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Datasheet for the decision of 17 July 2019

Case Number: T 1062/15 - 3.5.05

Application Number: 05251501.2

Publication Number: 1575235

IPC: H04L27/26, H04L25/02, H04B7/10, H04L5/02

Language of the proceedings: EN

Title of invention:
OFDM Signal transmission method and apparatus

Applicant:
Kabushiki Kaisha Toshiba

Headword:
OFDM pilot subcarriers transmission/TOSHIBA

Relevant legal provisions:
EPC Art. 84, 123(2), 56

Keyword:
Claims - clarity - main request (yes)
Amendments - allowable (yes)
Inventive step - (yes)

Decisions cited:

Catchword:

Europäisches Patentamt
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Beschwerdekammern

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Case Number: T 1062/15 - 3.5.05

D E C I S I O N
of Technical Board of Appeal 3.5.05
of 17 July 2019

Appellant: (Applicant)	Kabushiki Kaisha Toshiba 1-1, Shibaura 1-chome, Minato-ku Tokyo 105-8001 (JP)
Representative:	Moreland, David Marks & Clerk LLP Aurora 120 Bothwell Street Glasgow G2 7JS (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 23 December 2014 refusing European patent application No. 05251501.2 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 on 23 December 2014, refusing European patent application No. 05251501.2. A main request was refused for not meeting the provisions of Articles 84 and 123(2) EPC, and of Article 56 EPC having regard to the disclosure of

D1: US 2002/122381, in combination with

D4: C. Garnier et al.: "Performance of an OFDM-SDMA based System in a Time-Varying Multi-Path Channel", IEEE 54th Vehicular Technology Conference, Atlantic City, US, vol.3, pages 1686 to 1690, 7 October 2001.

An auxiliary request was not admitted into the proceedings in accordance with Rules 116 and 137(3) EPC.

II. Notice of appeal was received on 26 February 2015, and the appeal fee was paid on the same day. The statement setting out the grounds of appeal was received on 1 May 2015. The appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of a main request or first to fourth auxiliary requests submitted with the statement setting out the grounds of appeal, the main request being identical to the main request on which the decision was based. Oral proceedings were requested on an auxiliary basis.

III. A summons to oral proceedings was issued on 15 May 2019. In a communication pursuant to Article 15(1) RPBA annexed to the summons, the board gave its preliminary view on the case. In its opinion,

the main request did not meet the requirements of Articles 84 and 123(2) EPC and none of the requests met the requirements of Article 56 EPC, having regard to D1 in combination with D4.

IV. By letter of response dated 17 June 2019, the appellant withdrew the main request and resubmitted the previous first to fourth auxiliary requests as the main request and first to third auxiliary requests, respectively. The appellant further submitted a new fourth auxiliary request.

V. Oral proceedings were held on 17 July 2019. 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 one of the first to fourth auxiliary requests submitted with the letter dated 17 June 2019.

At the end of the oral proceedings, the board's decision was announced.

VI. Claim 1 according to the main request reads as follows:

"An orthogonal frequency division multiplexing (OFDM) apparatus configured to generate OFDM signals, the OFDM signals comprising a first OFDM signal for transmission by a first antenna (101a) and a second OFDM signal for transmission by a second antenna (101b), the apparatus comprising:
a subcarrier setting device (106) configured to generate data signals and pilot signals to be transmitted using at least one of a plurality of subcarriers, the plurality of subcarriers including data subcarriers and pilot subcarriers,
the subcarrier setting device being configured to

generate first to fourth pilot signals, by multiplying first to fourth complex numbers by a sequence,
wherein the first complex number and the third complex number provide a first vector, the second complex number and the fourth complex number provide a second vector and the first vector and the second vector are orthogonal,
the first complex number being used to generate the first pilot signal to be transmitted using a first pilot subcarrier, the second complex number being used to generate the second pilot signal to be transmitted using the first pilot subcarrier, the third complex number being used to generate the third pilot signal to be transmitted using a second pilot subcarrier, the fourth complex number being used to generate the fourth pilot signal to be transmitted using the second pilot subcarrier,
wherein the first OFDM signal comprises the first pilot signal and the third pilot signal and the second OFDM signal comprises the second pilot signal and the fourth pilot signal."

The main request comprises further independent claims (claims 10 and 11) related to a corresponding transmission apparatus and a corresponding method, respectively.

Due to the outcome of the appeal, there is no need to give details of the claims of the first to fourth auxiliary requests.

Reasons for the Decision

1. The appeal is admissible (see point II).

2. Main request - Admission

This request corresponds to the previous first auxiliary request filed with the statement setting out the grounds of appeal. The amendments with respect to the previous main request on which the decision under appeal was based are in response to the objections under Articles 84 and 123(2) EPC raised in this decision against the previous main request. The board has thus decided under Article 12(4) EPC to admit the main request into the proceedings.

3. Main request - Article 84 EPC

The board is satisfied that the relationships between the first and second vectors and the first to fourth complex numbers given in claim 1 now correctly reflect the teaching of the description.

In that respect, claim 1 specifies that
- the first to fourth pilot signals are generated using first to fourth complex numbers, respectively,
- the first and second pilot signals are transmitted using the first pilot subcarrier whereas the third and fourth pilot signals are transmitted using the second pilot subcarrier, and
- the first and third pilot signals are transmitted by the first antenna whereas the second and fourth pilot signals are transmitted by the second antenna.

The relationships between the pilot signals, pilot subcarriers, and complex numbers given in claim 1 correspond to equations (4) and (5) on page 12 of the description, in the case of two pilot subcarriers only, the complex numbers being referred to therein as Sa(1), Sb(1), Sa(2), Sb(2). The polarity data patterns which,

according to the description, govern the directions of the beams formed by the antenna pair on the first pilot subcarrier and on the second pilot subcarrier are (Sa(1), Sa(2)) and (Sb(1), Sb(2)), respectively. Thus the first and second vectors in claim 1 correspond to these polarity data patterns. The first vector is thus correctly defined in claim 1 as being provided, i.e. formed, by the first and third complex numbers, and the second vector is correctly defined as being provided, i.e. formed, by the second and fourth complex numbers.

The board further notes that claim 1 now specifies that the first and second vectors are orthogonal, thereby clearly overcoming the objection of lack of essential features raised in the decision (Reasons 2.2 and 2.3), and that the feature related to the simultaneous transmission of the first and second OFDM signals has been deleted from claim 1, thereby rendering moot the objection raised in Reasons 2.4 of the decision.

The board thus holds that claim 1 meets the requirements of Article 84 EPC.

4. Main request - Article 123(2) EPC

In the decision under appeal, objections were raised that there was no basis in the application documents for the feature of claim 1 whereby the first to fourth complex numbers are multiplied by a sequence.

The first objection raised in the decision under appeal was that originally filed claims 9, 12 and 14 could not provide a basis for this feature since these claims were limited to the use of complex numbers resulting in the generation of pilot signals which are orthogonal in the frequency domain, which represents an essential

feature of the invention. However, this objection does not apply anymore since claim 1 now contains the features that the vectors of complex numbers are orthogonal, which results in the generation of orthogonal pilot signals. The board thus holds that the generalisation of the specific complex numbers specified in claims 9, 12 and 14 is allowable.

The second objection raised in the decision under appeal was that the definition provided in claim 1 of multiplying first to fourth complex numbers by a sequence encompassed multiplying a sequence of four numbers element-wise by the four complex numbers. The board, however, agrees with the appellant that an element-wise multiplication, which implies multiplying each of the complex numbers by a single element of a sequence having four elements, is not supported by the wording of claim 1. Moreover, the description in relation to Figure 4 clearly shows that each complex number Sa(j) is multiplied by the whole sequence PNa.

The third objection raised in the decision under appeal was that the use of an undefined sequence had no basis in the application as originally filed and that the description in fact only disclosed the use of pseudorandom noise (PN) sequences. In that respect, the board agrees with the appellant that the application is concerned with the polarity patterns of the pilot signals, so as to increase the likelihood that a receiver will be able to receive at least some of the transmitted pilot signals. In claim 1, however, the polarity patterns are achieved solely as a result of the choice of the first and second vectors and not by the content of the sequence. The board further notes that originally filed claims 3 and 4 clearly do not define that the sequence generators 100, 100a and 100b

shown in Figures 4 and 12 are PN sequence generators. The board thus holds that the appellant is entitled not to specify that the sequence is a PN sequence.

For these reasons the board finds that claim 1, and the corresponding method claim 11, meet the requirements of Article 123(2) EPC.

5. Main request - Inventive step

5.1 It was common ground in the proceedings that D1 represented the closest prior art on file.

D1 relates to an OFDM apparatus transmitting pilot signals on multiple antennas. Figure 6 shows the pilot signals transmitted by two antennas (Tx1, Tx2) in two successive OFDM signals (1st OFDM sequence, 2nd OFDM sequence) on a single pilot subcarrier. Since the pilot symbols C(1) and C(2) transmitted on the pilot subcarrier by the two antennas during the first sequence have a different polarity than the pilot symbols $-C(2)^*$ and $C(1)^*$ transmitted on the pilot subcarrier by the two antennas during the second sequence, the directional pilot beams formed during the two successive sequences have different directions. A fixed receiver which is not able to receive the pilot signal in an OFDM time slot is thus more likely to receive it during the next OFDM time slot since the direction of the directional pilot beam is changed at the next OFDM sequence.

The differences between the subject-matter of claim 1 and the disclosure of D1 are that:
- pilot signals are generated by multiplying first to fourth complex numbers by a sequence, the first complex number and the second complex number forming a first

vector, the second complex number and the fourth complex number forming a second vector, and the first vector and the second vector being orthogonal,
- the first complex number being used to generate the first pilot signal to be transmitted using a first pilot subcarrier, the second complex number being used to generate the second pilot signal to be transmitted using the first pilot subcarrier, the third complex number being used to generate the third pilot signal to be transmitted using a second pilot subcarrier, the fourth complex number being used to generate the fourth pilot signal to be transmitted using the second pilot subcarrier,
- wherein the first OFDM signal comprises the first pilot signal and the third pilot signal and the second OFDM signal comprises the second pilot signal and the fourth pilot signal.

The technical effects of these distinguishing features are that, in substance, the apparatus:
- transmits on each antenna, in the same OFDM sequence, or time slot, two pilot signals using two different pilot subcarriers, and
- the polarities of the pilot signals sent on the first pilot subcarrier by the two antennas and the polarities of the pilot signals sent on the second pilot subcarrier by the two antennas are such that the directional beams formed by the two antennas on the first and second pilot subcarriers are in opposite directions.
As a consequence, a receiver is able to correctly receive at least one of the two pilot signals in each OFDM time slot.

The objective technical problem can thus be formulated as how to reduce over time the dead zones where a

receiver is not able to correctly receive a pilot signal.

In D1, in any given time slot, only a single pilot signal using a single pilot subcarrier is transmitted by the apparatus. The skilled person would thus get no hint from D1 to consider sending two pilot signals on two different pilot subcarriers since it would necessitate a substantial redesign of the apparatus, as plausibly argued by the appellant. Moreover, D1 does not even disclose or hint at the fact that pilot signal beams in successive time slots should be in quite opposite directions.

5.2 D4 was used by the examining division in combination with D1. D4 relates to an OFDM-SDMA system and teaches transmitting training symbols on pilot subcarriers from multiple antennas, or users, to a single receiver. In order for the receiver to be able to distinguish between the training symbols from the different users, an embodiment of D4 (illustrated in Figure 5(c)), teaches that each of the multiple antennas (see users 1, 2, 3, and 4 on the horizontal axis) transmits codes on several pilot subcarriers (see the vertical axis) during an OFDM symbol time. For instance, user 1 transmits codes c_1^1 and c_2^1 on the first and second pilot subcarriers, respectively, and user 2 transmits codes c_1^2 and c_2^2 on the first and second pilot subcarriers, respectively. Since the codes c_1^1 and c_2^1 are orthogonal to the codes c_1^2 and c_2^2, respectively, the receiver is able to distinguish between the training signals transmitted by users 1 and 2 on the same pilot subcarrier. D4 is thus directed to a scheme and apparatus which are substantially different from D1 in that multiple transmit antennas are not comprised by a single transmitter, but instead multiple mobile

stations, or users, each having a single antenna, transmit pilot signals, as also acknowledged in the decision under appeal (see Reasons 4.4). The issue of beam forming on a single transmitter with two diversity antennas, each antenna using two pilot subcarriers, which is the subject-matter of claim 1, is thus not addressed by D4. The board thus agrees with the appellant that a combination of D1 and D4 would not only be far-fetched but would not lead to the subject-matter of claim 1 either.

5.3 For these reasons the board finds that the subject-matter of claim 1, and of the corresponding method claim 11, involves an inventive step, having regard to the prior art on file (Article 56 EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent on the basis of claims 1 to 22 of the main request submitted with the letter dated 17 June 2019 with description pages 1, 2 and 4 to 58 as originally filed, description pages 3 and 3a as filed with the letter of 4 March 2013, and drawing sheets 1/36 to 36/36 as originally filed.

The Registrar: The Chair:

K. Götz-Wein A. Ritzka

Decision electronically authenticated

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Case Number: T 1062/15 - 3.5.05

D E C I S I O N
of the Technical Board of Appeal 3.5.05
of
correcting an error in the decision
of 17 July 2019

Appellant: (Applicant)	Kabushiki Kaisha Toshiba 1-1, Shibaura 1-chome, Minato-ku Tokyo 105-8001 (JP)
Representative:	Moreland, David Marks & Clerk LLP Aurora 120 Bothwell Street Glasgow G2 7JS (GB)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 23 December 2014 refusing European patent application No. 05251501.2 pursuant to Article 97(2) EPC.**

Composition of the Board:

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

The board took note of an obvious mistake in the order in the minutes of the oral proceedings before the board on 17 July 2019 and - accordingly - in the order of the written decision. Thus, the decision has to be corrected under Rule 140 EPC.

The minutes of the oral proceedings containing the obvious error were already corrected by the decision of 5 March 2020 for the following reasons:

In the order, a description page "3a as filed with the letter dated 4 March 2013" is mentioned. Since this page 3a is only the mark-up version of the correctly cited page 3 (as filed with the letter dated 4 March 2013) the mention of the words "pages 3 and 3a" will be deleted and replaced by "page 3" only.

The appellant, having been accordingly informed by the board, did not submit objections.

Consequently, the correct version of the order is as follows:

1. The decision under appeal is set aside.

2. The case is remitted to the examining division with the order to grant a patent on the basis of claims 1 to 22 of the main request submitted with the letter dated 17 June 2019 with description pages 1, 2 and 4 to 58 as originally filed, description page 3 as filed with the letter dated 4 March 2013, and drawing sheets 1/36 to 36/36 as originally filed.

The Registrar: The Chair:

K. Götz-Wein A. Ritzka

Decision electronically authenticated