

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
13 June 2002 (13.06.2002)

PCT

(10) International Publication Number
WO 02/47286 A2

- (51) International Patent Classification⁷: **H04B 7/00**
- (21) International Application Number: PCT/EP00/12269
- (22) International Filing Date: 6 December 2000 (06.12.2000)
- (25) Filing Language: English
- (26) Publication Language: English
- (71) Applicant (for all designated States except US): **NOKIA CORPORATION** [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **HOTTINEN, Ari** [FI/FI]; Ristinientie 4 o 30, FIN-02320 Espoo (FI). **WICHMAN, Risto** [FI/FI]; Viipurinkatu 10 A 20, FIN-00510 Helsinki (FI). **TIRKKONEN, Olav** [FI/FI]; Purontiitynpolku 5 A 6, FIN-00720 Helsinki (FI).
- (74) Agent: **COHAUSZ & FLORACK**; Kanzlerstrasse 8a, 40472 Düsseldorf (DE).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:**
— without international search report and to be republished upon receipt of that report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*



WO 02/47286 A2

(54) Title: METHOD FOR CONTROLLING THE WEIGHTING OF A DATA SIGNAL IN THE AT LEAST TWO ANTENNA ELEMENTS OF A RADIO CONNECTION UNIT, RADIO CONNECTION UNIT, MODULE AND COMMUNICATIONS SYSTEM

(57) Abstract: The invention relates to a method for controlling the weighting of a data signal in the at least two antenna elements of a first radio connection unit of a radio communications system, which data signal is to be distributed for parallel transmission to a second radio connection unit to at least two beams. In order to improve such a method, it comprises: determining in the second radio connection unit a weight information enabling the first radio connection unit to determine the sets of weights for suitable beams for transmission and transmitting it to the first radio connection unit; and distributing the data signal in the first radio connection unit to those sets of weights and transmitting the data signals simultaneously via the formed beams. Alternatively or additionally, the second unit determines the number of beams to be used and informs the first unit about it. The invention equally relates to corresponding radio connection units, radio connection unit modules and radio communications systems.

Method for controlling the weighting of a data signal in the at least two antenna elements of a radio connection unit, radio connection unit, module and communications system

FIELD OF THE INVENTION

The invention relates to a method for controlling the weighting of a data signal in the at least two antenna elements of a first radio connection unit of a radio communications system, which data signal is to be distributed to at least two beams for parallel transmission of the data signal in at least two at least partly different streams to a second radio connection unit with at least one antenna element, the beams being formed by weighting the data signal in the antenna elements with a set of weights for each beam. The invention equally relates to a radio connection unit, a radio connection unit module and a radio communications system to be employed for such a method.

BACKGROUND OF THE INVENTION

It is known from wireless communications systems of the state of the art to transmit data signals between two radio connection units, in particular from a base station to a terminal, in parallel via several transmit antenna elements. When using multiple antennas with adapted transmission and detection techniques, the spatial dimension can be exploited

at the terminal and the spectral efficiency of fading wireless channels can be increased significantly compared to conventional single antenna links. A terminal receiving signals from such a transceiver can be designed to distinguish several channels, if they are sufficiently uncorrelated.

The document "Link-Optimal BLAST Processing With Multiple-Access Interference" by F.R. Farrokhi, G.J. Foschini, A. Lozano, R.A. Valenzuela, Bell Laboratories (Lucent Technologies) in IEEE Vehicular Technology Conference, Boston, Massachusetts, USA, Sept. 24-28, 2000, proceeds from a wireless communications system with antenna arrays at both, transmitter and receiver. The system transmits parallel data streams simultaneously and in the same frequency band, using the multiple antennas. With rich propagation, the different streams can be separated at the receiver because of their distinct spatial signatures. It is proposed to make the channel and the interference covariance available to the transmitter. The transmitter finds the channel eigenmodes in the presence of the interference and sends multiple independent data streams through those eigenmodes. The total transmitted power is distributed among the eigenmodes according to an optimal water-fill process. Thereby, the maximised capacity is supposed to be achieved. The method, as described above, always assumes that the receiver has at least two antenna elements. Preferably, in the aforementioned concept, the number of transmit and receive elements is the same.

The parallel transmission via a plurality of antenna elements in transceiver and terminal enables a reduction of E_b/N_0 (E_b = energy per bit; N_0 = noise power density per Hz) requirements for achieving data rates associated with higher order constellations like 8PSK, 16QAM, or 64QAM. Moreover, it enables the expansion of the number of rate options for adaptive modulation and coding (AMC) and an increase of the maximum rate.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a further improved method for controlling the weighting of a data signal in the at least two antenna elements of a transceiver of a wireless communications system which allows for high data rates in the downlink matched to channel conditions.

This object is reached on the one hand by a first method for controlling the weighting of a data signal in the at least two antenna elements of a first radio connection unit of a radio communications system, which data signal is to be distributed to at least two beams for parallel transmission of the data signal in at least two at least partly different streams to a second radio connection unit with at least one antenna element, the beams being formed by weighting the data signal in the antenna elements with a set of weights for each beam, the method comprising:

- determining in the second radio connection unit a weight information enabling the first radio connection unit to

- determine the sets of weights for at least two suitable beams for transmission of a data signal from the first radio connection unit to the second radio connection unit;
- transmitting the determined weight information to the first radio connection unit; and
 - distributing the data signal in the first radio connection unit to at least two sets of weights determined from the received weight information and transmitting the data signals simultaneously via the at least two formed beams.

With regard to this first method, the invention proceeds from the idea that the second radio connection unit is in possession of the most comprehensive information relevant for selecting suitable beams for transmission of the data signal and for determining sets of weights for the selected beams. It is therefore proposed to calculate all relevant information needed for the weighting of the data signals in the antenna elements of the first radio connection unit already at the second radio connection unit. The feedback information includes a weight information from which the first radio connection unit can determine the set of weights for each beam that is to be used for transmission of the data signals from the first radio connection unit to the second radio connection unit. Each feedback information indicates the weighting of the data signal for each of the different antenna elements of the first radio connection unit. This way, the information needed for obtaining the weight sets can be determined with the full information

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.