

PATENT COOPERATION TREATY

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PCT

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**
(PCT Rule 43*bis*.1)

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| Date of mailing (day/month/year) see form PCT/ISA/210 (second sheet) |
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| FOR FURTHER ACTION See paragraph 2 below |
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| International application No. PCT/US2018/039979 |
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| Priority date (day/month/year) 31.08.2017 |
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| Applicant QUALCOMM INCORPORATED |
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1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

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| Name and mailing address of the ISA:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Fax: +49 89 2399 - 4465 |
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| Date of completion of this opinion see form PCT/ISA/210 |
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| Authorized Officer Franz, Stefan Telephone No. +49 89 2399-0 |
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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - the international application in the language in which it was filed.
 - a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

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|-------------------------------|-------------|-------------|
| Novelty (N) | Yes: Claims | <u>1-59</u> |
| | No: Claims | |
| Inventive step (IS) | Yes: Claims | |
| | No: Claims | <u>1-59</u> |
| Industrial applicability (IA) | Yes: Claims | <u>1-59</u> |
| | No: Claims | |

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

1 **Re Item V**

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.1 Reference is made to the following documents:

D1 US 2013/051438 A1 (LEE TSUNG-HSUAN [TW] ET AL) 28 February 2013 (2013-02-28)

D2 US 2016/183117 A1 (HSU FU-CHIEH [TW] ET AL) 23 June 2016 (2016-06-23)

D3 US 2017/167745 A1 (DORTMUND SVEN [DE] ET AL) 15 June 2017 (2017-06-15)

1.2 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of independent **claims 1, 9, 17, 25, 26, 29, 38, 47, 56, and 57** does not involve an inventive step in the sense of Article 33(3) PCT.

1.2.1 Document **D1** is regarded as being the prior art closest to the subject-matter of **claim 9**, and discloses:

**A method for wireless communications, comprising:
determining a link quality for each one of a plurality of radio frequency (RF) modules** (Paragraph 24: *"In each test period, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 130 for a period of time, and then to switch the transceiver 112 to the antenna set 140 for a period of time. When the transceiver 112 is switched to the antenna set 130, the transceiver 112 transmits and receives signal via the antenna set 130, and the control circuit 114 records information regarding throughput of the antenna set 130 during that period. When the transceiver 112 is switched to the antenna set 140, the transceiver 112 transmits and receives signals via the antenna set 140, and the control circuit 114 records information regarding throughput of the antenna set 140 during that period."*; Paragraph 36: *"In the wireless communication system 100, the control circuit 114 of the wireless communication circuit 110 may collect throughput statistics for the antenna set 130 and the antenna set*

140 by counting respective throughputs of the antenna set 130 and the antenna set 140 in a single test period or in a plurality of test periods, and then configure subsequent operation of the switching circuit 120 according to the resulting throughput statistics. The term "throughput statistic" as used herein may be a throughput or a time average of the throughput of a particular antenna set in a single test period, or may be a sum, an average value, a time average, a moving sum, or a moving average of throughput of the particular antenna set in a plurality of test periods.");

selecting a first one of the plurality of RF modules having a highest determined link quality; outputting a first portion of a signal to the first one of the plurality of RF modules for transmission (Paragraph 37: "For example, the control circuit 114 may compare a throughput statistic of the antenna set 130 with respect to a target test period [...] with a throughput statistic of the antenna set 140 with respect to the target test period at the end of the target test period, and then configure the switching circuit 120 according to the comparison result. In one embodiment, if the throughput statistic of the antenna set 130 is greater than the throughput statistic of the antenna set 140, the control circuit 114 determines that the antenna set 130 has better receiving quality at that time. Accordingly, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 130 after the target test period, so that the transceiver 112 receives and transmits signals via the antenna set 130 in the subsequent normal operation period. On the contrary, if the throughput statistic of the antenna set 130 is less than the throughput statistic of the antenna set 140, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 140 after the target test period.");

determining a throughput of the first one of the plurality of RF modules during thermal throttling of the first one of the plurality of RF modules; comparing the determined throughput of the first one of the plurality of RF modules with a throughput of a second one of the plurality of RF modules; and outputting a second portion of the signal to the second one of the plurality of RF modules for transmission if the throughput of the second one of the plurality of RF modules is higher than the determined throughput of the first one of the plurality of RF modules (Paragraph 36: "The term "throughput statistic" as used herein may be a throughput or a time

average of the throughput of a particular antenna set in a single test period, or may be a sum, an average value, a time average, a moving sum, or a moving average of throughput of the particular antenna set in a plurality of test periods."; It is noted that computing a moving average of throughput of a particular antenna set in a plurality of test periods implies that antenna selection is carried out repeatedly.).

The subject-matter of **claim 9** therefore differs from this known method in that:

F1: determining a throughput of the first one of the plurality of RF modules during thermal throttling of the first one of the plurality of RF modules

The technical effect of thermally throttling the RF module while transmitting the first portion of the signal is to reduce the temperature of the RF module.

The objective technical problem to be solved by the present invention may therefore be regarded as how to reduce the temperature of the transmitting RF module.

The skilled person aiming to solve the above technical problem would look into documents related to thermal throttling of the uplink and would find document **D2**. Document **D2** discloses the distinguishing feature **F1** (Paragraph 47-49: "*FIG. 6 is a flow chart 600 of a process illustrating the method for throttling uplink data based on a temperature state according to an implementation of the disclosure with reference to the communication device in FIG. 3. Referring to FIG. 6, in step S605, the temperature sensor senses an internal temperature of the communication device. Next, in step S610, the processor compares the internal temperature to a corresponding temperature range according to a predetermined table of temperature ranges. In step S615, the processor controls a packet buffer to adjust a current data rate to a corresponding target data rate according to the comparison result. As described above, an apparatus and a method for throttling uplink data based on a temperature state of the exemplary implementations of the present disclosure are capable of automatically adjusting the current data rate. Accordingly, it can avoid the issue of extreme heat caused by the high uplink data rate, and reduces the power consumption of the apparatus.*") thereby solving the above objective technical problem.

Therefore, the solution proposed in **claim 9** of the present application cannot be considered to involve an inventive step over the disclosures **D1** in combination with **D2** (Article 33(3) PCT).

1.2.2 The same objections as for claim 9 also apply, mutatis mutandis, to **claims 1, 17, 25, and 26**, aiming at the corresponding apparatus, computer readable medium, and wireless node, respectively.

1.2.3 Document **D1** is regarded as being the prior art closest to the subject-matter of **claim 38**, and discloses:

A method for wireless communications, comprising:
determining a link quality for each one of a plurality of radio frequency modules (Paragraph 24: *"In each test period, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 130 for a period of time, and then to switch the transceiver 112 to the antenna set 140 for a period of time. When the transceiver 112 is switched to the antenna set 130, the transceiver 112 transmits and receives signal via the antenna set 130, and the control circuit 114 records information regarding throughput of the antenna set 130 during that period. When the transceiver 112 is switched to the antenna set 140, the transceiver 112 transmits and receives signals via the antenna set 140, and the control circuit 114 records information regarding throughput of the antenna set 140 during that period."*;
Paragraph 36: *"In the wireless communication system 100, the control circuit 114 of the wireless communication circuit 110 may collect throughput statistics for the antenna set 130 and the antenna set 140 by counting respective throughputs of the antenna set 130 and the antenna set 140 in a single test period or in a plurality of test periods, and then configure subsequent operation of the switching circuit 120 according to the resulting throughput statistics. The term "throughput statistic" as used herein may be a throughput or a time average of the throughput of a particular antenna set in a single test period, or may be a sum, an average value, a time average, a moving sum, or a moving average of throughput of the particular antenna set in a plurality of test periods."*);

selecting a first one of the plurality of RF modules having a highest determined link quality; receiving a first portion of a signal from the

first one of the plurality of RF modules (Paragraph 37: "*For example, the control circuit 114 may compare a throughput statistic of the antenna set 130 with respect to a target test period [...] with a throughput statistic of the antenna set 140 with respect to the target test period at the end of the target test period, and then configure the switching circuit 120 according to the comparison result. In one embodiment, if the throughput statistic of the antenna set 130 is greater than the throughput statistic of the antenna set 140, the control circuit 114 determines that the antenna set 130 has better receiving quality at that time. Accordingly, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 130 after the target test period, so that the transceiver 112 receives and transmits signals via the antenna set 130 in the subsequent normal operation period. On the contrary, if the throughput statistic of the antenna set 130 is less than the throughput statistic of the antenna set 140, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 140 after the target test period.*");

determining a throughput of the first one of the plurality of RF modules during thermal throttling of the first one of the plurality of RF modules; comparing the determined throughput of the first one of the plurality of RF modules with a throughput of a second one of the plurality of RF modules; and receiving a second portion of the signal from the second one of the plurality of RF modules if the throughput of the second one of the plurality of RF modules is higher than the determined throughput of the first one of the plurality of RF modules (Paragraph 36: "*The term "throughput statistic" as used herein may be a throughput or a time average of the throughput of a particular antenna set in a single test period, or may be a sum, an average value, a time average, a moving sum, or a moving average of throughput of the particular antenna set in a plurality of test periods."*"); It is noted that computing a moving average of throughput of a particular antenna set in a plurality of test periods implies that antenna selection is carried out repeatedly.).

The subject-matter of **claim 38** therefore differs from this known method in that:

F1: determining a throughput of the first one of the plurality of RF modules during thermal throttling of the first one of the plurality of RF modules

The technical effect of thermally throttling the RF module while transmitting the first portion of the signal is to reduce the temperature of the RF module.

The objective technical problem to be solved by the present invention may therefore be regarded as how to reduce the temperature of the transmitting RF module.

The skilled person aiming to solve the above technical problem would look into documents related to thermal throttling of the uplink and would find document **D3**. Document **D3** discloses the distinguishing feature **F1** (Fig. 3; Paragraph 57: *"Methods and devices according to the disclosure as described below allow temperature reduction in LTE connected mode for high data throughput use cases by means of data throttling, in particular by using a smooth downlink throughput throttling that allows for control plane data reception by mimicking a temporary degrade of the radio conditions for a short period of time."*; Paragraph 62: *"The method 300 further includes: If the monitored temperature information indicates that the system temperature T exceeds 303 a first threshold, e.g. a first threshold $T1$ as described below with respect to FIG. 6, changing 304, i.e. transition to a second state 305 in which receiving the at least one data region is switched-off."*; Fig. 7: (706, 707)) thereby solving the above objective technical problem.

Therefore, the solution proposed in **claim 38** of the present application cannot be considered to involve an inventive step over the disclosures **D1** in combination with **D3** (Article 33(3) PCT).

1.2.4 The same objections as for claim 38 also apply, mutatis mutandis, to **claims 29, 47, 56, and 57**, aiming at the corresponding apparatus, computer readable medium, and wireless node, respectively.

1.3 Dependent **claims 2-8, 10-16, 18-24, 27-28, 30-37, 39-46, 48-55, 57-58** do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step, the reasons being as follows:

- 1.3.1 The distinguishing features of **claim 2, 10, 18, 30, 39, 48**, namely, further comprising outputting/receiving the second portion of the signal to the first one of the plurality of RF modules for transmission if the throughput of the second one of the plurality of RF modules is lower than the determined throughput of the first one of the plurality of RF modules, is disclosed in document **D1** (Paragraph 37: *"Accordingly, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 130 after the target test period, so that the transceiver 112 receives and transmits signals via the antenna set 130 in the subsequent normal operation period. On the contrary, if the throughput statistic of the antenna set 130 is less than the throughput statistic of the antenna set 140, the control circuit 114 configures the switching circuit 120 to switch the transceiver 112 to the antenna set 140 after the target test period."*).
- 1.3.2 The distinguishing features of **claim 3, 11, 19, 31, 40, 49**, namely, wherein the throughput of the second one of the plurality of RF modules is without thermal throttling of the second one of the plurality of RF modules, is disclosed in document **D1** (Paragraph 36: *"The term "throughput statistic" as used herein may be a throughput or a time average of the throughput of a particular antenna set in a single test period, or may be a sum, an average value, a time average, a moving sum, or a moving average of throughput of the particular antenna set in a plurality of test periods."*; It is noted that document **D1** does not disclose thermal throttling.).
- 1.3.3 The distinguishing features of **claims 4, 12, 20, 32, 41, 50**, namely, wherein the link quality of the first one of the plurality of RF modules comprises a throughput of the first one of the plurality of RF modules before the thermal throttling of the first one of the plurality of RF modules is disclosed in document **D1** (Paragraph 36: *"The term "throughput statistic" as used herein may be a throughput or a time average of the throughput of a particular antenna set in a single test period, or may be a sum, an average value, a time average, a moving sum, or a moving average of throughput of the particular antenna set in a plurality of test periods."*; It is noted that document **D1** does not disclose thermal throttling.).

- 1.3.4 The distinguishing features of **claims 5, 13, 21, 33, 42, 51**, namely, further comprising: monitoring a temperature of the first one of the plurality of RF modules during a time that the second portion of the signal is output to the second one of the plurality of RF modules; comparing the monitored temperature with a temperature threshold; and outputting/receiving a third portion of the signal to the first one of the plurality of RF modules for transmission if the monitored temperature is below the temperature threshold, is considered as an obvious design option in the light of document **D1 and D2** as well as **D1 and D3**.
- 1.3.5 The distinguishing features of **claims 6, 14, 22, 35, 44, 53** namely, further comprising: during the thermal throttling of the first one of the plurality of RF modules, putting the first one of the plurality of RF modules to sleep during sleep intervals and activating the first one of the plurality of RF modules during active intervals, is disclosed in document **D2** (Paragraph 44: *"As seen in FIG. 5, the value from predetermined table of temperature ranges can be transmitted to the timer 508. The timer 508 can be set to control the packet buffer 514 in different operating modes according to the predetermined table of temperature ranges. In one implementation, when the packet buffer 514 is in the first operating mode, the packet buffer resumes transmitting data packets. When the packet buffer 514 is in the second operating mode, the packet buffer stops transmitting the data packets."*) as well as document **D3** (Fig. 5: (510); Paragraph 80: *"At this, during "PDCCH only mode" 501, the downlink control channels are decoded and the RF receiver is turned off immediately after its reception, so that any allocations of the Physical Downlink Shared CHannel (PDSCH) is avoided."*).
- 1.3.6 The distinguishing features of **claims 7, 8, 15, 16, 23, 24, 36, 37, 45, 46, 54, and 55**, are considered as obvious design option known to the skilled person.
- 1.3.7 The distinguishing features of **claims 27 and 58**, namely, wherein the first one of the plurality of RF modules comprises at least one first antenna, and the second one of the plurality of RF modules comprises at least one second antenna, is disclosed in document **D1** (Fig. 1).

- 1.3.8 The distinguishing features of **claims 28 and 59**, namely, wherein the at least one first antenna and the at least one second antenna point in different directions, is considered an obvious design option known to the skilled person.
- 1.3.9 The distinguishing features of **claims 34, 43, 52** namely, wherein the processing system is configured to determine the link quality for each one of the plurality of RF modules based on at least one of a signal-to-noise ratio (SNR), a received signal strength indicator (RSSI), or a carrier-to-interference (C/I) ratio of a signal received via the RF module, is merely one of several straightforward possibilities from which the skilled person would select, in accordance with circumstances, without the exercise of inventive skill, in order to solve the problem posed.

2 **Re Item VII**

Certain defects in the international application

- 2.1 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in documents **D1 to D3** is not mentioned in the description, nor are these documents identified therein.
- 2.2 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

3 **Re Item VIII**

Certain observations on the international application

- 3.1 The application does not meet the requirements of Article 6 PCT, because **claims 1, 9, 17, 25, 26, 29, 38, 47, 56, and 57** are not clear.
- 3.2 Although **claims 1, 17, 26** have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter

for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.

- 3.3 Although **claims 29, 47, 57** have been drafted as separate independent claims, they appear to relate effectively to the same subject-matter and to differ from each other only with regard to the definition of the subject-matter for which protection is sought and in respect of the terminology used for the features of that subject-matter. The aforementioned claims therefore lack conciseness and as such do not meet the requirements of Article 6 PCT.
- 3.4 The term "*thermal throttling*" used in **claims 1, 9, 17, 25, 26, 29, 38, 47, 56, and 57** is vague and unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear, Article 6 PCT. Said claims should be amended based on paragraph 53 of the description defining the term "*thermal throttling*" as the adjustment of the active duty cycle of the main RF module.