appellant: Deutsche Telekom AG
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Representative: Blumbach Zinngrebe
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted on 11 December 2009 refusing European patent application No. 99966908.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chair A. Ritzka
Members: P. Cretaine
D. Prietzel-Funk

Summary of Facts and Submissions

I. This appeal is against the decision of the examining division posted 11 December 2009 and refusing European patent application No. 99966908.8. The decision was taken according to the state of the file and referred to the communication dated 7 May 2008. In said communication, novelty objections (Article 54 EPC) were raised against the independent claims of a sole request, based on the disclosure of

D1: US 5 867 478,

and inventive step objections (Article 56 EPC) were raised against the dependent claims, based on the disclosures of D1 and

D2: US 5 537 443.

II. Notice of appeal was received on 3 February 2010 and the appeal fee was paid on the same day. A statement setting out the grounds of appeal was received on 9 April 2010. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the claims of the main request or of auxiliary requests 1 to 3 submitted with the letter setting out the grounds of appeal. In addition, oral proceedings were requested as an auxiliary measure.

III. A summons to oral proceedings scheduled for 14 October 2014 was issued on 11 July 2014. In an annex accompanying the summons the board gave its preliminary opinion that the application did not meet the requirements of the EPC. In particular, objections under Article 54 EPC in view of D1 were raised against the main request and auxiliary request 1, and

objections under Article 56 EPC in view of D1 and D2 were raised against auxiliary requests 2 and 3.

- IV. By letter dated 13 October 2014 the appellant maintained its previous requests and submitted new arguments supporting these requests. The appellant's representative further informed the board that he would not be attending the hearing on 14 November 2014.
- V. Oral proceedings were held as scheduled on 14 November 2014 in the absence of the appellant. After due deliberation on the basis of the written submissions, the board announced its decision.
- VI. Claim 1 of the **main request** reads as follows:

"A receiver for use in a digital multi-carrier communication system, comprising

a) at least one receiving branch (#1, #2), wherein each receiving branch comprises demodulating means (O; O₁, O₂) for converting a received serial multi-carrier signal including at least one desired and interference signal into a plurality (L) of sub-carrier signals, and

b) a plurality (L) of interference cancellers (17₁-17_L) each of which is associated to a respective one of said subcarrier signals for cancelling co-channel interference; wherein each interference canceller (17₁-17_L) comprises a transmitted symbol estimation part (40) connected to a metric generator (18; 18₁, 18₂) for applying a set of symbol candidates both for the at least desired and interference signals to the metric generator (18; 18₁, 18₂) and for receiving metric values generated by the metric generator (18; 18₁, 18₂) by using a received sub carrier signal and said set of

symbol candidates, wherein said transmitted symbol estimation part (40) is configured to determine the most likely set of symbol candidates by using the metric values."

The **main request** comprises a further independent claim (claim 18) directed to a corresponding method.

Claim 1 of **auxiliary request 1** adds to claim 1 of the main request the following feature, inserted after the wording "for cancelling co-channel interference":

"thereby subtracting an estimated desired received sub-carrier signal and an estimated interference sub-carrier signal from a received sub-carrier signal"

Auxiliary request 1 comprises a further independent claim (claim 18) directed to a corresponding method.

Claim 1 of **auxiliary request 2** adds to claim 1 of the main request the following feature, appended at the end of the claim:

"wherein the metric generator (18; 18₁, 18₂) comprises a channel parameter estimation part (50; 50₁, 50₂) for estimating signal transmission channel parameters both of the at least one desired and interference signals by using the set of the desired and the interference signal symbol candidates provided by said transmitted symbol estimation part (40) and an estimation error signal provided by an error estimation part (30; 30₁, 30₂), a replica generator (20; 20₁, 20₂) for generating a replica signal from both of the desired and the interference signals by using the set of the desired and the interference signal symbol candidates and the desired and the interference signal channel

parameters provided by said channel parameter estimation part (50; 50₁, 50₂) wherein said error estimation part (30; 30₁, 30₂) is adapted to generate the estimation error signal by using said received sub carrier signal and the replica signal and a metric calculator (60, 60₁, 60₂) connected to said transmitted symbol estimation part (40) for generating metric values from the estimation error signal."

Auxiliary request 2 comprises a further independent claim (claim 17) directed to a corresponding method.

Claim 1 of **auxiliary request 3** is a combination of claim 1 of auxiliary request 1 and claim 1 of auxiliary request 2.

Auxiliary request 3 comprises a further independent claim (claim 17) directed to a corresponding method.

Reasons for the Decision

1. The appeal is admissible.
2. Non-attendance at oral proceedings

Although the appellant's representative announced his intention not to attend, the appellant did not withdraw its request for oral proceedings. Pursuant to Article 15(3) RPBA, the board is not obliged to delay any step in the appeal proceedings, including its decision, by reason only of the absence at the oral proceedings of any party duly summoned who may then be treated as relying only on its written case.

The appellant could reasonably have expected that during the oral proceedings the board would consider the objections and issues raised in the communication annexed to the summons to oral proceedings. In deciding not to attend the oral proceedings, the appellant chose to rely only on its arguments presented in the statement setting out the grounds of appeal and in the response to the annex to the summons to oral proceedings.

3. Main request

Claim 1 corresponds in substance to claim 1 on which the decision was based. The board concurs with the examining division that the subject-matter of this claim is already disclosed in D1 (Article 54 EPC).

In that respect, D1 discloses (the references in parentheses applying to this document), according to all the features of claim 1 and using the terminology of this claim:

A receiver for use in a digital multi-carrier communication system, comprising

- a) at least one receiving branch (see column 18, lines 1 to 8), wherein each receiving branch comprises demodulating means for converting a received serial multi-carrier signal including at least one desired and interference signal into a plurality of sub-carrier signals (see column 14, lines 50 to 53), and
- b) a plurality of interference cancellers each of which is associated to a respective one of said sub-carrier signals for cancelling co-channel interference (see column 18, lines 9 to 48), wherein each interference canceller comprises a transmitted symbol estimation

part connected to a metric generator (see column 28, lines 22 to 25) for applying a set of symbol candidates both for the at least desired and interference signals to the metric generator (see column 18, lines 26 to 48: candidate symbol sets $x_k(m,n)$) and for receiving metric values generated by the metric generator (see column 18, lines 26 to 30: metric J) by using a received sub-carrier signal ($y(m,n)$) and said set of symbol candidates ($x^{\wedge}_k(m,n)$), wherein said transmitted symbol estimation part is configured to determine the most likely set of symbol candidates by using the metric values (see column 18, lines 22 to 30: the set $x^{\wedge}_k(m,n)$ minimizing the metric J).

The appellant argued that the device in D1 does not cancel the interference but rather reduces the contribution of the interference signals to the received signal and that the desired received signal and interference signals are not added together in claim 1. The board is not convinced by this argument since the joint detector disclosed in D1 (see column 18, lines 22 to 48) performs the same functions as the transmitted symbol estimation part and the metric generator defined in claim 1: symbol candidates ($x^{\wedge}_k(m,n)$) for the desired signal ($k = 1$) and for interference signals ($k = 2$ to K), multiplied by estimated channel parameters $g^{\wedge}_k(m,n)$, are added to build a replica of the received signal ($\sum x^{\wedge}_k(m,n)g^{\wedge}_k(m,n)$, $k=1$ to K). This replica signal is subtracted from the received signal $y(m,n)$ and sent to a metric generator $J(x^{\wedge}_k(m,n)) = |y(m,n) - \sum x^{\wedge}_k(m,n)g^{\wedge}_k(m,n)|^2$. The board concurs with the examining division that minimising the metric J to estimate the K symbols, as disclosed in D1 (see column 18, lines 22 to 26 and

lines 42 to 45) implies that all possible sets of candidate symbols of the desired and interference signals are tried out.

The appellant further argued that the estimation part according to claim 1, unlike the detector disclosed in D1, already uses metric values and determines thereupon the most likely estimates on the basis of which the metric generator again generates new metric values, and so on. The appellant referred to Figure 3 and pages 17 to 18 of the published application in support of its assertion.

However, the board does not regard this argument as persuasive since it appears to contradict the teaching of the present application. According to the description and figures of the present application, the estimation part 40 provides the metric generator with a plurality of symbol candidates and the metric generator 18 calculates metric values by using a received signal value $Y_1(n)$ at the terminal IN and the transmitted symbol candidates (see page 16, lines 27 to 32). The metric generator 18 further outputs the metric values corresponding to each combination of the transmitted symbol candidates provided by the estimation part 40, which then selects as output OUTd the most likely combination set of symbol candidates (see from page 16, line 32 to page 17, line 7). Thus, in the board's judgement, the metric generator does not generate new metric values on the basis of the most likely estimates determined by the estimation part, as alleged by the appellant, but on the basis of symbol candidates provided by the estimation part (see also the examples described from page 35, line 21 to page 38, line 2).

In conclusion, the main request is not allowable under Article 54 EPC.

4. Auxiliary request 1

With regard to claim 1 according to the main request, claim 1 contains the single additional feature of "subtracting an estimated desired received sub-carrier signal and an estimated interference sub-carrier signal from a received sub-carrier signal". This additional feature is however already disclosed by the metric equation in D1, column 18, lines 25 to 30, wherein $y(m,n)$ represents the received sub-carrier signal and $x^k(m,n)$ represents the desired signal for $k = 1$ and the interference signals for the other values of k , m being the subcarrier index.

Therefore, the subject-matter of claim 1 is already disclosed in D1 and auxiliary request 1 is not allowable under Article 54 EPC.

5. Auxiliary request 2

Claim 1 adds **in substance** to claim 1 according to the main request the features that the channel parameters, both for the desired signal and for the interference signals, are estimated based on the estimated desired signal and interference signals and on an error signal generated using the received signal and replica signals of the estimated desired signal and the interference signals.

In D1, the channel parameters $g^k(m,n)$ for the desired signal (for $k=1$) and the interference signals (for the other values of k) are estimated based on a pilot code

scheme with a multi-channel response measurement, as detailed in column 15, lines 1 to 46.

Claim 1 therefore differs from the disclosure of D1 by the afore-mentioned channel parameter estimation scheme. The technical effect of this difference is that the channel parameters are estimated continuously whereas in D1 they are estimated based on pilot symbols transmitted at predetermined points in time of a signal frame and further interpolated over the data portion of the frame. The objective technical problem can thus be formulated as how to improve the accuracy of the channel parameters estimation in the presence of rapid time-variations of the channel.

By trying to solve this problem, the skilled person would look for prior-art disclosures related to channel parameters estimation and would come across document D2. D2 discloses an interference signal cancelling receiver comprising a channel parameter estimation part (see Figure 3). The receiver estimates both a desired signal and an interference signal which are to be received in an estimation part. The estimated desired signal and the estimated interference signal are subtracted in an error estimation part from the received signal to compute an estimation error signal. The estimation part estimates a desired signal sequence and an interference signal sequence on the basis of the estimation error signals obtained for the respective candidates. A channel parameter estimation part controls conversion parameters of the desired signal estimation part and the interference signal estimation part by an adaptation algorithm on the basis of the estimated desired signal and interference signal sequences and the estimation error signals (see

column 7, lines 9 to 30 and column 10, lines 14 to 62). By replacing, in the receiver of D1, the pilot-code-based channel estimation scheme with the channel parameter estimation scheme disclosed in D2, the skilled person would arrive at the subject-matter of claim 1.

The appellant argued that the skilled person would not combine D1 and D2 for the following reasons.

First, D2 related to a single-carrier communication system whereas the receiver according to D1 related to a multi-carrier communication system, as required by claim 1. The board is not convinced by this argument since the channel estimation in D1, like the channel estimation defined in claim 1, is performed independently for each received sub-carrier signal of the multi-carrier communication system. The skilled person would thus consider applying the teaching of D2 for each interference canceller of D1 corresponding to a subcarrier index m in the metric defined in D1, column 18, lines 25 to 30.

Secondly, D2 relied on the determination of estimates of transmitted symbol sequences whereas claim 1 defined a detection on a symbol-by-symbol basis. The estimation performed in D2 would thus require a large amount of signal processing and the skilled person would therefore be deterred from using the teaching of D2. In the board's finding however, the teaching of D2 may also be applied to one-symbol sequences, thereby requiring less amount of signal processing. Hence, the person skilled in the art would readily use the channel parameter estimation scheme of D2 in the receiver of D1, without exercising any inventive skills.

In view of the above, the subject-matter of claim 1 does not involve an inventive step, having regard to the combination of D1 and D2. Auxiliary request 2 is thus not allowable under Article 56 EPC.

6. Auxiliary request 3

Claim 1 is a direct combination of claim 1 according to auxiliary request 1 and claim 1 according to auxiliary request 2.

It follows from the findings of the board expressed in paragraphs 4 and 5 above that the subject-matter of claim 1 does not involve an inventive step, having regard to the disclosure of D1 and D2. Auxiliary request 3 is thus not allowable under Article 56 EPC.

7. In conclusion, in the absence of an allowable request the appeal must be dismissed.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chair:



K. Götz-Wein

A. Ritzka

Decision electronically authenticated