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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TEXARKANA DIVISION

PANTECH CORPORATION and PANTECH WIRELESS, LLC, Plaintiffs, v. ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD., Defendant.	C.A. No. 5:22-cv-00069-RWS **JURY TRIAL DEMANDED** **FILED UNDER SEAL**

ONEPLUS'S RULE 50(B) MOTION FOR JUDGMENT AS A MATTER OF LAW

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INTRODUCTION

Defendant OnePlus Technology (Shenzhen) Co. Ltd. ("OnePlus") respectfully renews its motions for judgment as a matter of law ("JMOL") pursuant to Federal Rule of Civil Procedure 50.[1] For the reasons set forth below, OnePlus is entitled to JMOL of no damages because no reasonable jury could find damages of any amount in light of Pantech Corporation and Pantech Wireless, LLC's (together, "Pantech") failure to introduce legally sufficient evidence tying any royalty rate to the facts of the case, let alone the $260,291.57 the jury awarded with respect to U.S. Patent No. 9,063,654 ("the '654 NEP") and the $739,708.43 the jury awarded with respect to U.S. Patent Nos. 9,548,839 ("the '839 SEP"), 10,869,247 ("the '247 SEP"), and 11,012,954 ("the '954 SEP") (collectively, "the SEPs").

Through its damages expert, Dr. Putnam, Pantech presented a damages theory based on licenses to its entire patent portfolio, which contains about 1,800 patents. Day 1 Tr. at 205:8–12; Day 2 Sealed Tr. at 29:15–30:3. Dr. Putnam used these licenses to determine a portfolio royalty rate, and then he assigned individual royalty rates to the asserted patents. Dr. Putnam calculated his final damages figures—$295,383 for the '654 NEP and $836,591 for the SEPs—by multiplying these individual royalty rates by OnePlus's accused smartphone sales. Day 2 Tr. at 336:21–337:8. Because Pantech did not present legally sufficient evidence supporting these patent-specific royalty rates, Pantech did not carry its burden of proving damages.

For the '654 NEP, Dr. Putnam assigned a rate equal to the rate he assigned to the '247 SEP, without any evidence establishing that these two patents are of comparable value. And with respect to the SEPs, Dr. Putnam assigned royalty rates based on forward citations not only to the asserted

[1] OnePlus also preserves for appeal purposes all of its JMOL motions made in its Rule 50(b) motion following the prior trial, including noninfringement, no willful infringement, invalidity, subject-matter ineligibility, and patent exhaustion. Dkt. 300.

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patents, but also to unasserted family members, without any showing that they cover the same subject matter as the asserted claims. For both sets of patents, therefore, Pantech failed to prove damages reflecting the value of the asserted patents in question, as required by law.

Additionally, JMOL of no damages should further be granted because Pantech pursued a legally flawed damages methodology, at least by virtue of Dr. Putnam's reliance on the lump-sum [redacted] license agreement, which by its own terms states that the consideration for that license is not reflective of the value of the licensed patents.

LEGAL STANDARDS

"When a case is tried to a jury, a motion for judgment as a matter of law 'is a challenge to the legal sufficiency of the evidence supporting the jury's verdict.'" *Cowart v. Erwin*, 837 F.3d 444, 450 (5th Cir. 2016) (quoting *Heck v. Triche*, 775 F.3d 265, 272 (5th Cir. 2014)). "JMOL should be granted when a party has been fully heard on an issue and there is no legally sufficient evidentiary basis for a reasonable jury to find for that party on that issue." *Montano v. Orange Cty., Texas*, 842 F.3d 865, 873 (5th Cir. 2016) (internal quotation marks omitted). "The burden of proving damages falls on the patentee." *Lucent Techs., Inc. v. Gateway, Inc.*, 580 F.3d 1301, 1324 (Fed. Cir. 2009). The Patent Act "does not require an award of damages if none are proven that adequately tie a dollar amount to the infringing acts." *TecSec, Inc. v. Adobe Inc.*, 978 F.3d 1278, 1291 (Fed. Cir. 2020) ("[T]here can be an award of no damages where 'none were proven.'" (quoting *Gustafson, Inc. v. Intersystems Indus. Prods., Inc.*, 897 F.2d 508, 509 (Fed. Cir. 1990)); *see also Garretson v. Clark*, 111 U.S. 120, 120–21 (1884) (affirming determination of no damages where patentee "produced no evidence to apportion the profits or damages between the improvement constituting the patented feature and the other features").

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ARGUMENT

I. Pantech Failed to Prove Any Damages For the '654 NEP

The jury's award of $260,291.57 for the '654 NEP is not supported by the evidence. At trial, Dr. Putnam opined that the damages for this patent "are $294,383," based on his assumption of the royalty rate for this patent "being the same as the rate for the '247 [SEP]." Day 2 Tr. at 338:21–22; Day 2 Tr. at 368:1–5; *see also* Day 2 Sealed Tr. at 58:18–23.[2] But there is no factual basis for equating the '654 NEP with the '247 SEP. Pantech has offered no economic or technical reason why the two patents should have the same royalty rate, and Dr. Putnam's *ipse dixit* statement that their rates should be the same cannot support the jury's verdict.

First, no expert has conducted any analysis comparing the '654 NEP to the '247 SEP. Dr. Putnam testified that he "assigned [the '654 NEP] the same rate as the '247 [SEP] on the basis that Mr. Mauro testified that it was commercially essential," Day 2 Sealed Tr. at 58:18–25, and admitted that Dr. Mauro's statement was the *sole* basis for his opinion, Day 2 Tr. at 61:9–12. But Mr. Mauro confirmed that he had no opinions regarding the '247 SEP or how it compares with the '654 NEP. Day 2 Tr. at 326:10–328:1. Indeed, Mr. Mauro testified that he had "not looked at that patent." Day 2 Tr. at 326:10–13. Mr. Mauro further confirmed that he had not reviewed any materials comparing the '654 NEP with the '247 SEP, and that he is not qualified to offer opinions about the '247 SEP. Day 2 Tr. at 326:10–327:10.

Pantech also presented no evidence comparing the two patents through Dr. Cooklev. Dr. Cooklev confirmed that he had no opinions regarding—and had not read—the '654 NEP, nor how the '654 NEP compares in value to the '247 SEP. Day 1 Tr. at 248:6–249:19. That was not "part

[2] OnePlus previously moved to strike this opinion, and the Court declined to do so on the ground that "Dr. Putnam has at least put forth a baseline theory that the '247 patent may be economically comparable." Dkt. 178 at 34. But that theory was not borne out by evidence at trial.

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of [his] assignment." Day 1 Tr. at 248:22–249:6. Nor did he review any technical documents or internal Pantech documents, market reports, or any materials comparing the '654 NEP with the '247 SEP. Day 1 Tr. at 249:7–19. In short, neither of Pantech's technical experts compared the value of the '247 SEP with the '654 NEP, nor spoke with Dr. Putnam regarding such a comparison. Day 1 Tr. at 250:5–22; Day 2 Tr. at 327:11–328:1; Day 2 Sealed Tr. at 54:18–56:15.

Dr. Putnam himself is also not qualified to compare the '654 NEP with the '247 SEP, let alone conclude that they are of equal value. Dr. Putnam acknowledged that, as an economic expert, he is not qualified to form an understanding of the technical impact of the '654 NEP on his own. Day 2 Sealed Tr. at 61:2–8. The same is true with respect to the '247 SEP. According to Dr. Cooklev, one would need technical training in order to read and understand the SEPs, and the '247 SEP, for example, is addressed to an audience of persons of ordinary skill in the art, who would have "at least a bachelor's degree in electrical engineering, telecommunications engineering, or [a] related field, with at least two years of experience in the field of networking and wireless devices." Day 1 Tr. at 236:24–237:7. Because Dr. Putnam is not qualified to form an understanding of the technical merits of either the '654 NEP or the '247 SEP, he also is not qualified to perform the comparison needed to conclude that they are equally valuable and therefore should have the same royalty rate. *See* Day 2 Sealed Tr. at 40:22–23 (Dr. Putnam testifying that he is "not competent to evaluate the claims and the technology of individual patents.").

Second, Dr. Putnam's own testimony establishes that his assignment of a 0.075% royalty rate was arbitrary and was not supported by the evidence. Dr. Putnam acknowledges that not all standard-essential patents are created equal. Some are more valuable than others. Based on his citation analysis, Dr. Putnam determined that the rate for the '839 SEP should be 0.01%, while the '247 SEP was more than seven times as valuable, with a royalty rate of 0.075%. *See* Day 2 Tr. at

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363:18–364:6. He also opined that the SEPs asserted in this case had above-average values compared to the other standard-essential patents in Pantech's portfolio, with the three families accounting for 21% of the total value of Pantech's entire SEP portfolio. Day 2 Tr. at 363:12–17.

Dr. Putnam offered no economic basis for equating the '654 NEP's value to that of a standard-essential patent. But even if he had, there is no evidence to support his assumption that the '654 NEP is as valuable as the '247 SEP, which is, in his opinion, the *most* valuable standard-essential patent in this case—such that the '654 NEP accounts for *half* of the 0.15 percent that Dr. Putnam had said is an established rate for Pantech's *entire* NEP portfolio. Day 2 Sealed Tr. at 59:6–61:12. Dr. Putnam provided no explanation or rationale as to why the '654 NEP should be comparable to the '247 SEP, as opposed to the '839 SEP or any of the even less-valuable patents in Pantech's portfolio.

Dr. Putnam further admitted that he did not perform a proper economic analysis of the '654 NEP. He did not compare the '654 NEP to any other NEPs:

> Q. Dr. Putnam, when you valued the three asserted SEPs, you looked at the big pie and you cut a slice, correct?
>
> A. Yes.
>
> Q. You didn't do the same analysis with the '654 patent, correct?
>
> A. Of course not.
>
> Q. You did not apportion the value of the '654 patent relative to the other NEP patents that Pantech owns, correct?
>
> A. Of course not.

Day 2 Sealed Tr. at 59:6–15. Nor did he do any independent analysis to determine the importance or value of the '654 NEP:

> Q. You didn't conduct a consumer survey to determine whether OnePlus's use of the '654 technology drove consumer demand, correct?

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A. No.

Q. And you did not conduct a consumer survey to determine whether OnePlus's phones could not compete effectively in the marketplace if the use of the '654 technology was removed, correct?

. . .

A. I did not do such a study.

Day 2 Sealed Tr. at 60:4–61:1. Instead, Dr. Putnam arbitrarily assigned a rate of 0.075% to the '654 NEP based *solely* of Dr. Mauro's testimony that the patent is "commercially essential." By Dr. Putnam's own admission, "[t]here's no other analysis in [his] report or that [he's] offering today concerning setting the royalty rate of the '654 patent." Day 2 Sealed Tr. at 61:9–12. Dr. Putnam's rate is therefore "arbitrary and speculative" and cannot support the verdict. *LaserDynamics, Inc. v. Quanta Comput., Inc.*, 694 F.3d 51, 81 (Fed. Cir. 2012).

Third, Mr. Mauro's conclusion that the '654 NEP is "commercially essential" lacks any factual basis. This is another *ipse dixit* conclusion, and it is belied by Mr. Mauro's own testimony. Mr. Mauro made clear that, with respect to patent value, he does not "proffer actual financial impact," but rather just a "list of benefits or lack of benefits from reading the patent." Day 2 Tr. at 334:21–325:5. Mr. Mauro testified that there is *no quantitative measurement* he could present to the jury regarding the value of the '654 NEP. Day 2 Tr. at 326:4–7. And Mr. Mauro's "essentiality" conclusion is untethered from Pantech's interpretation of the asserted claims. Mr. Mauro testified that he had no opinion on whether there is any specific value associated with the pop-up-clearing function accused of infringing the '654 NEP. Day 2 at 321:3–6. Nor had Mr. Mauro seen any evidence that this feature was driving sales of OnePlus phones, further undermining Mr. Mauro's conclusion that the '654 NEP is commercially essential. Day 2 Tr. at 323:2–13. According to Mr. Mauro, individual "features" like those accused of infringing the '654 NEP are not what drive sales of smartphones. Day 2 Tr. at 323:14–25; *see* Day 2 at 321:11–20 (describing the "function of being

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able to remove a pop-up after a period of time which can be set or determined" as "a feature").[3] Thus, Mr. Mauro's testimony is insufficient to establish the purported commercial essentiality of the '654 NEP.

As the Federal Circuit has explained, "[i]t is not enough to merely show that the [patented feature] is viewed as valuable, important, or ***even essential*** to the use of the [overall product]." *VirnetX, Inc. v. Cisco Sys., Inc.*, 767 F.3d 1308, 1326–27 (Fed. Cir. 2014) (alterations in original) (quoting *LaserDynamics*, 694 F.3d at 79) (emphasis added). Rather, a reasonable royalty analysis must "carefully tie proof of damages to the claimed invention's footprint in the market place." *Id.* (internal citations omitted). Accordingly, Dr. Putnam's arbitrary assignment of a royalty rate for the '654 NEP, based solely on commercial essentiality and divorced from the incremental value of the patented technology, is flawed as a matter of law. *See, e.g.*, *Exmark Mfg. Co. Inc. v. Briggs & Stratton Power Prods. Grp., LLC*, 879 F.3d 1332, 1349 (Fed. Cir. 2018) (testimony where expert "concluded with little explanation" that the parties "would have agreed to a 5% royalty rate on the sales of the [accused products] as the value for the [patented feature]" should have been excluded). The testimony Pantech presented in support of the '654 royalty rate is based on nothing more than "vague qualitative notions of the relative importance of the . . . technology," which is not a substitute for a properly apportioned royalty rate. *LaserDynamics*, 694 F.3d at 69. JMOL of no damages should be granted with respect to the '654 NEP because the jury has heard no evidence tying the value of the invention of the '654 NEP to the royalty rate Pantech presented.

[3] Although Mr. Mauro at trial attempted to suggest that the '654 NEP covers a variety of user interactions, the removal of the pop-up after a "reference period of time" is the sole feature that Pantech accused of satisfying the patent's claims.

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II. Pantech Failed to Present Legally Sufficient Evidence Supporting a Royalty Rate for the SEPs

Pantech also relied on Dr. Putnam to present evidence establishing royalty rates for the asserted SEPs. Dr. Putnam's testimony is insufficient as a matter of law to support the damages award with respect to the SEPs.

First, Dr. Putnam's forward-citation analysis rests on an unsupported assumption regarding the number of "actually" essential SEPs in Pantech's portfolio. Dr. Putnam used a forward-citation analysis that counted citations to family members of the asserted SEPs, as well as other patent families in Pantech's portfolio that he deemed standard-essential. Day 2 Tr. at 358:1–359:1, 360:2–17, 362:7–363:5. Dr. Putnam then determined what he considered the "share of Pantech's portfolio value" attributable to the asserted SEPs, which he translated to a percentage of his portfolio rate, thereby arriving at a royalty rate for the asserted patents. Day 2 Tr. at 363:6–364:6. This analysis rests on Dr. Putnam's assumption that there are 29 actually essential SEP families in Pantech's portfolio in addition to the families of the asserted SEPs. Day 2 Tr. at 358:11–6. But Dr. Putnam provided no evidence at trial establishing how many actually essential SEPs are in Pantech's portfolio. By his own admission, determining whether a patent "actually is essential" is a technical determination made by a legal authority. According to Dr. Putnam, while Pantech may "disclose" patents it believes may be "potentially essential," whether a patent "actually is essential" is determined by "someone like a court." Day 2 Sealed Tr. at 25:11–23. As an economic expert, Dr. Putnam is not qualified to make a determination as to how many of Pantech's patents are actually standard essential. At trial, Dr. Putnam did not cite any court decisions determining Pantech patents to be actually essential, nor identify *which* Pantech patents he believes are essential, nor to which standards. Without a basis for Dr. Putnam's conclusion that Pantech owns 29 actually essential

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patent families beyond the families of the three asserted SEPs, the jury was not provided substantial evidence supporting the rates Dr. Putnam assigned to the asserted SEPs.

Second, Dr. Putnam gave no explanation for how he translated from citation counts to the values he assigned to the patent families of the asserted SEPs, beyond his conclusory assertion that they reflect a share of the value of Pantech's SEPs based on a forward-citation analysis. At trial, Dr. Putnam testified that he counted the number of citations to families of actually essential SEPs in Pantech's portfolio and "translate[d] that to the share of Pantech's portfolio value that's accounted for by the three SEPs in this case." Day 2 Tr. at 363:1–4. Based on this analysis, Dr. Putnam asserted that "the share of the total Pantech portfolio is 2 percent for the '839 family, 3 percent for the '954 family, [and] 15 percent for the '247 family, for a total of 21 percent for the three SEPs in this case out of the total Pantech portfolio." Day 2 Tr. at 363:12–17. Then, Dr. Putnam assigned royalty rates to the asserted SEPs by multiplying their percentage share of the portfolio by his portfolio rate of 0.5 percent. Day 2 Tr. at 363:19–364:1. Dr. Putnam, however, did not explain to the jury how he "translated" citation counts to percentage shares of the portfolio's value; he simply asked the jury to accept the percentages he presented to it, along with the royalty rates he derived from those percentages. For example, Dr. Putnam did not explain why he compared citations to family members of the '247 SEP—a patent that Pantech considers essential to the 5G standard—against citations to patent families that Dr. Putnam considers essential to the 4G standard. Day 2 Sealed Tr. at 53:3–54:13; *see also* Day 1 Tr. at 229:18–230:7 (Dr. Cooklev testifying that '247 SEP does not cover the 4G standard because it use an "NDI" bit instead of a "NACK" to inform the handset to resend data). Nor did he articulate his methodology for translating relative family citation counts to patent value.

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Third, the royalty rates Dr. Putnam assigned to the three SEPs improperly include value attributable to other, unasserted family members, not only the asserted SEPs. "[W]here a royalty is at issue, no matter what the form of the royalty, a patentee must take care to seek only those damages attributable to the infringing features." *Omega Pats., LLC v. CalAmp Corp.*, 13 F.4th 1361, 1376 (Fed. Cir. 2021) (alteration and internal quotation marks omitted) (quoting *VirnetX*, 767 F.3d at 1326). For this reason, "[t]he patentee must in every case give evidence tending to separate or apportion the patentee's damages between the patented feature and the unpatented features." *Id.* (quoting *LaserDynamics*, 694 F.3d at 67 (cleaned up)). "[S]uch evidence must be reliable and tangible, and not conjectural or speculative." *LaserDynamics*, 694 F.3d at 67 (quoting *Garretson*, 111 U.S. at 121); *see also id*. ("A damages theory must be based on sound economic and factual predicates.") (internal quotation marks omitted). "The essential requirement is that the ultimate reasonable royalty award must be based on the incremental value that the patented invention adds to the end product." *Ericsson, Inc. v. D-Link Sys., Inc.*, 773 F.3d 1201, 1226 (Fed. Cir. 2014). Dr. Putnam's testimony does not satisfy this requirement because his royalty rates incorporate value from unasserted family members, rather than reflecting only the "incremental value that the patented invention adds to the end product." *Id.*

Dr. Putnam's damages theory presumes that, the more citations a patent receives, the more valuable the patent is. *See, e.g.*, Day 2 Tr. at 362:24 ("More citations, higher value."). But Dr. Putnam did not count the number of citations received by the *asserted patents* only. Instead, he calculated the number of citations received by the *families* of the asserted patents. *See, e.g.*, Day 2 Tr. at 360:5–6 ("[Y]ou count the family of patents."). For example, when asked whether he "distinguish[ed] between which family member of, say, the '247 family received the citation or not," Dr. Putnam responded that the citations he "added up" were those to "each one of the family

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members." Day 2 Sealed Tr. at 53:12–21. Furthermore, Dr. Putnam conceded that he did not know how many patents were contained in each of the families of the asserted SEPs, nor how many times each of the asserted SEPs had been cited, nor even whether any of them had been cited. Day 2 Sealed Tr. at 52:16–21. Dr. Putnam thus calculated the relative value of patent families, not the asserted patents themselves. Day 2 Sealed Tr. at 50:6–51:4, 53:7–24. This approach is wrong as a matter of law. As of this motion, the '247 SEP's family contains twelve U.S. patents, the '839 SEP's family contains eight U.S. patents, and the '954 SEP's family contains four U.S. patents, as reflected on the first two pages of each of the most recent family members. *See* Ex. A (U.S. Patent No. 11,706,681, the most recent member of the '247 SEP's family); Ex. B (U.S. Patent No. 11,770,218, the most recent member of the '839 SEP's family); Ex. C (U.S. Patent No. 11,659,503, the most recent member of the '954 SEP's family). However, OnePlus has not been alleged to infringe, let alone found to infringe, *every* patent in these families. Dr. Putnam, therefore, improperly imposed royalties for patents that OnePlus has not infringed.

Dr. Cooklev also presented no evidence that could be used to support Dr. Putnam's SEP royalty rates. Although Dr. Cooklev testified that patent citations support his opinions regarding the technical value of the SEPs, including citations from leading companies such as Ericsson, Nokia, and Qualcomm, he could not demonstrate on cross-examination that it was the patents *themselves*, not their family members, that were cited. Day 1 Tr. at 245:21–245:5. Indeed, Dr. Cooklev was unaware that, based on information provided by Pantech, the actual number of citations for the '247 SEP are two, the actual number of citations for the '839 SEP are five, and the actual number of citations for the '954 SEP are zero. Day 1 Tr. at 247:3–12.

The '247 SEP is a prime example of why citations to family members do not translate to the incremental value of the patented features of the asserted patents. Dr. Cooklev opined that the

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'247 SEP is essential to the 5G standard. Day 1 Tr. at 235:18–20. But he was unaware that earlier family members of the '247 SEP had been disclosed as essential to the 3G standard, as stated in a sworn interrogatory response by Pantech. Day 1 Tr. at 240:24–242:5; *see* Ex. D (Second Supp. Responses to OnePlus's First Set of Interrogatories), No. 13 at 50. Particularly in view of Dr. Cooklev's own testimony that the 3G, 4G, and 5G standards are quite different, Day 1 Tr. at 233:25–234:4, 237:10–20, and Pantech's stated position that earlier members of the '247 patent family were essential to the 3G standard, Ex. D, counting citations to the '247 SEP's earlier family members would compensate Pantech not only for the '247 SEP's alleged contributions to the 5G standard but also for the contributions of other patents to the 3G standard.

Pantech presented no evidence that remedies Dr. Putnam's failure to tie damages to the value of the asserted patents, rather than their family members. Both Dr. Putnam and Dr. Cooklev testified that patent family members often share the same specification, suggesting that this is a reason why it would be appropriate to count citations to family members in valuing the asserted SEPs. Day 1 Tr. at 251:19–252:22; Day 2 Tr. at 360:14–16. But it is the *claims* that define an invention, not the specification. *E.g.*, *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312 (Fed. Cir. 2005) ("It is a 'bedrock principle' of patent law that 'the claims of a patent define the invention to which the patentee is entitled the right to exclude.'") (quoting *Innova/Pure Water, Inc. v. Safari Water Filtration Sys., Inc.*, 381 F.3d 1111, 1115 (Fed. Cir. 2004)). And it is the "inventive aspects of the *asserted claims*" that must be reflected in a damages award. *See, e.g.*, *Omega*, 13 F.4th at 1378 (emphasis added); *see also, e.g.*, *VirnetX*, 767 F.3d at 1327 (courts must "carefully tie proof of damages to the *claimed invention's* footprint in the market place") (emphasis added; internal

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quotation marks omitted). Accordingly, the fact that family members often share specifications is not a reason to count citations to family members in valuing an individual patent.[4]

III. The Court Should Grant JMOL of No Damages

By failing to present evidence tying the royalty rates assigned by Dr. Putnam to the value of the '654 NEP and the three SEPs, Pantech has failed to prove a reasonable royalty rate—for the NEP—and FRAND royalty rates—for the SEPs—that could provide the basis for a legally supported damages award. Without such a showing, Pantech's damages case cannot meet the legal requirement of apportionment. *See Omega*, 13 F.4th at 1377, 1380–81 (holding that patentee failed to prove damages where it did not separate value added by patented improvement from other conventional features, and where damages testimony regarding multi-patent licensing agreements did not tie royalty rate to the value of the asserted patent).

Section 284 of Title 35 "does not require an award of damages if none are proven that adequately tie a dollar amount to the infringing acts." *TecSec*, 978 F.3d at 1291; *see Promega Corp. v. Life Techs. Corp.*, 875 F.3d 651, 666 (Fed. Cir. 2017) (concluding patentee was entitled to no damage where it "deliberately abandon[ed] valid theories of recovery in a singular pursuit of an ultimately invalid damages theory"). For example, in *Garretson v. Clark*, the Supreme Court affirmed a determination of infringement but no damages where there was "no proof presented . . . that the plaintiffs had suffered any damages" because the plaintiff "produced no evidence to apportion the profits or damages between the improvement constituting the patented feature and the other features" of the accused product. 111 U.S. at 1211. *Garretson* continues to be cited by the Federal Circuit in apportionment cases and is instructive here, where Pantech has failed to

[4] Dr. Putnam also opined that it is appropriate to count citations to family members because the FRAND commitment "applies to every member of a family." Day 2 Tr. at 360:10–13. But he did not explain why that would be the so.

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apportion for the incremental value of the patented features. *See, e.g.*, *Ericsson,* 773 F.3d at 1226 ("[W]here multi-component products are involved, the governing rule is that the ultimate combination of royalty base and royalty rate must reflect the value attributable to the infringing features of the product, and no more." (citing *Garretson*, 111 U.S. at 121)); *Commonwealth Sci. & Indus. Rsch. Org. v. Cisco Sys., Inc.*, 809 F.3d 1295, 1301 (Fed. Cir. 2015) (discussing *Garretson*). Here, because Pantech has not proven royalty rates tied to the value of the '654 NEP and the three SEPs, neither damages award can stand as a matter of law.

IV. JMOL of No Damages is Additionally Appropriate Because Pantech Pursued an Invalid Damages Theory Based on a Lump-Sum License Agreement That Does Not Reflect the Value of the Licensed Patents

A further flaw in Pantech's damages case is its reliance on the [redacted] license as one of the licenses used to determine a portfolio royalty rate. "[L]ump sum payments . . . should not support running royalty rates without testimony explaining how they apply to the facts of the case," *Whitserve, LLC v. Comput. Packages, Inc.*, 694 F.3d 10, 30 (Fed. Cir. 2012), and the Federal Circuit has vacated damages awards where the derivation of a reasonable royalty from a lump sum was "incompatible with the . . . agreement as a whole," *MLC Intell. Prop., LLC v. Micron Tech., Inc.*, 10 F.4th 1358, 1368 (Fed. Cir. 2021). Here, Dr. Putnam's analysis of the [redacted] license, which he used to support his 0.05% portfolio royalty rate, is incompatible with the license itself, which states: "[redacted]," PX 43 ([redacted] Agreement) § 4.1. Dr. Putnam's damages theory lacks support in the [redacted] license because it inappropriately derives a per-unit royalty from a lump-sum license that, by its own terms, "[redacted]." *Id.* Dr. Putnam did not attempt to

[redacted]

address this language, and Dr. Jung declined to do so on the basis that he was not qualified to interpret legal documents. Day 1 Sealed Tr. at 24:16–26:14.

The Federal Circuit's recent grant of *en banc* rehearing in *EcoFactor, Inc. v. Google LLC,* 115 F.4th 1380 (Fed. Cir. 2024), underscores this flaw in Pantech's damages theory. As pointed out in Judge Prost's dissent from the now-vacated panel opinion in *EcoFactor*, two of the licenses at issue in that case included language indicating that they were "not based upon sales and do[] not reflect or constitute a royalty." *EcoFactor, Inc. v. Google LLC*, 104 F.4th 243, 258 (Fed. Cir. 2024) (Prost, J., dissenting). In the dissent's view, this language "contradicted" and "directly refuted" the recitals upon which the disputed royalty rate was based. *Id.* at 257, 259 (Prost, J., dissenting). This language is highly similar to the language in the [redacted] license, which likewise contradicts Dr. Putnam's use of the [redacted] license to support his portfolio royalty rate, which Dr. Putnam contended is meant to account for the value of the licensed patents. At least because Dr. Putnam relied on the [redacted] license in support of his determination of a portfolio rate, his damages theory is flawed and JMOL of no damages should be granted.

V. JMOL of No Damages Is Additionally Appropriate Because Pantech Pursued an Invalid Damages Theory That Ignores Comparable Licenses and Fails to Apportion the Value of the Asserted SEPs from the Value of Standardization

OnePlus incorporates by reference additional arguments, made in OnePlus's Rule 50(b) motion filed following the prior trial in this matter, that JMOL of no damages should be granted due to flaws in the damages theory Pantech presented through Dr. Putnam. Pantech presented the same damages theory in this trial, and it is flawed for the same reasons. *First*, Dr. Putnam's damages theory improperly ignores the [redacted] and [redacted] even though these are highly relevant, comparable licenses. Dkt. 300 at 29–35; *see, e.g.*, Day 1 Sealed Tr. at 3:1–8:14, 11:19–14:2, 15:7–13, 17:3–28:24, 31:3–37:25; Day 1 Tr. at 216:20–221:13; Day 2 Tr. at 336:2–337:8, 338:11–343:12, 344:17–364:21, 367:14–368:25, 387:5–396:25; Day 2 Sealed Tr. at 3:10–61:12;

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PX 41; PX 42; PX 40; PX 43; DTX 005; DTX 007. *Second*, Dr. Putnam's damages theory did not attempt to apportion the value of the asserted SEPs from the value of standardization, which is required under Federal Circuit case law. Dkt. 300 at 35–36; *see* Day 2 Tr. at 336:2 –337:8, 338:11–343:12, 344:17–364:21, 367:14–368:25; Day 2 Sealed Tr. at 3:10–61:12, 63:4–100:1. Recognizing that the Court did not grant JMOL based on these arguments following the prior trial, OnePlus preserves them for appeal.

VI. CONCLUSION

For the foregoing reasons, OnePlus requests that the Court grant JMOL of no damages with respect to the '654 NEP and the SEPs.

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Date: October 30, 2024

Respectfully Submitted,

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CERTIFICATE OF SERVICE

I hereby certify that the foregoing document was electronically filed on October 30, 2024, and Defendant served a true and correct copy of the foregoing document on Plaintiffs' counsel of record by electronic mail.

/s/ G. Blake Thompson
G. Blake Thompson

[redacted]

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TEXARKANA DIVISION

PANTECH CORPORATION and PANTECH WIRELESS, LLC,

Plaintiffs,

v.

ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD.,

Defendant.

C.A. No. 5:22-cv-00069-RWS

JURY TRIAL DEMANDED

[redacted]

DECLARATION OF CHRISTOPHER J. GASS IN SUPPORT OF DEFENDANT ONEPLUS TECHNOLOGY (SHENZHEN) CO. LTD.'S RULE 50(B) MOTION FOR JUDGMENT AS A MATTER OF LAW

I, Christopher J. Gass, being of full age, hereby declare as follows:

1. I am an attorney-at-law and associated with the law firm of Leydig, Voit & Mayer, Two Prudential Plaza, 180 N. Stetson Avenue, Suite 4900, Chicago, IL 60601.

2. I serve as outside counsel for Defendant OnePlus Technology (Shenzhen) Co., Ltd. ("OnePlus") in this action. This Court has admitted me to appear and participate in this action *pro hac vice*. ECF No. 20.

3. I am a member in good standing of the Bar of the State of Illinois (2010), as well as the United States Patent and Trademark Office (2012) and the United States District Court for the Northern District of Illinois (2015).

4. I submit this Declaration in support of OnePlus's Rule 50(b) Motion for Judgment As a Matter of Law, filed concurrently herewith.

5. I have personal knowledge of the facts stated in this Declaration and am competent to testify to the same.

6. More particularly, I submit this Declaration to authenticate, and provide to the Court, certain documents cited in OnePlus's Rule 50(b) Motion for Judgment As a Matter of Law, submitted concurrently herewith.

7. Attached hereto as **Exhibit A** is a true and correct copy of U.S. Patent No. 11,706,681, dated July 18, 2023.

8. Attached hereto as **Exhibit B** is a true and correct copy of U.S. Patent No. 11,770,218, dated September 26, 2023.

9. Attached hereto as **Exhibit C** is a true and correct copy of U.S. Patent No. 11,659,503, dated May 23, 2023.

10. Attached hereto as **Exhibit D** is a true and correct copy of an excerpt of Plaintiffs' Second Supplemental Objections and Responses to OnePlus's First Set of Interrogatories (Nos. 1-14), dated August 25, 2023.

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

Executed on this 30th day of October, 2024.

/s/ Christopher J. Gass
Christopher J. Gass

EXHIBIT A

[redacted]

US011706681B2

(12) **United States Patent**
Zhang et al.

(10) **Patent No.: US 11,706,681 B2**
(45) **Date of Patent: *Jul. 18, 2023**

(54) **SUPPORTING UPLINK TRANSMISSIONS**

(71) Applicant: **Pantech Wireless, LLC**, Cedar Park, TX (US)

(72) Inventors: **Guodong Zhang**, Syosset, NY (US); **Sung-Hyuk Shin**, Northvale, NJ (US); **Stephen E. Terry**, Northport, NY (US); **James M. Miller**, Verona, NJ (US); **Stephen G. Dick**, Nesconset, NY (US)

(73) Assignee: **Pantech Wireless, LLC**, Cedar Park, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/848,070**

(22) Filed: **Jun. 23, 2022**

(65) **Prior Publication Data**

US 2022/0330121 A1 Oct. 13, 2022

Related U.S. Application Data

(63) Continuation of application No. 17/532,538, filed on Nov. 22, 2021, now Pat. No. 11,375,425, which is a (Continued)

(51) **Int. Cl.**
H04W 36/18 (2009.01)
H04L 1/1867 (2023.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04W 36/18*** (2013.01); ***H04L 1/1812*** (2013.01); ***H04L 1/1887*** (2013.01);
(Continued)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,628,631 A 5/1997 Aneha
5,794,149 A 8/1998 Hoo
(Continued)

FOREIGN PATENT DOCUMENTS

DE 10225428 12/2003
EP 0 977 393 2/2000
(Continued)

OTHER PUBLICATIONS

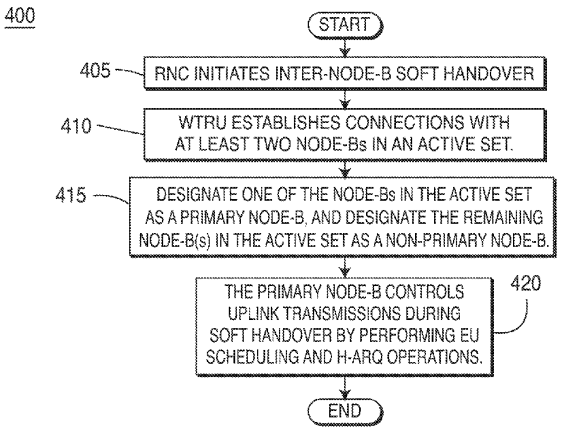
"Hybrid ARQ text proposal for Section 7 of TR25.896" TSG-RAN WG1 #31, R1-030208, Tokyo, Japan, Feb. 18-21, 2002, 4 pages.
(Continued)

Primary Examiner — Brian S Roberts
(74) *Attorney, Agent, or Firm* — Volpe Koenig

(57) **ABSTRACT**

Apparatuses and methods supporting uplink transmissions are disclosed. A method includes receiving signaling including information indicating a primary cell and at least one non-primary cell, receiving a message with scheduling information indicating an allocation of uplink resources and a HARQ process ID, and transmitting to at least the one non-primary cell an uplink transmission using a HARQ process indicated by the HARQ process ID and the allocation of uplink resources. Another method includes transmitting signaling including information indicating a primary cell and at least one non-primary cell, transmitting a message with scheduling information indicating an allocation of uplink resources and a HARQ process ID to a wireless transmit/receive unit (WTRU), and receiving an uplink transmission using a HARQ process indicated by the HARQ process ID and the allocation of uplink resources on at least the one non-primary cell.

18 Claims, 4 Drawing Sheets



Related U.S. Application Data

continuation of application No. 17/099,354, filed on Nov. 16, 2020, now Pat. No. 11,272,416, which is a continuation of application No. 17/008,439, filed on Aug. 31, 2020, now Pat. No. 10,869,247, which is a continuation of application No. 16/545,398, filed on Aug. 20, 2019, now Pat. No. 10,791,491, which is a continuation of application No. 16/283,407, filed on Feb. 22, 2019, now Pat. No. 10,791,490, which is a continuation of application No. 15/699,418, filed on Sep. 8, 2017, now Pat. No. 10,219,196, which is a continuation of application No. 14/869,313, filed on Sep. 29, 2015, now Pat. No. 9,763,156, which is a continuation of application No. 13/908,242, filed on Jun. 3, 2013, now Pat. No. 9,215,636, which is a continuation of application No. 13/308,950, filed on Dec. 1, 2011, now Pat. No. 8,457,072, which is a continuation of application No. 11/434,330, filed on May 15, 2006, now Pat. No. 8,130,720, which is a continuation of application No. 10/962,720, filed on Oct. 12, 2004, now Pat. No. 7,046,648.

(60) Provisional application No. 60/578,674, filed on Jun. 10, 2004, provisional application No. 60/520,692, filed on Nov. 17, 2003, provisional application No. 60/519,990, filed on Nov. 14, 2003, provisional application No. 60/517,656, filed on Nov. 5, 2003.

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H04B 7/022	(2017.01)
H04W 36/30	(2009.01)
H04W 88/08	(2009.01)

(52) **U.S. Cl.**

CPC ***H04L 1/1893*** (2013.01); ***H04W 74/004*** (2013.01); ***H04W 74/04*** (2013.01); *H04B 7/022* (2013.01); *H04W 36/30* (2013.01); *H04W 88/08* (2013.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,933,787	A	8/1999	Gilhousen et al.
5,946,320	A	8/1999	Decker et al.
6,351,460	B1	2/2002	Tiedemann, Jr. et al.
6,414,947	B1	7/2002	Legg et al.
6,434,396	B1	8/2002	Rune
6,507,567	B1	1/2003	Willars
6,584,084	B1	6/2003	Barany et al.
6,628,631	B1	9/2003	Mazawa et al.
6,643,813	B1	11/2003	Johansson et al.
6,650,905	B1	11/2003	Toskala et al.
6,678,249	B2	1/2004	Toskala et al.
6,678,523	B1	1/2004	Ghosh et al.
6,690,939	B1	2/2004	Jonsson et al.
6,754,496	B2	6/2004	Mohebbi et al.
6,778,830	B1	8/2004	Oizumi et al.
6,799,045	B1	9/2004	Brouwer
6,829,482	B2	12/2004	Rune et al.
6,850,771	B2	2/2005	Malladi et al.
6,892,071	B2	5/2005	Park et al.
6,907,245	B2	6/2005	Ohlsson et al.
6,915,465	B2	7/2005	Fujiwara et al.
6,977,888	B1	12/2005	Frenger et al.
7,013,143	B2	3/2006	Love et al.
7,026,911	B2	4/2006	Aono et al.
7,046,648	B2	5/2006	Zhang et al.
7,054,633	B2	5/2006	Seo et al.
7,065,359	B2	6/2006	Chuah et al.
7,082,304	B2	7/2006	Wakabayashi
7,103,729	B2	9/2006	Altahan et al.
7,124,350	B2	10/2006	Chao et al.
7,158,504	B2	1/2007	Kadaba et al.
7,185,256	B2	2/2007	Miki et al.
7,206,598	B2	4/2007	Attar et al.
7,212,824	B2	5/2007	Terry
7,266,384	B2	9/2007	Kim et al.
7,269,420	B2	9/2007	Heo et al.
7,277,407	B2	10/2007	Kim et al.
7,283,508	B2	10/2007	Choi et al.
7,283,509	B2	10/2007	Moon et al.
7,283,782	B2	10/2007	Sinnarajah et al.
7,315,741	B2	1/2008	Chun
7,317,700	B2	1/2008	Hwang
7,346,035	B2	3/2008	Lee et al.
7,366,538	B2	4/2008	Seki et al.
7,372,898	B2	5/2008	Shin et al.
7,392,051	B2	6/2008	Rajala et al.
7,403,513	B2	7/2008	Lee et al.
7,414,989	B2	8/2008	Kuchibhotla et al.
7,428,424	B2	9/2008	Hwang et al.
7,433,337	B2	10/2008	Chao et al.
7,519,016	B2	4/2009	Lee et al.
7,558,230	B2	7/2009	Lee et al.
7,606,205	B2	10/2009	Ranta-Aho et al.
7,848,290	B2	12/2010	Cheng et al.
7,903,610	B2	3/2011	Cheng et al.
7,974,630	B1	7/2011	Haumont et al.
8,023,463	B2	9/2011	Dick et al.
8,682,325	B1	3/2014	Cooper
9,438,381	B2	9/2016	Dick et al.
10,390,279	B2	8/2019	Dick et al.
2001/0020285	A1	9/2001	Fujiwara et al.
2002/0080719	A1	6/2002	Parkvall et al.
2002/0093937	A1	7/2002	Kim et al.
2002/0095635	A1	7/2002	Wager et al.
2002/0115460	A1	8/2002	Rune et al.
2002/0115467	A1	8/2002	Hamabe
2002/0141360	A1	10/2002	Baba et al.
2002/0172208	A1	11/2002	Malkamaki
2002/0191544	A1	12/2002	Cheng et al.
2002/0198025	A1	12/2002	Brownlee et al.
2003/0002470	A1	1/2003	Park et al.
2003/0007480	A1	1/2003	Kim et al.
2003/0031119	A1	2/2003	Kim et al.
2003/0043786	A1	3/2003	Kall et al.
2003/0054824	A1	3/2003	Choi et al.
2003/0081692	A1	5/2003	Kwan et al.
2003/0123403	A1	7/2003	Jiang
2003/0123470	A1	7/2003	Kim et al.
2003/0131124	A1	7/2003	Yi et al.
2003/0147370	A1	8/2003	Wu
2003/0161284	A1	8/2003	Chen
2003/0171118	A1	9/2003	Miya
2003/0176195	A1	9/2003	Dick et al.
2003/0189909	A1	10/2003	Chao et al.
2003/0202500	A1	10/2003	Ha et al.
2003/0210668	A1	11/2003	Malladi et al.
2004/0004954	A1	1/2004	Terry et al.
2004/0072567	A1	4/2004	Cao et al.
2004/0085934	A1	5/2004	Balachandran et al.
2004/0109433	A1	6/2004	Khan
2004/0120306	A1	6/2004	Wigard et al.
2004/0160925	A1	8/2004	Heo et al.
2004/0202129	A1	10/2004	Kolding et al.
2004/0203991	A1	10/2004	Chen et al.
2004/0219917	A1	11/2004	Love et al.
2004/0219919	A1	11/2004	Whinnett et al.
2004/0219920	A1	11/2004	Love et al.
2004/0228313	A1	11/2004	Cheng et al.
2005/0041694	A1	2/2005	Liu
2005/0047354	A1	3/2005	Zeira et al.
2005/0048920	A1	3/2005	Liu
2005/0083888	A1	4/2005	Smee et al.
2005/0207374	A1	9/2005	Petrovic et al.
2006/0045010	A1	3/2006	Baker et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2006/0092972	A1	5/2006	Petrovic et al.
2006/0105796	A1	5/2006	Malladi et al.
2006/0274712	A1	12/2006	Malladi et al.
2007/0047501	A1	3/2007	Usuda et al.
2007/0079207	A1	4/2007	Seidel et al.

FOREIGN PATENT DOCUMENTS

EP	1 217 777	6/2002
GB	2 353 439	2/2001
JP	04-157821	5/1992
JP	2000-217139	8/2000
JP	2001-8251	1/2001
JP	2001-128209	5/2001
JP	2002-009741	1/2002
JP	2003-134180	5/2003
JP	2003-163960	6/2003
JP	2007-511135	4/2007
KR	20020095231	12/2002
KR	20030003943	1/2003
KR	20030040972	5/2003
RU	2003112283	12/2005
RU	2005110767	10/2006
TW	536896	6/2003
TW	200303689	9/2003
WO	99/027740	6/1999
WO	00/35226	6/2000
WO	00/074263	12/2000
WO	02/01893	1/2002
WO	02/37572	5/2002
WO	02/037872	5/2002
WO	02/047317	6/2002
WO	02/082108	10/2002
WO	02/101966	12/2002
WO	02/102109	12/2002
WO	03/003643	1/2003
WO	03/026231	3/2003
WO	03/037027	5/2003
WO	03/047155	6/2003
WO	03/053087	6/2003
WO	2003/049481	6/2003
WO	03/067953	8/2003
WO	03/088545	10/2003
WO	2005/048503	5/2005

OTHER PUBLICATIONS

3GPP TSG RAN WG1 #31, Tdoc R1-03-0273, Qualcomm, "Channel Structure for Consideration in Enhanced Uplink", Tokyo, Japan, Feb. 18-21, 2003.

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Feasibility Study for Enhanced Uplink for UTRA FDD; (Release 6)," 3GPP TR 25.896 V1.0.2 (Oct. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Feasibility Study for Enhanced Uplink for UTRA FDD (Release 6)," 3GPP TR 25.896 V6.0.0 (Mar. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Multiplexing and channel coding (FDD) (Release 1999)," 3GPP TS 25.212 V3.11.0 (Sep. 2002).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Medium Access Control (MAC) protocol specification (Release 1999)." 3GPP TS 25.321 V3.16.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Multiplexing and channel coding (FDD) (Release 4)," 3GPP TS 25.212 V4.6.0 (Sep. 2002).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Multiplexing and channel coding (FDD) (Release 5)," 3GPP TS 25.212 V5.6.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Multiplexing and channel coding (FDD) (Release 5)," 3GPP TS 25.212 V5.9.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Multiplexing and channel coding (FDD) (Release 6)," 3GPP TS 25.212 V6.2.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Medium Access Control (MAC) protocol specification (Release 1999)," 3GPP TS 25.321 V3.17.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Medium Access Control (MAC) protocol specification (Release 6)," 3GPP TS 25.321 V6.2.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Medium Access Control (MAC) protocol specification (Release 4)," 3GPP TS 25.321 V4.9.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Medium Access Control (MAC) protocol specification (Release 5)," 3GPP TS 25.321 V5.9.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Medium Access Control (MAC) protocol specification (Release 4)," 3GPP TS 25.321 V4.10.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Medium Access Control (MAC) protocol specification (Release 5)," 3GPP TS 25.321 V5.6.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Feasibility Study for Enhanced Uplink for UTRA FDD; (Release 6)," 3GPP TR 25.896 V1.0.1 (Oct. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC) protocol specification (Release 1999)," 3GPP TS 25.331 V3.16.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC) protocol specification (Release 1999)," 3GPP TS 25.331 V3.20.0 (Sep. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 4)," 3GPP TS 25.331 V4.11.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 4)," 3GPP TS 25.331 V4.15.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 5)," 3GPP TS 25.331 V5.6.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 5)," 3GPP TS 25.331 V5.10.0 (Sep. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Radio Resource Control (RRC); Protocol Specification (Release 6)," 3GPP TS 25.331 V6.3.0 (Sep. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Tub interface NBAP signaling (Release 1999)," 3GPP TS 25.433 V3.14.2 (Sep. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Tub interface NBAP signaling (Release 1999)," 3GPP TS 25.433 V3.14.0 (Sep. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Tub interface NBAP signaling (Release 4)," 3GPP TS 25.433 V4.10.0 (Sep. 2003).

(56) **References Cited**

OTHER PUBLICATIONS

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Tub interface NBAP signaling (Release 4)," 3GPP TS 25.433 V4.13.0 (Sep. 2004).
3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Tub interface NBAP signaling (Release 5)," 3GPP TS 25.433 V5.6.0 (Sep. 2003).
3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Tub interface NBAP signaling (Release 5)," 3GPP TS 25.433 V5.10.0 (Sep. 2004).
3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN Tub interface NBAP signaling (Release 6)," 3GPP TS 25.433 V6.3.0 (Sep. 2004).
3GPP, "Third Generation Partnership Project; Technical Specification Group Radio Access Network; FDD Enhanced Uplink; Overall Description; Stage 2 (Release 6)," 3GPP TS 25.309 V6.0.0 (Sep. 2004).
3GPP2 C.20003-C, "Medium Access Control (MAC) Standard for cdma2000 Spread Spectrum Systems", 3rd Generation Partnership Project 2 "3GPP2", Version 2.0, Release C, Aug. 2004.
3GPP2 C.S0004-C, "Signaling Link Access Control (LAC) Standard for cdma2000 Spread Spectrum Systems", 3rd Generation Partnership Project 2 "3GPP2", Version 2.0, Revision C, Jul. 23, 2004.
3GPP2 C.S0005-C, "Upper Layer (Layer 3) Signaling Standard for cdma2000 Spread Spectrum Systems", 3rd Generation Partnership Project 2 "3GPP2", Version 2.0, Revision c, Jul. 23, 2004.
ETSI, UMTS XX. 15V0.3.0 Jan. 1999, UTRA Handover, 21pp.
GPP2 C.S0002-C, "Physical Layer Standard for cdma2000 Spread Spectrum Systems", 3rd Generation Partnership Project 2 "3GPP2", Version 2.0, Revision C, Jul. 23, 2004.
Heck et al., "Diversity Effects on the Soft Handover Gain in UMTS Networks," Proceedings of the IEEE Vehicular Technology Conference, vol. 2, pp. 1269-1273 (Sep. 2002).
Interdigital, "Performance Analysis of HARQ in Soft Handover," 3GPP TSG-RAN WG1 #34 meeting, R1-030979 (Oct. 6-10, 2003).
Nokia, "HARQ overhead issues", TSG-RAN1 #33, R1-030733 (Aug. 25-29, 2003).
Panasonic, "HARQ operation during Soft Handover," 3GPP TSG-RAN WG1 Meeting #33, R1-030802, New York, USA (Aug. 25-29, 2003).
Panasonic, HARQ Operation During Soft Handover, 3GPP TSG-RAN WG1 Meeting #33 R1-030802, Aug. 25-29, 2003.
Qualcomm, "Impact of Downlink Support Channels," 3GPP TSG RAN WG1 #32, Tdoc R1-03-0433, Paris, France (May 19-23, 2003).
R1-030803, "HARQ operation during Soft Handover", Panasonic, TSG RAN1 #33.
Samsung, "HARQ performance in soft handover", TSG RAN1 #33, R1-030765 (Aug. 25-29, 2003).
Samsung, "HARQ Structure", 3GPP TSG-RAN WG1 #31, R1-030247, Tokyo, Japan, 3 pages (Feb. 18-21, 2003).
Samsung, "Transport channel multiplexing options considering SHO", 3GPP TSG RAN WG1 #33, R1-030767, New York, USA, 5 pages (Aug. 25-29, 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Feasibility Study for Enhanced Uplink for UTRA FDD; (Release 6," 3GPP TR 25.896 V0.4.2 (R1-030952) (Sep. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 1999)," 3GPP TS 25.133 V3.19.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 4)," 3GPP TS 25.133 V4.10.0 (Sep. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 4)," 3GPP TS 25.133 V4.13.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 5)," 3GPP TS 25.133 V5.12.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 6)," 3GPP TS 25.133 V6.7.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 1999)," 3GPP TS 25.133 V3.15.0 (Sep. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 5)," 3GPP TS 25.133 V5.8.0 (Sep. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Requirements for support of radio resource management (FDD) (Release 6)," 3GPP TS 25.133 V6.3.0 (Sep. 2003).
Third Generation Partnership Project, Technical Specification Group Radio Access Network; Feasibility Study for Enhanced Uplink for UTRA FDD (Release 6), 3GPP TR 25.896 V0.2.1, R1-030372, pp. 14-17 (Feb. 26, 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical layer procedures (FDD) (Release 1999)," 3GPP TS 25.214 V3.12.0 (Mar. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical layer procedures (FDD) (Release 4)," 3GPP TS 25.214 V4.6.0 (Mar. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical layer procedures (FDD) (Release 5)," 3GPP TS 25.214 V5.6.0 (Sep. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical layer procedures (FDD) (Release 5)," 3GPP TS 25.214 V5.9.0 (Jun. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (FDD) (Release 1999)," 3GPP TS 25.211 V3.12.0 (Sep. 2002).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (FDD) (Release 4)," 3GPP TS 25.211 V4.6.0 (Sep. 2002).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (FDD) (Release 5)," 3GPP TS 25.211 V5.5.0 (Sep. 2003).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (FDD) (Release 5)," 3GPP TS 25.211 V5.6.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical channels and mapping of transport channels onto physical channels (FDD) (Release 6)," 3GPP TS 25.211 V6.2.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; Physical layer procedures (FDD) (Release 6)," 3GPP TS 25.214 V6.3.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (Release 6)," 3GPP TS 25.308 V6.2.0 (Sep. 2004).
Third Generation Partnership Project, "Technical Specification Group Radio Access Network; High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (Release 5)," 3GPP TS 25.308 V5.6.0 (Sep. 2004).

(56) **References Cited**

OTHER PUBLICATIONS

Third Generation Partnership Project, "Technical Specification Group Radio Access Network; High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (Release 5)," 3GPP TS 25.308 V5.4.0 (Mar. 2003).

TSGR1#3(99)187, "Improvements to Site Selection Delivery Transmission (SSDT)", TSG-RAN Working Group 1 meeting #3, Source: Motorola, Stockholm, Sweden, 5 pages (Mar. 22-26, 1999). ftp://www.3gpp.org/tsg_ran/WG1_RL1/TSGR1_03/Docs/pdfs/R1-99187.PDF.

Ericsson, "E-DCH multiplexing and transport channel structure," TSG-RAN Working Group 2 meeting #42, Tdoc R2-040917, Montreal, Canada, (May 2004).

Holma et al., "WCDMA For UMTS—Radio Access For Third Generation Mobile Communications," First Edition, (2000).

Third Generation Partnership Project, "Technical Specification Group Radio Access Network, FDD Enhanced Uplink, Overall description, Stage 2 (Release 6)," 3GPP TS 25.309 V0.2.0 (Jun. 2004).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN lub Interface User Plane Protocols for Common Transport Channel data streams KRelease 5)," 3GPP TS 25.435 V5.5.0 (Jun. 2003).

3GPP, "3rd Generation Partnership Project; Technical Specification Group Radio Access Network; UTRAN lub interface User Plane Protocols for Common Transport Channel data streams KRelease 6)," 3GPP TS 25.435 V6.1.0 (Mar. 2004).

3GPP, "3rd Generation Partnership Project; echnical Specification Group Radio Access Network; Radio resource management strategies (Release 5)," 3GPP TR 25.922 V5.0.0 (Mar. 2002).

Universal Mobile Telecommunications System (UMTS); "Radio resource management strategies (3GPP TR 25.922 version 5.1.0 Release 5)," ETSI TR 125 922 V5.1.0 (Sep. 2003).

Universal Mobile Telecommunications System (UMTS); "Radio resource management strategies (3GPP TR 25.922 version 6.0.1 Release 6)," ETSI TR 125 922 V6.0.1 (Apr. 2004).

Third Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network General Packet Radio Service (GPRS); Mobile Station (MS)—Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol (Release 6), 3GPP TS 44.060 V6.4.0 (Sep. 2003).

Third Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network General Packet Radio Service (GPRS); Mobile Station (MS)—Base Station System (BSS) interface; Radio Link Control/Medium Access Control (RLC/MAC) protocol (Release 6), 3GPP TS 44.060 V6.9.0 (Sep. 2004).

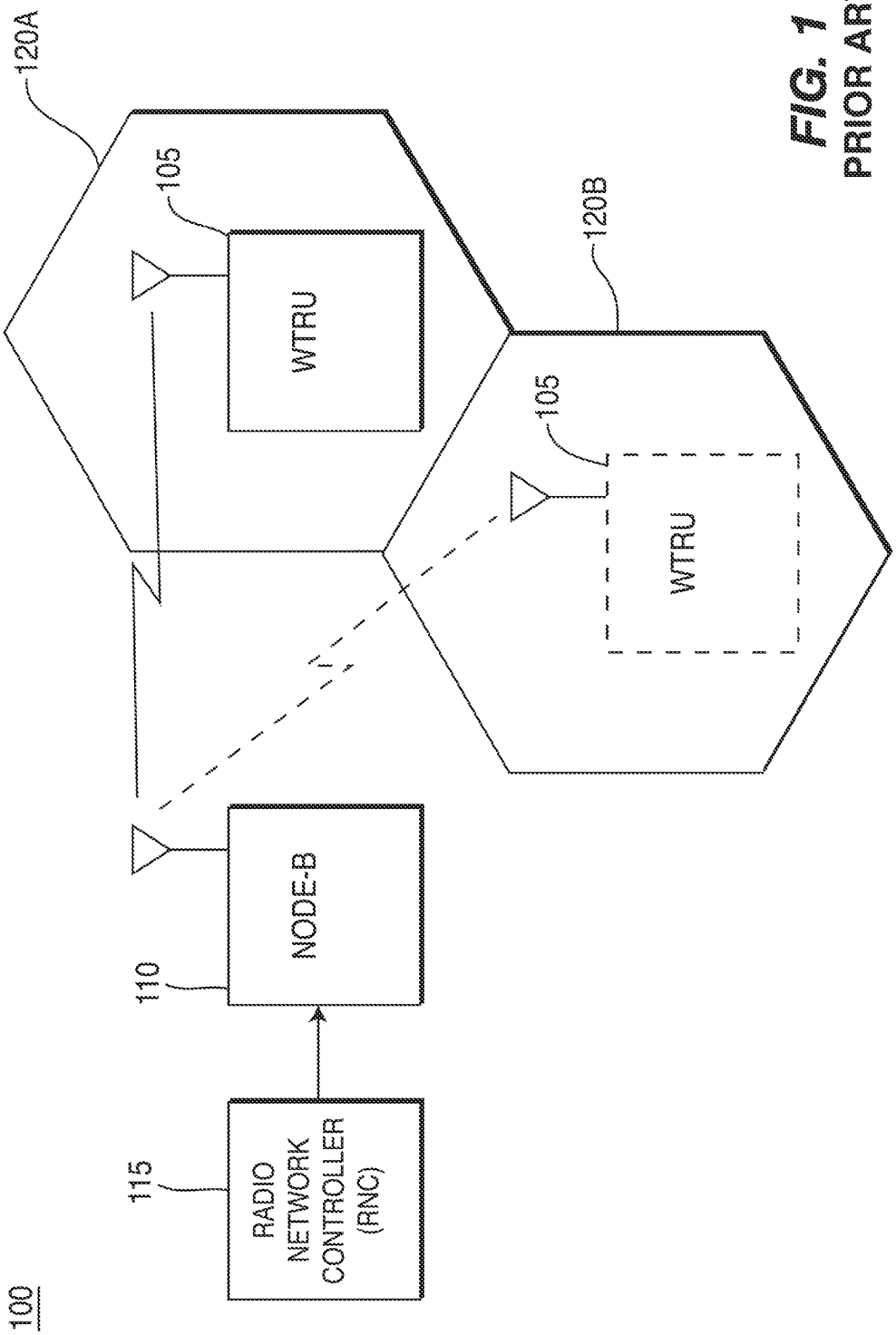

FIG. 1
PRIOR ART

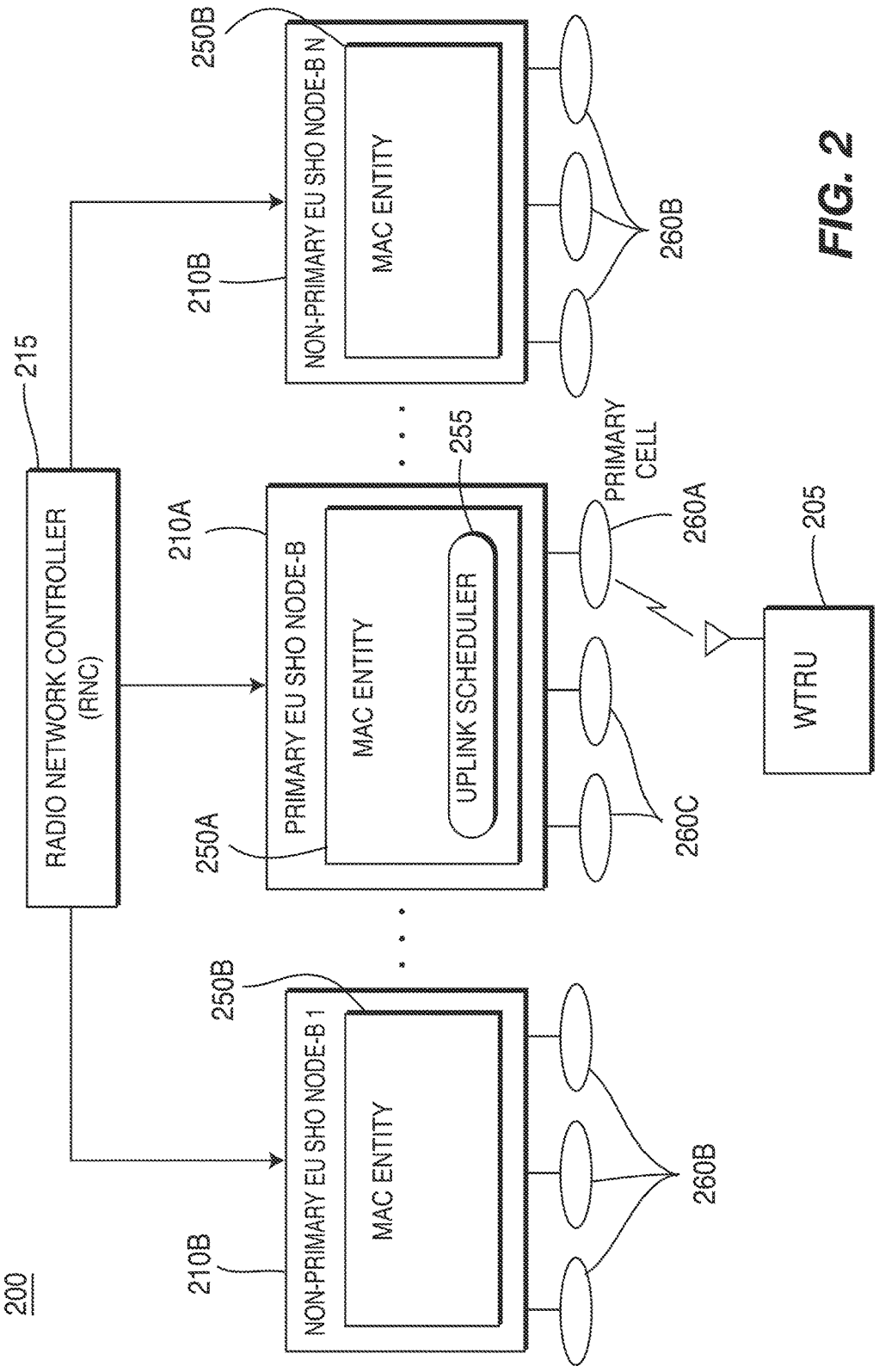
200
RADIO NETWORK CONTROLLER (RNC)
215
PRIMARY EU SHO NODE-B
MAC ENTITY
UPLINK SCHEDULER
210A
250A
255
NON-PRIMARY EU SHO NODE-B 1
MAC ENTITY
210B
250B
NON-PRIMARY EU SHO NODE-B N
MAC ENTITY
210B
250B
PRIMARY CELL
260A
260B
260C
WTRU
205

FIG. 2

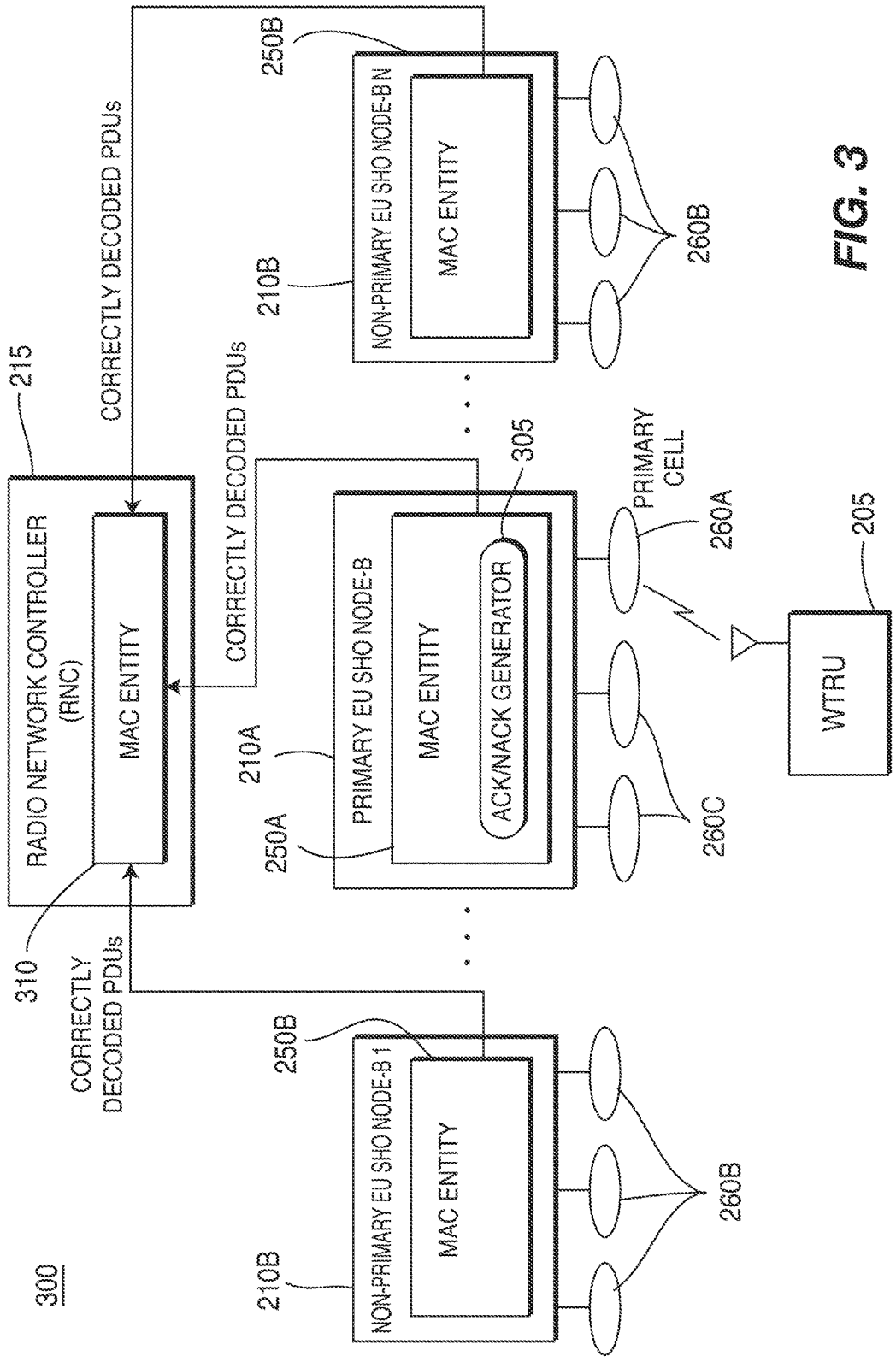
300
RADIO NETWORK CONTROLLER (RNC)
MAC ENTITY
215
310
CORRECTLY DECODED PDUs
CORRECTLY DECODED PDUs
CORRECTLY DECODED PDUs
PRIMARY EU SHO NODE-B
MAC ENTITY
ACK/NACK GENERATOR
305
210A
250A
NON-PRIMARY EU SHO NODE-B 1
MAC ENTITY
210B
250B
NON-PRIMARY EU SHO NODE-B N
MAC ENTITY
210B
250B
PRIMARY CELL
260A
260C
260B
260B
WTRU
205

FIG. 3

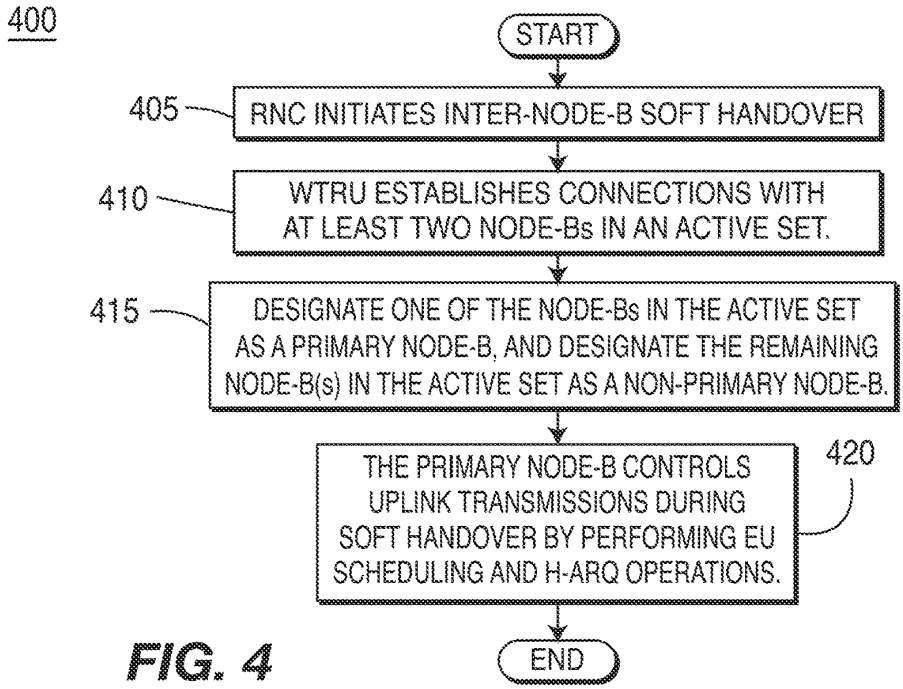
400
START
405
RNC INITIATES INTER-NODE-B SOFT HANDOVER
410
WTRU ESTABLISHES CONNECTIONS WITH AT LEAST TWO NODE-Bs IN AN ACTIVE SET.
415
DESIGNATE ONE OF THE NODE-Bs IN THE ACTIVE SET AS A PRIMARY NODE-B, AND DESIGNATE THE REMAINING NODE-B(s) IN THE ACTIVE SET AS A NON-PRIMARY NODE-B.
420
THE PRIMARY NODE-B CONTROLS UPLINK TRANSMISSIONS DURING SOFT HANDOVER BY PERFORMING EU SCHEDULING AND H-ARQ OPERATIONS.
END

FIG. 4

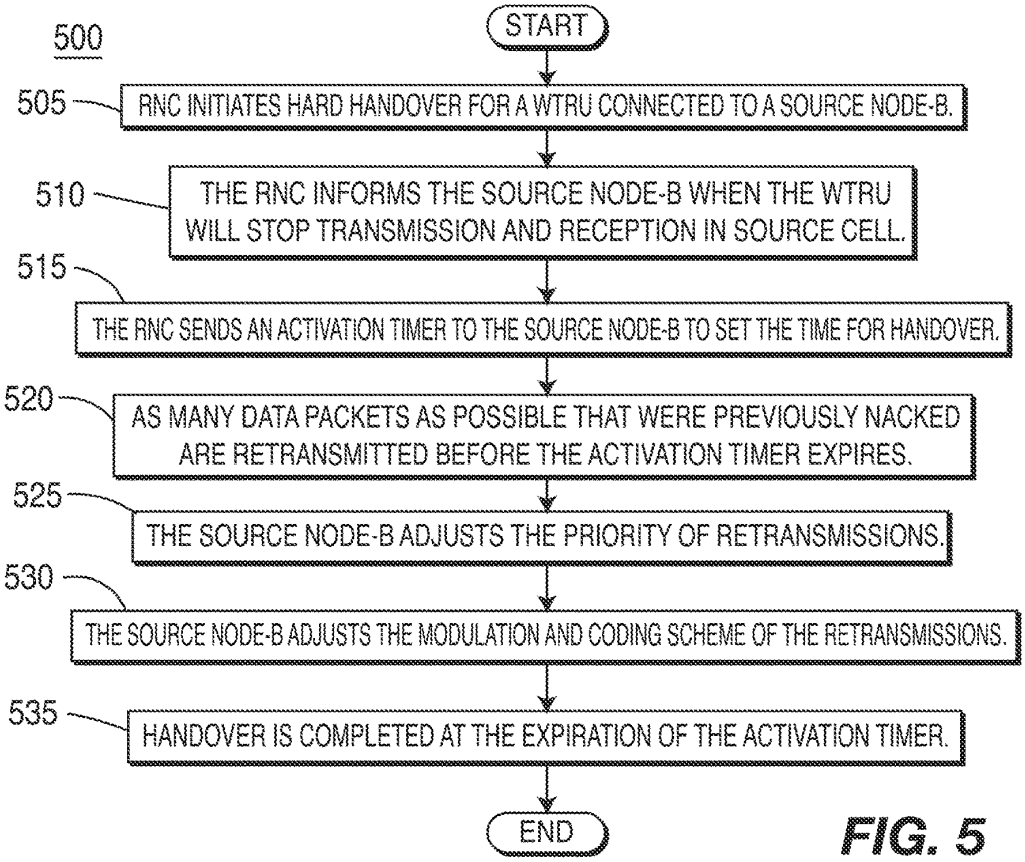
500
START
505
RNC INITIATES HARD HANDOVER FOR A WTRU CONNECTED TO A SOURCE NODE-B.
510
THE RNC INFORMS THE SOURCE NODE-B WHEN THE WTRU WILL STOP TRANSMISSION AND RECEPTION IN SOURCE CELL.
515
THE RNC SENDS AN ACTIVATION TIMER TO THE SOURCE NODE-B TO SET THE TIME FOR HANDOVER.
520
AS MANY DATA PACKETS AS POSSIBLE THAT WERE PREVIOUSLY NACKED ARE RETRANSMITTED BEFORE THE ACTIVATION TIMER EXPIRES.
525
THE SOURCE NODE-B ADJUSTS THE PRIORITY OF RETRANSMISSIONS.
530
THE SOURCE NODE-B ADJUSTS THE MODULATION AND CODING SCHEME OF THE RETRANSMISSIONS.
535
HANDOVER IS COMPLETED AT THE EXPIRATION OF THE ACTIVATION TIMER.
END

FIG. 5

SUPPORTING UPLINK TRANSMISSIONS

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 17/532,538, filed on Nov. 22, 2021, which is a continuation of U.S. patent application Ser. No. 17/099,354, filed on Nov. 16, 2020, now U.S. Pat. No. 11,272,416 issued on Mar. 8, 2022, which is a continuation of U.S. patent application Ser. No. 17/008,439, filed Aug. 31, 2020, now U.S. Pat. No. 11,259,228 issued on Feb. 22, 2022, which is a continuation of U.S. patent application Ser. No. 16/545,398, filed Aug. 20, 2019, now U.S. Pat. No. 10,791,491 issued on Sep. 29, 2019, which is a continuation of U.S. patent application Ser. No. 16/283,407, filed Feb. 22, 2019, now U.S. Pat. No. 10,791,490 issued on Sep. 29, 2019, which is a continuation of U.S. patent application Ser. No. 15/699,418 filed on Sep. 8, 2017, now U.S. Pat. No. 10,219,196 issued on Feb. 26, 2019, which is a continuation of U.S. patent application Ser. No. 14/869,313, filed on Sep. 29, 2015, now U.S. Pat. No. 9,763,156 issued on Sep. 12, 2017, which is a continuation of U.S. patent application Ser. No. 13/908,242 filed on Jun. 3, 2013, now U.S. Pat. No. 9,215,636 issued on Dec. 15, 2015, which is a continuation of U.S. patent application Ser. No. 13/308,950 filed on Dec. 1, 2011, now U.S. Pat. No. 8,457,072 issued on Jun. 4, 2013, which is a continuation of U.S. patent application Ser. No. 11/434,330 filed on May 15, 2006, now U.S. Pat. No. 8,130,720 issued on Mar. 6, 2012, which is a continuation of U.S. patent application Ser. No. 10/962,720 filed Oct. 12, 2004, now U.S. Pat. No. 7,046,648 issued on May 16, 2006, which claims the benefit of U.S. Provisional Application Ser. No. 60/578,674 filed Jun. 10, 2004; 60/520,692 filed Nov. 17, 2003; 60/519,990 filed Nov. 14, 2003; and 60/517,656 filed Nov. 5, 2003, all of which are incorporated by reference as if fully set forth. This application is also related to U.S. patent application Ser. No. 17/008,468, filed on Aug. 31, 2020, now U.S. Pat. No. 11,259,228 issued on Feb. 22, 2022, and U.S. patent application Ser. No. 17/099,397, filed on Nov. 16, 2020, now U.S. Pat. No. 11,277,778 issued on Mar. 15, 2022.

FIELD OF INVENTION

The present invention is related to a wireless communication system. More particularly, the present invention is related to a method and apparatus for coordinating Node-Bs and supporting enhanced uplink (EU) transmissions during handover.

BACKGROUND

Many schemes have been proposed to improve coverage, throughput, and transmission latency for EU transmissions in third generation partnership project (3GPP). One of the developments is to move the functions for scheduling and assigning uplink (UL) physical channel resources from a radio network controller (RNC) to a Node-B. A Node-B can make more efficient decisions and manage UL radio resources on a short-term basis better than the RNC, even if the RNC retains overall control over Node-Bs. A similar approach has already been adopted in downlink for high speed data packet access (HSDPA) in both universal mobile telecommunication system (UMTS) frequency division duplex (FDD) and time division duplex (TDD) modes.

It has also been recognized that performance is greatly enhanced with the use of medium access control (MAC) level automatic repeat request (ARQ) and hybrid ARQ (H-ARQ). Application of these techniques during soft handover provides additional significant benefits.

FIG. **1** shows a conventional wireless multi-cell communication system **100** including a wireless transmit/receive unit (WTRU) **105**, a Node-B **110**, an RNC **115**, and at least two cells **120**A, **120**B. Each of the cells **120**A, **120**B, is served by the Node-B **110**. Node-B **110** is controlled by the RNC **115**. When a change in the cell offering the best radio conditions is determined between cells **120**A and **120**B, a handover process is initiated.

An "intra-Node-B handover" occurs when a WTRU changes from one cell to another cell controlled by the same Node-B, as shown in FIG. **1**. An "inter-Node-B handover" occurs when a WTRU changes from one cell to another cell controlled by a different Node-B. In the latter case, the Node-B that controls the cell before the handover is called a source Node-B, and the Node-B that controls the cell after the handover is called a target Node-B.

During soft handover, a WTRU establishes a plurality of connections with a plurality of Node-Bs in an active set. In this situation, a problem may arise for scheduling and H-ARQ operation. A WTRU may receive conflicting EU transmission scheduling from more than one Node-B. It is also difficult for the WTRU to receive, decode and process H-ARQ positive and negative acknowledgements (ACKs/NACKs) generated by a plurality of Node-Bs. The soft buffer of an H-ARQ process in Node-Bs may be corrupted during soft handover.

One method to support H-ARQ across multiple Node-Bs, when the WTRU is in soft handover, is to place the ACK/NACK generation function in the RNC, which derives a single ACK/NACK based on the results from the multiple Node-Bs. However, this approach presents a significant delay to the ACK/NACK process, which is highly undesirable for performance reasons.

When a WTRU undergoes an inter-Node-B hard handover, there is a possibility that a source Node-B, which is a Node-B before hard handover is completed, may not successfully receive EU transmissions for data packets that have been NACKed prior to hard handover activation time. Other WTRUs competing for UL resources may not be provided with enough physical resources in the source cell. If data blocks that have been NACKed prior to the handover are retransmitted to the source Node-B before the handover activation timer expires, those data blocks can be combined with the previous data blocks for H-ARQ decoding. In this way, the decoding takes the advantage of previous, although failed, transmissions of those data blocks in the source cell. If data blocks that have been NACKed prior to the handover are not retransmitted to the source Node-B before the handover activation timer is expired, they have to be transmitted again in the target cell as new data blocks. In this case, the previous transmissions of those data blocks in the source cell are not utilized.

SUMMARY

An enhanced uplink user equipment is in soft handover. A radio network controller selects a primary Node-B out of a plurality of Node-Bs supporting the soft handover. The radio network controller receiving successfully received enhanced uplink data packets from the plurality of Node-Bs. The radio network controller reordered the successfully received enhanced uplink data packets for in-sequence deliver. The

primary Node-B sends specified scheduling information to the user equipment that the other Node-Bs does not transmit. At least the primary Node-B transmits acknowledgements and negative acknowledgements to the user equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

A more detailed understanding of the invention may be had from the following description, given by way of example and to be understood in conjunction with the accompanying drawings wherein:

FIG. **1** shows a conventional wireless communication system;

FIG. **2** shows a system which uses a UL scheduler located in a primary Node-B during soft handover for EU in accordance with the present invention;

FIG. **3** shows a system which uses an ACK/NACK generation function located in a primary Node-B during soft handover for EU in accordance with the present invention;

FIG. **4** is a flowchart of a process including method steps for coordinating Node-Bs during soft handover in accordance with one embodiment of the present invention; and

FIG. **5** is a flowchart of a process including method steps for prioritizing the transmission of NACKed data in a source Node-B before hard handover is completed in accordance with a separate embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described with reference to the drawing figures wherein like numerals represent like elements throughout.

Hereafter, the terminology "WTRU" includes but is not limited to a user equipment (UE), a mobile station, a fixed or mobile subscriber unit, a pager, or any other type of device capable of operating in a wireless environment.

When referred to hereafter, the terminology "Node-B" includes but is not limited to a base station, a site controller, an access point or any other type of interfacing device in a wireless environment.

The present invention may be implemented in any type of wireless communication systems, such as UMTS-FDD, TDD, time division synchronous code division multiple access (TDSCDMA), code division multiple access 2000 (CDMA2000) (EV-DO and EV-DV) or any other type of wireless communication system.

The features of the present invention may be incorporated into an IC or be configured in a circuit comprising a multitude of interconnecting components.

FIG. **2** shows a wireless multi-cell communication system **200** which uses a UL scheduler located in a primary Node-B in accordance with the present invention. The wireless multi-cell communication system **200** includes a WTRU **205**, a plurality of Node-Bs **210** (i.e., **210**A, **210**B), an RNC **215** and a plurality of cells **260** (i.e., **260**A, **260**B, **260**C). Cells **260**A and **260**C are served by the Node-B **210**A. Cells **260**B are served by the Node-Bs **210**B. All of the Node-Bs **210** are controlled by the RNC **215**.

During soft handover, the WTRU **205** establishes multiple connections with the Node-Bs **210** included in an active set. Each transmission from the WTRU **205** is processed independently at each of the Node-Bs **210**. One of the Node-Bs **210** in the active set is designated as a primary Node-B **210**A, and the other Node-Bs are designated as non-primary Node-Bs **210**B.

As shown in FIG. **2**, the primary Node-B **210**A includes a MAC entity **250**A including a UL scheduler **255**. Each of the non-primary Node-Bs **210**B also includes a MAC entity **250**B. Each of the MAC entities **250**A, **250**B, handles EU transmissions. The UL scheduler **255** in the MAC entity **250**A is responsible for scheduling the EU transmissions.

In accordance with one embodiment of the present invention, the UL scheduler **255** is implemented only at the primary Node-B **210**A during soft handover. The WTRU **205** receives a UL transmission schedule only from the primary Node-B **210**A in a primary cell **260**A. However, the primary Node-B **210**A cannot send the scheduling information to the non-primary Node-Bs **210**B in every transmission time interval (TTI). In order to allow the primary Node-B **210**A to allocate resources for the WTRU **205** to transmit in cells controlled by the non-primary Node-Bs **210**B, those resources scheduled by the primary Node-B **250**A in a plurality of cells **260**B controlled by the non-primary Node-Bs **210**B cannot be assigned by the non-primary Node-Bs **210**B. Therefore, some physical resources common to all of the cells in the active EU subset should be assigned and reserved by a particular Node-B for the WTRU **205** during the soft handover, so that those resources can be used only by the primary Node-B **210**A.

The UL scheduler **255** located in the primary Node-B **210**A considers the interference level caused by the EU transmission at any cell **260**A, **260**B, **260**C, in the EU active subset to be below a predetermined maximum allowed interference level. Thus, the primary Node-B **250**A limits the transmit power level of the WTRU **205** such that the interference levels are also within the maximum allowed interference levels at other cells **260**B, **260**C. To achieve this, the RNC **215** needs to relay necessary information, such as transmission power level and interference level, of the cells **260**B controlled by the non-primary Node-Bs **210**B to the primary Node-B **210**A, which then uses the information to schedule the UL transmissions.

The EU scheduling information is transmitted to the WTRU **205** only by the primary Node-B **210**A through the primary cell **260**A. During soft handover, the WTRU **205** receives EU scheduling information only in the primary cell **260**A, although the EU scheduling information is valid in all other cells **260**B, **260**C.

In one embodiment, the primary Node-B **250**A is selected by either the RNC **215** or the WTRU **205**. The RNC **215** may choose a Node-B that has the highest percentage of correctly received data blocks during a predefined time window as a primary Node-B.

In another embodiment, the RNC **215** generates statistics for each Node-B, such as a bit error rate (BER) or a frame error rate (FER), or the like, over a predetermined time period. Then, the RNC **215** may select a Node-B having the best performance to be the primary Node-B **210**A. The RNC **215** then notifies the WTRU **205** and all other Node-Bs about the primary Node-B **210**A via radio resource control (RRC) and Iub signaling, respectively.

In another embodiment, the WTRU **102** may choose a Node-B **210** that has the best downlink pilot power, (i.e., best downlink path loss or highest code power), as a primary Node-B **210**A. The WTRU **205** measures the power of pilot signals received from all Node-Bs **210** and selects the Node-B **210** having the highest pilot power to be the primary Node-B **210**A. The WTRU **205** then notifies all other Node-Bs about the primary Node-B **210**A via fast physical layer signaling.

The WTRU **205** may report the downlink pilot power of all cells **260** to the RNC **215**. The RNC **215** then chooses one

Node-B **210** to be the primary Node-B **210***a* based on the combined uplink and downlink quality. The uplink quality of a cell **260** based on the percentage of correctly received data blocks, (or BER, FER, or the like), during a predefined time window, and the downlink quality of a cell **260** is based on the WTRU received downlink pilot power. Then, the RNC **215** notifies the WTRU **205** and all of the Node-Bs **210** about the primary Node-B **210**A via RRC and Iub signaling, respectively.

The present invention is advantageous over prior art systems. Using the present invention, a WTRU does not receive conflicting scheduling of EU transmissions from Node-Bs during soft handover. In addition, EU transmission is scheduled in consideration of an interference level and radio resources in cells controlled by non-primary Node-Bs. Signaling delay from the primary Node-B **210**A to the WTRU **205** is much lower as compared to signaling delay from the RNC **215** to the WTRU **205**.

In a separate embodiment, FIG. **3** shows a wireless multi-cell communication system **300**, similar to the system **200** shown in FIG. **2**. As shown in FIG. **3**, the primary Node-B **210**A includes a MAC entity **250**A including an ACK/NACK generator **305**. Only the primary Node-B **210**A has the ACK/NACK generator **305**. The primary Node-B **210**A may perform H-ARQ with incremental redundancy, or only ARQ without implementing incremental redundancy.

Still referring to FIG. **3**, the primary Node-B **210**A receives at least one data packet from the WTRU **205** through the primary cell **260**A and performs an error check on the data packet. Any error checking method, such as a cyclic redundancy check (CRC), may be utilized. If the primary Node-B **210**A correctly decodes the data packet, such as passing the CRC, the primary Node-B **210**A transmits an ACK to the WTRU **205** and also transmits the correctly decoded data packet to the RNC **215**. If the primary Node-B **210**A fails to correctly decode the data packet, the primary Node-B **210**A transmits a NACK to the WTRU **205**.

The non-primary Node-Bs **210**B also perform an error check on the data packet. However, the non-primary Node-Bs **210**B do not send ACKs or NACKs to the WTRU **205**. Instead, the non-primary Node-Bs send successfully decoded data packets to the RNC **215**. During soft handover, only the primary Node-B **210**A generates H-ARQ (or ARQ), ACKs and NACKs, and controls retransmissions.

The MAC layer WTRU identities received by the non-primary Node-Bs **210**B may be used for routing of successfully received transmissions in a universal terrestrial radio access network (UTRAN). Since the non-primary Node-Bs **210**B are not aware of which WTRUs have been scheduled for EU transmission by the primary Node-B **210**A, the non-primary Node-Bs **210**B may rely on in-band MAC layer signaling of the WTRU ID to route correctly received transmissions to the correct RNC radio link. Even though the primary Node-B **210**A may be aware of which WTRU is scheduled, the same method may be implemented by the primary Node-B **210**A.

Preferably, the primary Node-B **210**A may use soft combining to process transmissions, while the non-primary Node-Bs **210**B may process each transmission without soft combining. If the primary Node-B sends a NACK to the WTRU **205**, the NACKed data packet is stored in a buffer of the primary Node-B **210**A, and the NACKed data packet is combined with a retransmitted data packet. In contrast, the non-primary Node-Bs **210**B do not store the NACKed data packets. This eliminates the problem of soft buffer corruption between the Node-Bs **210**, and the complexities of multiple independent ACKs and/or NACKs.

When an incremental combining process is implemented, measures should be taken to avoid soft buffer corruption. Sequence information or a new data indicator is required to enable a Node-B **210** to detect that the WTRU **205** is no longer repeating data for a particular WTRU H-ARQ process, but instead is sending new data. This is specifically required because the Node-B **210** has no other way to learn that a new transmission has started. Alternatively, the non-primary Node-Bs **210**B may simply perform an ARQ, without using an incremental combining process. This eliminates the soft buffer corruption problem.

In the case where non-primary Node-Bs **210**B perform simple ARQ without incremental combining, the WTRU **205** must transmit self-decodable data packets to ensure that all of the Node-Bs **210** may decode transmissions, regardless of the result of earlier transmissions. Preferably, the H-ARQ functionality is terminated at the Node-Bs **210**. Each of the Node-Bs **210** sends to the RNC **215** successfully decoded data packets with explicit identification of transmission, such as a transmission sequence number (TSN). The RNC **215** may optionally use data packets delivered from the non-primary Node-Bs **210**B. A MAC entity **310**, located in the RNC **215**, is used to implement an in-sequence delivery process for delivering data to higher layers over all of the packets received from the Node-Bs **210**. After the RNC MAC entity **310** has completed its re-ordering process, it sends the data to a radio link control (RLC) (not shown). Missed packets are identified at the RNC **215** and the WTRU **205** is informed through RLC messaging.

Alternatively, EU transmissions may identify WTRU ID, H-ARQ process, transmission sequence and/or new data indication (NDI) to allow for soft combining in the non-primary Node-B's **210**B. If this method is used to allow soft combining in the non-primary Node-Bs **210**B, the primary Node-B **210**A may not have to rely on scheduling and H-ARQ ACK/NACK decisions to determine when combining should be performed.

There are two options for the transmission of ACK/NACK messages. The first option is a synchronous transmission. The ACK/NACK messages are transmitted after a unique time delay with respect to the corresponding uplink transmission or the EU channel allocation message. The second option is an asynchronous transmission. There is no unique delay between the transmission of ACK/NACK messages and the corresponding uplink transmission or the EU channel allocation message. Explicit information in the ACK/NACK message identifies the corresponding uplink transmission to enable the WTRU **205** to make the correct association between the ACK/NACK message and the transmission. This association is made by either identifying the H-ARQ process number and/or a unique sequence number, such as a TSN with each ACK/NACK feedback message to the WTRU **205**.

In a separate embodiment, preferably implemented for the asynchronous ACK/NACK feedback case, the non-primary Node-Bs **210**B may provide H-ARQ ACK/NACK results to the primary Node-B **210**A in order to avoid unnecessary retransmissions for transmissions that are not correctly received by the primary Node-B **210**A, but are correctly received by the non-primary Node-Bs **210**B. A non-primary Node-B **210**B does not directly send an ACK or NACK message to the WTRU **205**. The non-primary Node-Bs **210**B sends ACK/NACK or CRC results to the RNC **215**. Then, the RNC **215** sends ACK or CRC results to the primary Node-B **210**A.

In order to speed up H-ARQ processing, the first ACK message from any non-primary Node-B **210**B received by the RNC is preferably immediately forwarded to the primary Node-B **210**A. The primary Node-B **210**A also immediately generates an ACK message if the transmission is received correctly in the primary Node-B **210**A without waiting for feedback from the non-primary Node-Bs **210**B. The primary Node-B **210**A also generates an ACK message immediately upon reception of a forwarded ACK message from the RNC, even if other ACK messages may be forwarded. Since an ACK is generated if any of the paths are successful, an ACK can be generated as soon as the first successful transmission is found.

Alternatively, in order to simplify the design of the ACK/NACK generator **205**, only a subset of the generating nodes may be used. For example, ACKs may be generated only at the RNC, or at the RNC and the primary Node-B **210**A.

When the WTRU **205** sends an uplink transmission, for each H-ARQ process the WTRU **205** waits at least the time required for the primary Node-B **210**A to send ACK/NACK feedback. For each H-ARQ process, if an ACK is received by the WTRU **205**, the WTRU **205** may send new data in the next available or assigned opportunity.

A NACK message can only originate in the RNC **215** since it is the only node that has all of the information necessary in the soft handover to determine that there have been no successful receptions at any Node-B **210**. The RNC **215** generates a NACK command if the RNC **215** receives no ACK from the Node-Bs **210** within a predetermined time interval. The RNC **215** forwards the NACK message to the WTRU **205** via the primary Node-B **210**A.

It is also possible that this procedure can be implemented without an explicit NACK command. In this case, the lack of ACK reception within a particular period of time is considered the same as an explicit NACK command at either the primary Node-B **210**A and/or the WTRU **205**.

FIG. **4** is a flowchart of a process **400** including method steps for coordinating Node-Bs during soft handover in accordance with one embodiment of the present invention. In step **405**, the RNC **215** makes a decision to initiate an inter-Node-B soft handover. In step **410**, the WTRU **205** establishes connections with at least two Node-Bs **210** in an active set. In step **415**, one of the Node-Bs **210** in the active set is designated as a primary Node-B **210**A and the one or more Node-B(s) **210** remaining in the active set are designated as a non-primary Node-Bs **210**B. In step **420**, the primary Node-B **210**A controls UL transmissions during soft handover by performing EU scheduling and H-ARQ operations.

FIG. **5** is a flowchart of a process **500** including method steps for prioritizing the transmission of NACKed data in a source Node-B before hard handover is completed in accordance with a separate embodiment of the present invention. In step **505**, the RNC **215** makes a decision to initiate a hard handover for a WTRU **205** connected to a source Node-B **210**. In step **510**, the RNC **215** informs the source Node-B **210** when the WTRU **205** will stop transmission and reception in the source cell **260**. In step **515**, the RNC **215** sends an activation timer to the source Node-B **210** to set the time for handover.

Still referring to FIG. **5**, if the source Node-B **210** determines that there are data packets that were previously NACKed, as many previously NACKed data packets as possible should be retransmitted before the handover activation timer expires. Otherwise, the system may lose the benefit of incrementally combining the previous transmission with the retransmission. Therefore, the source Node-B scheduler **255** takes the handover activation time into account when it schedules the data packets that have been NACKed. If there is not enough radio resource for the source Node-B **210** to schedule transmission of all the NACKed data packets in time, the source Node-B **210** should manage to schedule transmission of as many NACKed data packets as possible.

Still referring to FIG. **5**, in order to transmit as many NACKed data packets as possible before the activation timer expires, the source Node-B **210** adjusts the priority of transmissions (step **525**) and, in step **530**, the source node-B **210** adjusts the MCS of the transmissions (step **530**). Higher priority of scheduling is given to the data packets that have been NACKed. If the radio resources are sufficient, a more robust MCS may be used to increase the probability of successful transmissions from the WTRU **205** to the source Node-B **210**. In step **535**, the handover is completed at the expiration of the activation timer.

In order for the WTRU **205** to understand that the scheduled uplink transmission is intended for data blocks with previous transmission failures, the source Node-B **210** uplink scheduler **255** may specify that the scheduled UL transmission is intended for the data blocks that were previously NACKed. This may be implemented by including H-ARQ process identification in the UL scheduling information that is sent from the source Node-B **210** to the WTRU **205**. By receiving the scheduling information from the source Node-B **210**, the WTRU **205** knows that the scheduled transmission is for specific data associated with HARQ process identification sent together with the scheduling information.

While this invention has been particularly shown and described with reference to preferred embodiments, it will be understood by those skilled in the art that various changes in forms and details may be made therein without departing from the scope of the invention as described above.

What is claimed is:

1. A method performed by a wireless transmit receive unit (WTRU), the method comprising:

receiving signaling including information indicating a primary cell and at least one non-primary cell;

receiving a message with scheduling information indicating an allocation of uplink resources and a hybrid automatic repeat request (HARQ) process ID, wherein the WTRU has one or more HARQ processes; and

transmitting to at least the one non-primary cell an uplink transmission using a HARQ process indicated by the HARQ process ID and the allocation of uplink resources.

2. The method of claim **1**, wherein a negative acknowledgement is determined based on the received HARQ process ID.

3. The method of claim **1**, wherein the primary cell schedules uplink transmissions that are transmitted by the WTRU to the at least one non-primary cell.

4. The method of claim **1** further comprising communicating HARQ feedback using a control channel only of the primary cell.

5. The method of claim **1**, wherein the WTRU has a maximum transmission level for all cell transmissions.

6. A wireless transmit receive unit (WTRU) comprising:

a receiver; and

a transmitter,

wherein the receiver and the transmitter are configured to cause the WTRU to:

receive signaling including information indicating a primary cell and at least one non-primary cell;

receive a message with scheduling information indicating an allocation of uplink resources and a hybrid automatic repeat request (HARQ) process ID, wherein the WTRU has one or more HARQ processes; and

transmit to at least the one non-primary cell an uplink transmission using a HARQ process indicated by the HARQ process ID and the allocation of uplink resources.

7. The WTRU of claim **6**, wherein a negative acknowledgement is determined based on the received HARQ process ID.

8. The WTRU of claim **6**, wherein the primary cell schedules uplink transmissions that are transmitted by the WTRU to the at least one non-primary cell.

9. The WTRU of claim **6**, wherein the receiver and the transmitter are further configured to communicate HARQ feedback using a control channel only of the primary cell.

10. The WTRU of claim **6**, wherein the WTRU has a maximum transmission level for all cell transmissions.

11. A base station comprising:

a receiver; and

a transmitter,

wherein the receiver and the transmitter are configured to cause the base station to:

transmit signaling including information indicating a primary cell and at least one non-primary cell;

transmit a message with scheduling information indicating an allocation of uplink resources and a hybrid automatic repeat request (HARQ) process ID to a wireless transmit/receive unit (WTRU), wherein the WTRU has one or more HARQ processes; and

receive an uplink transmission using a HARQ process indicated by the HARQ process ID and the allocation of uplink resources on at least the one non-primary cell.

12. The base station of claim **11**, wherein a negative acknowledgement is communicated based on the received HARQ process ID.

13. The base station of claim **11**, wherein the primary cell schedules uplink transmissions that are received by the base station on the at least one non-primary cell.

14. The base station of claim **11**, wherein the receiver and the transmitter are further configured to communicate HARQ feedback using a control channel only of the primary cell.

15. A method performed by a base station, the method comprising:

transmitting signaling including information indicating a primary cell and at least one non-primary cell;

transmitting a message with scheduling information indicating an allocation of uplink resources and a hybrid automatic repeat request (HARQ) process ID to a wireless transmit/receive unit (WTRU), wherein the WTRU has one or more HARQ processes; and

receiving an uplink transmission using a HARQ process indicated by the HARQ process ID and the allocation of uplink resources on at least the one non-primary cell.

16. The method of claim **15**, wherein a negative acknowledgement is communicated based on the received HARQ process ID.

17. The method of claim **15**, wherein the primary cell schedules uplink transmissions that are received by the base station on the at least one non-primary cell.

18. The method of claim **15**, further comprising communicating HARQ feedback using a control channel only of the primary cell.

* * * * *

EXHIBIT B

[redacted]

US011770218B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.: US 11,770,218 B2**
(45) **Date of Patent: Sep. 26, 2023**

(54) **METHOD FOR MAPPING PHYSICAL HYBRID AUTOMATIC REPEAT REQUEST INDICATOR CHANNEL**

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(72) Inventors: **Jung Hoon Lee**, Anyang-si (KR); **Joon Kui Ahn**, Anyang-si (KR)

(73) Assignee: **PANTECH CORPORATION**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/751,580**

(22) Filed: **May 23, 2022**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 16/884,836, filed on May 27, 2020, now Pat. No. 11,343,027, which is a (Continued)

(30) **Foreign Application Priority Data**

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H04L 1/1829 (2023.01)
H04L 1/1812 (2023.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04L 1/1861*** (2013.01); ***H04L 1/1812*** (2013.01); ***H04L 1/1854*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC H04W 72/04; H04W 72/20; H04L 1/1861; H04L 1/1812; H04L 1/1854;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

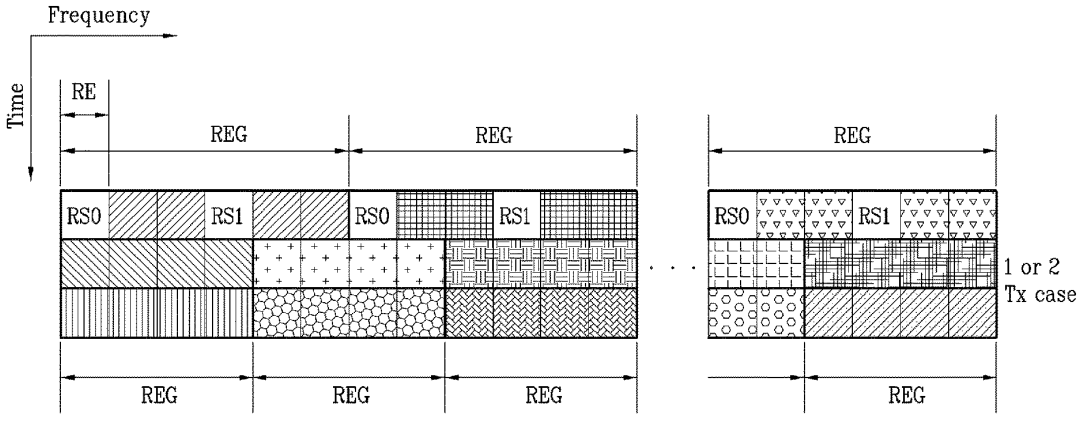
7,894,330 B2 * 2/2011 Lee H04L 1/1854 370/208
8,631,297 B2 * 1/2014 Lee H04W 72/04 370/208
(Continued)

Primary Examiner — Benjamin H Elliott, IV
(74) *Attorney, Agent, or Firm* — Ladas & Parry, LLP

(57) **ABSTRACT**

A method for mapping a physical hybrid automatic repeat request indicator channel (PHICH) is described. The method for mapping a PHICH includes determining an index of a resource element group transmitting a repetitive pattern of the PHICH, according to a ratio of the number of available resource element groups in a symbol in which the PHICH is transmitted and the number of available resource element groups in a first or second OFDM symbol, and mapping the PHICH to the symbol according to the determined index. In transmitting the PHICH, since efficient mapping is performed considering available resource elements varying with OFDM symbols, repetition of the PHICH does not generate interference between neighbor cell IDs and performance is improved.

20 Claims, 11 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/997,919, filed on Jun. 5, 2018, now Pat. No. 10,680,767, which is a continuation of application No. 15/406,403, filed on Jan. 13, 2017, now Pat. No. 10,014,988, which is a continuation of application No. 14/726,014, filed on May 29, 2015, now Pat. No. 9,548,839, which is a continuation of application No. 14/184,345, filed on Feb. 19, 2014, now Pat. No. 9,048,991, which is a continuation of application No. 13/012,702, filed on Jan. 24, 2011, now Pat. No. 8,681,599, which is a continuation of application No. 12/388,243, filed on Feb. 18, 2009, now Pat. No. 7,894,330.

(60) Provisional application No. 61/029,895, filed on Feb. 19, 2008.

(51) **Int. Cl.**

H04L 5/00	(2006.01)
H04W 72/20	(2023.01)
H04L 1/1867	(2023.01)
H04W 72/04	(2023.01)
H04L 1/06	(2006.01)

(52) **U.S. Cl.**

CPC ***H04L 1/1864*** (2013.01); ***H04L 1/1896*** (2013.01); ***H04L 5/0007*** (2013.01); ***H04L 5/0053*** (2013.01); ***H04L 5/0055*** (2013.01); ***H04L 5/0073*** (2013.01); ***H04W 72/04*** (2013.01); ***H04W 72/20*** (2023.01); *H04L 1/0668* (2013.01); *H04L 5/0016* (2013.01)

(58) **Field of Classification Search**

CPC ... H04L 1/1864; H04L 1/1896; H04L 5/0007; H04L 5/0053; H04L 5/0055; H04L 5/0073; H04L 1/0668; H04L 5/0016; H04L 1/18

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

8,631,298	B2 *	1/2014	Lee	H04W 72/20 370/208
8,681,599	B2 *	3/2014	Lee	H04L 1/1864 370/208
9,048,991	B2 *	6/2015	Lee	H04L 5/0007
9,548,839	B2 *	1/2017	Lee	H04L 1/1854
10,014,988	B2 *	7/2018	Lee	H04W 72/04
10,680,767	B2 *	6/2020	Lee	H04L 1/1864
11,343,027	B2 *	5/2022	Lee	H04L 5/0055
2009/0097447	A1 *	4/2009	Han	H04L 5/0078 370/330
2009/0147743	A1 *	6/2009	Parkvall	H04W 72/23 370/329
2009/0175233	A1 *	7/2009	Ojala	H04L 1/1896 370/329
2009/0245187	A1 *	10/2009	Nam	H04L 5/0007 370/329
2009/0274037	A1 *	11/2009	Lee	H04L 5/0055 370/208
2009/0290597	A1 *	11/2009	Baumgartner	H04L 5/003 370/468
2010/0322324	A1 *	12/2010	Lindh	H04L 1/1854 375/259
2011/0179331	A1 *	7/2011	Lee	H04L 1/1896 714/E11.113
2012/0263143	A1 *	10/2012	Han	H04W 72/23 370/330
2013/0114551	A1 *	5/2013	Lee	H04L 1/1812 370/329
2013/0114552	A1 *	5/2013	Lee	H04L 1/1812 370/329
2014/0169150	A1 *	6/2014	Lee	H04L 1/1864 370/208
2015/0023397	A1 *	1/2015	Kim	H04L 5/0044 375/295
2015/0263827	A1 *	9/2015	Lee	H04L 5/0053 370/329
2017/0126369	A1 *	5/2017	Lee	H04W 72/04
2018/0287747	A1 *	10/2018	Lee	H04W 72/20
2020/0287667	A1 *	9/2020	Lee	H04L 5/0007
2022/0286240	A1 *	9/2022	Lee	H04L 1/1812

* cited by examiner

FIG. 1

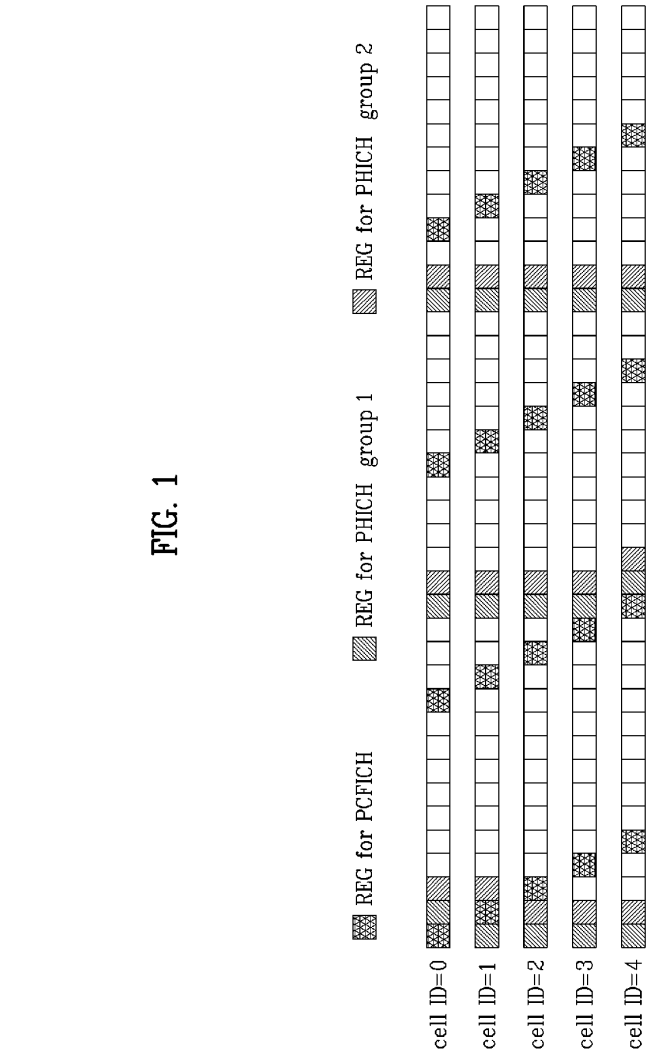

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FIG. 2

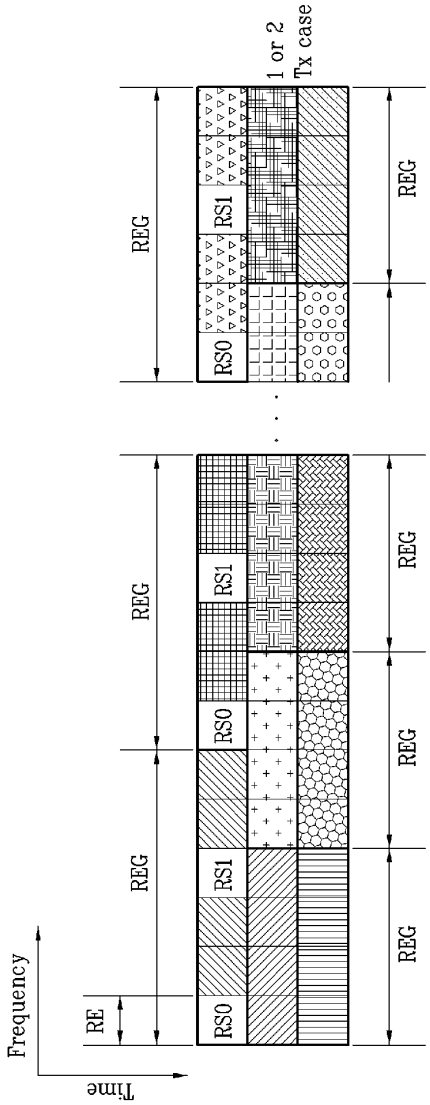


FIG. 3

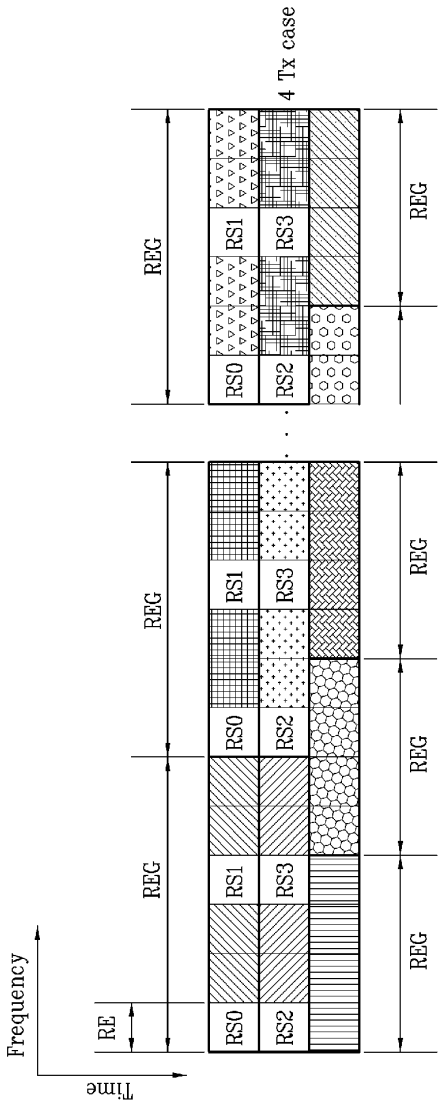


FIG. 4

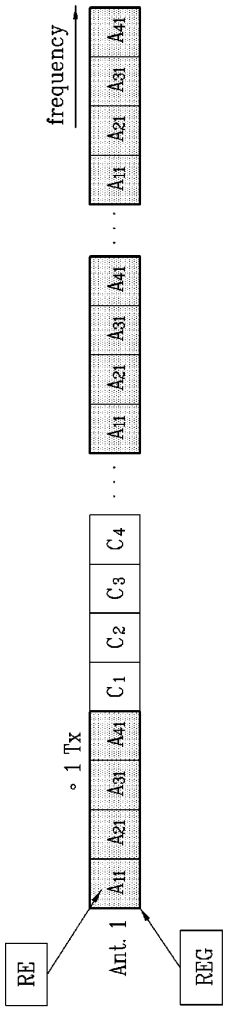


FIG. 5

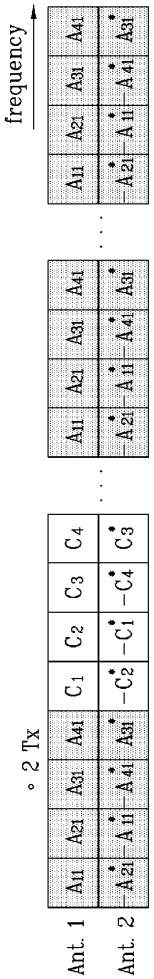


FIG. 6

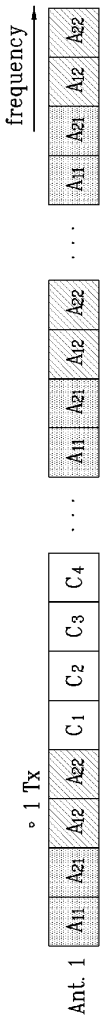


FIG. 7

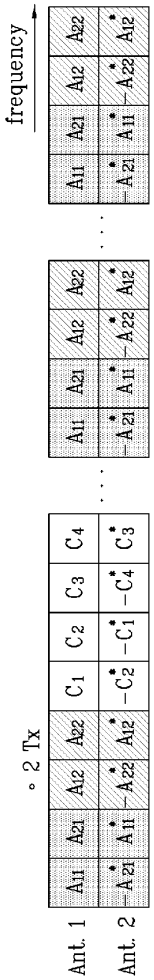


FIG. 8

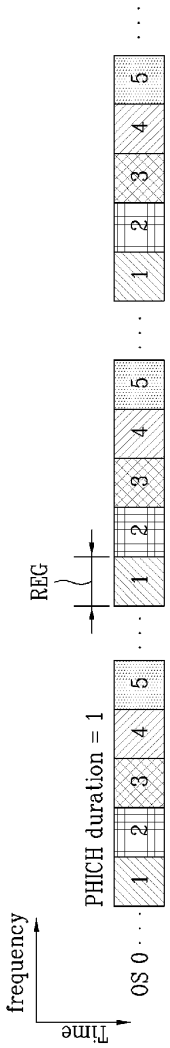


FIG. 9

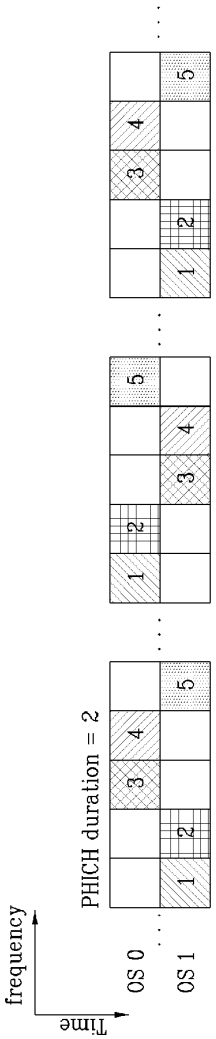


FIG. 10

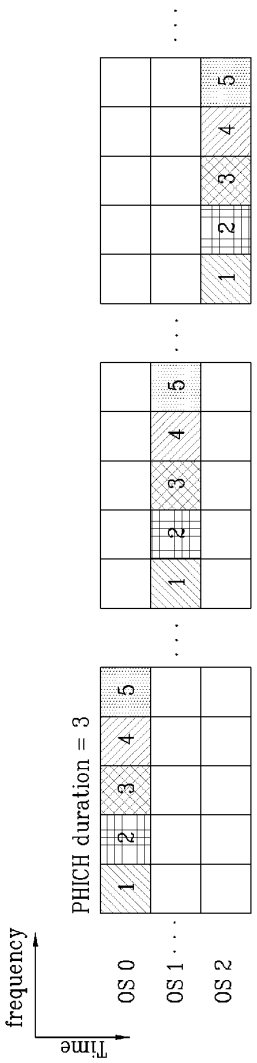
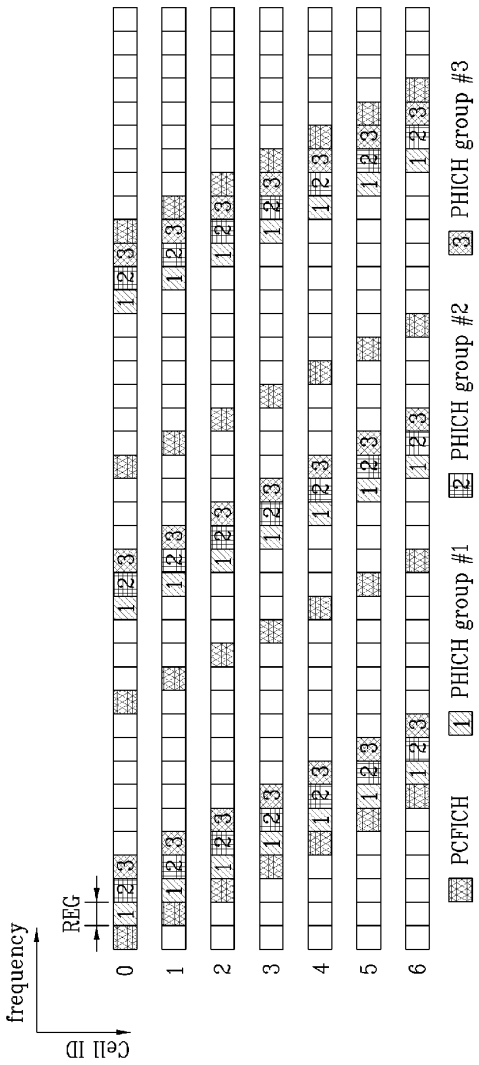


FIG. 11


frequency
Cell ID
REG
0
1
2
3
4
5
6
PCFICH
PHICH group #1
PHICH group #2
PHICH group #3

METHOD FOR MAPPING PHYSICAL HYBRID AUTOMATIC REPEAT REQUEST INDICATOR CHANNEL

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. application Ser. No. 16/884,836, filed on May 27, 2020, which is a continuation of U.S. application Ser. No. 15/997,919 filed on Jun. 5, 2018 and issued as U.S. Pat. No. 10,680,767, which is a continuation of U.S. application Ser. No. 15/406,403, filed on Jan. 13, 2017 and issued as U.S. Pat. No. 10,014,988, which is a continuation of U.S. application Ser. No. 14/726,014, filed on May 29, 2015 and issued as U.S. Pat. No. 9,548,839, which is a continuation of U.S. application Ser. No. 14/184,345, filed on Feb. 19, 2014 and issued as U.S. Pat. No. 9,048,991, which is a continuation of U.S. application Ser. No. 13/012,702, filed on Jan. 24, 2011 and issued as U.S. Pat. No. 8,681,599, which is a continuation of U.S. application Ser. No. 12/388,243, filed on Feb. 18, 2009 and issued as U.S. Pat. No. 7,894,330, all of which claim priority from and the benefit of U.S. Provisional Application Ser. No. 61/029,895, filed on Feb. 19, 2008, and Korean Patent Application No. 10-2008-0124084, filed on Dec. 8, 2008, which are all hereby incorporated by reference for all purposes as it fully set forth herein.

BACKGROUND

Field

The present invention relates to a mapping method for frequency and orthogonal frequency division multiplexing (OFDM) symbol regions of a signal transmitted on downlink in a cellular OFDM wireless packet communication system.

Discussion of the Background

When transmitting/receiving a packet in a mobile communication system, a receiver should inform a transmitter as to whether or not the packet has been successfully received. If the reception of the packet is successful, the receiver transmits an acknowledgement (ACK) signal to cause the transmitter to transmit a new packet. If the reception of the packet fails, the receiver transmits a negative acknowledgement (NACK) signal to cause the transmitter to re-transmit the packet. Such a process is called automatic repeat request (ARQ). Meanwhile, hybrid ARQ (HARQ), which is a combination of the ARQ operation and a channel coding scheme, has been proposed. HARQ lowers an error rate by combining a re-transmitted packet with a previously received packet and improves overall system efficiency. In order to increase throughput of the system, HARQ demands a rapid ACKINACK response from the receiver compared with a conventional ARQ operation. Therefore, the ACKINACK response in HARQ is transmitted by a physical channel signaling method. The HARQ scheme may be broadly classified into chase combining (CC) and incremental redundancy (IR). The CC method serves to re-transmit a packet using the same modulation method and the same coding rate as those used when transmitting a previous packet. The IR method serves to re-transmit a packet using a different modulation method and a different coding rate from those used when transmitting a previous packet. In this case, the receiver can raise system performance through coding diversity.

In a multi-carrier cellular mobile communication system, mobile stations belonging to one or a plurality of cells transmit an uplink data packet to a base station. That is, since a plurality of mobile stations within one sub-frame can transmit an uplink data packet, the base station must be able to transmit ACKINACK signals to a plurality of mobile stations within one sub-frame. If the base station multiplexes a plurality of ACK/NACK signals transmitted to the mobile stations within one sub-frame using CDMA scheme within a partial time-frequency region of a downlink transmission band of the multi-carrier system, ACK/NACK signals with respect to other mobile stations are discriminated by an orthogonal code or a quasi-orthogonal code multiplied through a time-frequency region. If quadrature phase shift keying (QPSK) transmission is performed, the ACK/NACK signals may be discriminated by different orthogonal phase components.

When transmitting the ACK/NACK signals using CDMA multiplexing scheme in order to transmit a plurality of ACK/NACK signals within one sub-frame, a downlink wireless channel response characteristic should not be greatly varied in a time-frequency region in which the ACK/NACK signals are transmitted. This is because if orthogonality is maintained between the multiplexed different ACK/NACK signals, a receiver can obtain satisfactory reception performance without applying a special receiving algorithm such as channel equalization. Accordingly, the CDMA multiplexing of the ACK/NACK signals should be performed within the time-frequency region in which a wireless channel response is not significantly varied. However, if the wireless channel quality of a specific mobile station is poor in the time-frequency region in which the ACK/NACK signals are transmitted, the ACK/NACK reception performance of the mobile station may also be greatly lowered.

Accordingly, the ACK/NACK signals transmitted to any mobile station within one sub-frame may be repeatedly transmitted over separate time-frequency regions in a plurality of time-frequency axes, and the ACK/NACK signals may be multiplexed with ACK/NACK signals transmitted to other mobile stations by CDMA in each time-frequency region. Therefore, the receiver can obtain a time-frequency diversity gain when receiving the ACK/NACK signals.

However, in a conventional physical hybrid ARQ indicator channel (PHICH) mapping method, there exists a defect that PHICH groups between neighbor cells have difficulty avoiding collision as illustrated in FIG. **1**.

SUMMARY

An object of the present invention devised to solve the problem lies in providing a method for mapping a PHICH so that repetition of the PHICH does not generate interference between neighbor cell IDs by considering available resource elements varying with OFDM symbols.

The object of the present invention can be achieved by providing a method for mapping a PHICH, including determining an index of an OFDM symbol in which a PHICH group is transmitted, determining an index of a resource element group transmitting a repetitive pattern of the PHICH group, according to a ratio of the number of available resource element groups in the determined OFDM symbol and the number of available resource element groups in a first or second OFDM symbol, and mapping the PHICH group according to the determined index.

The PHICH may be transmitted in units of a plurality of PHICH groups, and an index of an OFDM symbol in which an i-th repetitive pattern is transmitted may be defined by the following equation:

$$l'_i = \begin{cases} 0, & \text{normal } PHICH \text{ duration} \\ i, & \text{all subframes} \\ & \text{extended } PHICH \text{ duration} \\ & \text{non-}MBSFN \text{ subframes} \\ (\lfloor m'/2 \rfloor + i + 1) \bmod 2, & \text{extended } PHICH \text{ duration} \\ & MBSFN \text{ subframes} \end{cases}$$

where m' denotes an index of a PHICH group

The index of the resource element group may be determined according to a value obtained by multiplying the ratio by a cell ID.

The index of the resource element group may be determined by the following equation:

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0 \right) \right\rfloor + m'\right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0 \right) \right\rfloor + m' + \left\lfloor n'_{l'_i} / 3 \right\rfloor\right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0 \right) \right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3 \right\rfloor\right) \bmod n'_{l'_i} & i = 2 \end{cases}$$

where N_{ID}^{cell} denotes a cell ID, i denotes an index of a repetitive pattern, $n'_{l'_i}/n'_0$ denotes a ratio between the number of available resource element groups in an OFDM symbol l'_i and the number of available resource element groups in a first OFDM symbol, and m' denotes an index of a PHICH group.

In accordance with another aspect of the present invention, there is provided a method for mapping a PHICH, including determining an index of a resource element group transmitting a repetitive pattern of the PHICH, according to a ratio of the number of available resource element groups in a symbol in which the PHICH is transmitted and the number of available resource element groups in a second OFDM symbol, and mapping the PHICH to the symbol according to the determined index.

The PHICH may be transmitted in units of a plurality of PHICH groups each consisting of four resource elements.

The PHICH may be transmitted in units of a plurality of PHICH groups each consisting of two resource elements.

The index of the resource element group may be determined by the following equation:

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1 \right) \right\rfloor + m'\right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1 \right) \right\rfloor + m' + \left\lfloor n'_{l'_i} / 3 \right\rfloor\right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1 \right) \right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3 \right\rfloor\right) \bmod n'_{l'_i} & i = 2 \end{cases}$$

where N_{ID}^{cell} denotes a cell ID, i denotes an index of a repetitive pattern, $n'_{l'_i}/n'_1$ denotes a ratio between the number of available resource element groups in an OFDM symbol l'_i and the number of available resource element groups in a second OFDM symbol, and m' denotes an index of a PHICH group.

According to the exemplary embodiment of the present invention, efficiency mapping is performed by considering available resource elements varying according to OFDM symbols during PHICH transmission, so that PHICH repetition does not generate interference between neighbor cell IDs and performance is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention.

In the drawings:

FIG. **1** illustrates an example of a conventional PHICH mapping method;

FIGS. **2** and **3** illustrate resource element groups to which a PHICH is mapped;

FIGS. **4** and **5** illustrate examples of mapping a PHICH when a spreading factor is 4;

FIGS. **6** and **7** illustrate examples of mapping a PHICH when a spreading factor is 2;

FIGS. **8** to **10** illustrate examples of repetitive mapping of a PHICH applied to the present invention; and

FIG. **11** illustrates an example of a PHICH mapping method according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to the exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The detailed description, which will be given below with reference to the accompanying drawings, is intended to explain exemplary embodiments of the present invention, rather than to show the only embodiments that can be implemented according to the invention.

When transmitting data through downlink of an OFDM wireless packet communication system, a channel transmitting ACK/NACK signals may be referred to as a physical hybrid ARQ indicator channel (PHICH).

In a 3rd generation partnership project (3GPP) long term evolution (LTE) system, the PHICH is repeatedly transmitted three times in order to obtain diversity gain. Through how many OFDM symbols the PHICH is transmitted is determined depending on information transmitted through a primary broadcast channel (PBCH) and on whether or not a subframe is for multicast broadcast over single frequency network (MBSFN). If the PHICH is transmitted through one OFDM symbol, the PHICH repeating three times should be evenly distributed over a frequency bandwidth of one OFDM symbol. If the PHICH is transmitted through three OFDM symbols, each repetition is mapped to a corresponding OFDM symbol.

FIGS. **2** and **3** illustrate resource element groups (REGs) to which the PHICH is mapped.

Each REG is comprised of four resource elements. Since a first OFDM symbol includes reference signals RS**0** and RS**1**, locations except for the reference signal locations are available for the resource elements. In FIG. **3**, even a second OFDM symbol includes reference signals RS**2** and RS**3**.

FIGS. **4** and **5** illustrate examples of mapping a PHICH when a spreading factor (SF) is 4. When an SF is 4, one repetition of one PHICH group is mapped to one REG.

In FIGS. **4** and **5**, precoding for transmit diversity is applied. A_{11}, A_{21}, A_{31}, and A_{41} denote resource elements of an REG constituting a specific PHICH. C_1, C_2, C_3, and C_4 denote resource elements of an REG for PCHICH or a physical downlink control channel (PDCCH). FIGS. **4** and **5** correspond to the cases where the number of antennas is 1 and 2, respectively, when reference signals are not considered.

FIGS. **6** and **7** illustrate examples of mapping a PHICH when an SF is 2. When an SF is 2, one repetition of two PHICH groups is mapped to one REG.

Precoding for transmit diversity is applied to FIGS. **6** and **7**. FIGS. **6** and **7** correspond to the cases where the number of antennas is 1 and 2, respectively, when reference signals are not considered.

In actual implementation as illustrated in FIGS. **2** and **3**, it should be considered that the number of available REGs in an OFDM symbol including reference signals is not equal to the number of available REGs in an OFDM symbol which does not include reference signals.

Meanwhile, if a sequence for mapping the PHICH is denoted as $\bar{y}^{(p)}(0)$, K, $\bar{y}^{(p)}(M_{symb}-1)$, then $\bar{y}^{(p)}(n)$ satisfies $\bar{y}^{(p)}(n)=\Sigma y_i^{(p)}(n)$, which indicates the sum of all PHICHs in one PHICH group. $y_i^{(p)}(n)$ denotes an i-th PHICH in a specific PHICH group. In this case, $z^{(p)}(i)=(y^{(p)}(4i), y^{(p)}(4i+1), y^{(p)}(4i+2), y^{(p)}(4i+3))$ (where i=0, 1, 2) denotes a symbol quadruplet for an antenna port p.

An index of a PHICH group has m'=0 as an initial value. A symbol quadruplet $z^{(p)}(i)$ at m' is mapped to an REG of $(k',l')_i$ (where l_i' is an index of an OFDM symbol in which i-th repetition of a PHICH group is transmitted, and k_i' is an index of a frequency domain).

When a PHICH is transmitted through two OFDM symbols, the PHICH is repeated twice upon a first OFDM symbol and repeated once upon a second OFDM symbol according to a transmitted PHICH group. Conversely, the PHICH may be repeated once upon the first OFDM symbol and repeated twice upon the second OFDM symbol. This may be expressed by the following Equation 1.

$$l_i' = \begin{cases} 0, & \text{normal } PHICH \text{ duration} \\ & \text{all subframes} \\ i, & \text{extended } PHICH \text{ duration} \\ & \text{non-}MBSFN \text{ subframes} \\ (\lfloor m'/2 \rfloor + i + 1) \bmod 2, & \text{extended } PHICH \text{ duration} \\ & MBSFN \text{ subframes} \end{cases} \quad \text{[Equation 1]}$$

In Equation 1, l_i' denotes an index of an OFDM symbol in which i-th repetition of a PHICH group is transmitted, m' denotes an index of a PHICH group, and i denotes the number of repetitions of a PHICH. When the PHICH is repeated three times, i has values of 0, 1, and 2.

FIGS. **8** to **10** illustratively show Equation 1.

FIGS. **8** and **9** show the cases where $l_i'=0$ and $l_i'=(\lfloor m'/2 \rfloor+i+1) \bmod 2$, respectively. FIG. **10** shows the case where $l_i'=1$ and a PHICH group is repeated at a PHICH duration of 3.

A PHICH, which is an important channel for transmitting ACK/NACK signals indicating whether or not data has been received, should be transmitted as stably as possible. Further, since ACK/NACK signals should be transmitted to a user even in a cell edge, substantial power is used compared with other channels. If locations for transmitting the PHICHs in respective cells are the same, PHICH transmission performance may be deteriorated due to interference caused by transmission of the PHICH between neighbor cells. Accordingly, if transmission locations of the PHICH in respective cells differ, interference caused by transmission of the PHICH between neighbor cells is reduced. Consequently, PHICH transmission performance can be improved. Namely, if mapping locations of the PHICH are determined according to cell IDs, the above-described problem can be solved. The PHICH is repeatedly transmitted three times to obtain diversity gain. To increase the diversity gain, each repetition should be evenly distributed over an entire frequency bandwidth.

To satisfy the above conditions, a PHICH group is transmitted in units of an REG consisting of 4 resource elements. The location of a transmission start REG of the PHICH is designated according to a cell ID and each repetition of the PHICH is arranged at an interval of a value obtained by dividing the number of REGs which can be transmitted by 3 based on the transmission start REG. However, when such a repetition of the PHICH is distributed over a plurality of OFDM symbols, the number of REGs which can be used for PHICH transmission in each OFDM symbol differs. That is because, in the first OFDM symbol, a physical control format indicator channel (PCFICH) for transmitting information including the number of OFDM symbols used for a control channel is transmitted, and because reference signals transmitted in the first and second OFDM symbols differ according to the number of transmit antennas. When the PHICH is transmitted through multiple OFDM symbols including different REGs, since the number of REGs in each OFDM symbol differs, repetitions of each PHICH are not evenly dispersed over an entire frequency bandwidth. The location of the first REG should be designated according to a cell ID and a repetitive pattern should be allocated at regular intervals based on an index of the first REG However, since resolution of a frequency location depending on the index differs according to the number of REGs in each OFDM symbol, there exists a defect that a reference location is changed.

Therefore, when the PHICH is transmitted through multiple OFDM symbols, if the start location according to the cell ID is determined in consideration of a ratio of REGs of the first start symbol to REGs of the other symbols, the above problem can be solved. When the PHICH is transmitted through one or three OFDM symbols, the location of the first start symbol is always the first OFDM symbol. However, when the PHICH is transmitted through two OFDM symbols, the first PHICH group is started from the second OFDM symbol. Accordingly, if the ratio of REGs is considered, a reference symbol should be changed.

The above description may be expressed by the following equation 2.

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0 \right) \right\rfloor + m' \right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0 \right) \right\rfloor + m' + \left\lfloor n'_{l'_i} / 3 \right\rfloor \right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0 \right) \right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3 \right\rfloor \right) \bmod n'_{l'_i} & i = 2 \end{cases} \quad \text{[Equation 2]}$$

In Equation 2, $\overline{n}_i$ denotes an index of an REG in which a repetitive pattern$_0$ of each PHICH is transmitted, N_{ID}^{cell} denotes a cell ID, $n_{l_i'}$ denotes the number of REGs which can be used for PHICH transmission in an OFDM symbol l'_i, $n'_{l'_i}/n'_0$ denotes a ratio between the number of available resource element groups in an OFDM symbol l_i', and the number of available resource element groups in a first OFDM symbol and is a parameter for solving a problem caused by the different number of REGs between symbols, and m' denotes an index of a PHICH group as indicated in Equation 1. m' is desirably increased by 1.

FIG. **11** illustrates an example of a PHICH mapping method according to an exemplary embodiment of the present invention. As illustrated in FIG. **11**, PHICH resource collision can be avoided based on cell planning.

If the PHICH is mapped from the second OFDM symbol, $n'_{l'_i}/n'_0$ is changed to $n'_{l'_i}/n'_1$. This may be expressed by the following Equation 3.

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m'\right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m' + \left\lfloor n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 2 \end{cases}$$

In Equation 3, N_{ID}^{cell} denotes a cell ID, i denotes an index of a repetitive pattern, $n'_{l'_i}/n'_1$ denotes a ratio between the number of available resource element groups in an OFDM symbol l'_i and the number of available resource element groups in a second OFDM symbol, and m' denotes an index of a PHICH group. As in Equation 2, m' is desirably increased by 1.

Meanwhile, the location of the first PHICH group is allocated and then the other PHICH groups may be mapped successively after the first PHICH group.

It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

The present invention provides a mapping method for frequency and OFDM symbol regions of a signal transmitted on downlink in a cellular OFDM wireless packet communication system and may be applied to a 3GPP LTE system, etc.

What is claimed is:

1. A method of a mobile station for receiving acknowledgement/negative-acknowledgement (ACK/NACK) signal through a physical automatic repeat request indicator channel (PHICH) mapped to resource element groups (REGs) in one or more orthogonal frequency division multiplexing (OFDM) symbols, the method comprising:

determining indexes of REGs to which the PHICH is mapped in the OFDM symbols; and

receiving ACK/NACK signal through the PHICH in the OFDM symbols according to the determined indexes,

wherein an index of REG to which the PHICH is mapped in an OFDM symbol having index l'_i in a subframe is determined based on a ratio of the number of available REGs in the OFDM symbol having index l'_i and the number of available REGs in a reference OFDM symbol, and

wherein the number of available REGs in a specific OFDM symbol denotes the number of REGs not assigned to a physical control format indicator channel (PCFICH) among a total REGs in the specific OFDM symbol.

2. The method of claim **1**, wherein when the PHICH is transmitted through one or three OFDM symbols in the subframe, the reference OFDM symbol is determined to be a first OFDM symbol having an index 0 in the subframe.

3. The method of claim **2**, wherein when the PHICH is transmitted through one or three OFDM symbols in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0\right)\right\rfloor + m'\right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0\right)\right\rfloor + m' + \left\lfloor n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0\right)\right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'_i}$ denotes the number of available REGs in the OFDM symbol having index l'_i, in the subframe and n'_0 denotes the number of available REGs in the first OFDM symbol having index 0 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

4. The method of claim **1**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the reference OFDM symbol is determined to be a second OFDM symbol having an index 1 in the subframe.

5. The method of claim **4**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m'\right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m' + \left\lfloor n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'_i}$ denotes the number of available REGs in the OFDM symbol having index l'_i, in the subframe and n'_1 denotes the number of available REGs in the second OFDM symbol having index 1 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

6. A mobile station for receiving acknowledgement/negative-acknowledgement (ACK/NACK) signal through a physical automatic repeat request indicator channel (PHICH) mapped to resource element groups (REGs) in one or more orthogonal frequency division multiplexing (OFDM) symbols, the mobile station comprising a processor configured to:

determine indexes of REGs to which the PHICH is mapped in the OFDM symbols; and

receive the ACK/NACK signal through the PHICH in the OFDM symbols according to the determined indexes,

wherein an index of REG to which the PHICH is mapped in an OFDM symbol having index l'_i in a subframe is determined based on a ratio of the number of available REGs in the OFDM symbol having index l'_i and the number of available REGs in a reference OFDM symbol, and

wherein the number of available REGs in a specific OFDM symbol denotes the number of REGs not assigned to a physical control format indicator channel (PCFICH) among a total REGs in the specific OFDM symbol.

7. The mobile station of claim **6**, wherein when the PHICH is transmitted through one or three OFDM symbols in the subframe, the reference OFDM symbol is determined to be a first OFDM symbol having an index 0 in the subframe.

8. The mobile station of claim **7**, wherein when the PHICH is transmitted through one or three OFDM symbols

in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_0) \rfloor + m') \bmod n'_{l'_i} & i = 0 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_0) \rfloor + m' + \lfloor n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 1 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_0) \rfloor + m' + \lfloor 2n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'_i}$ denotes the number of available REGs in the OFDM symbol having index l'_i, in the subframe and n'_0 denotes the number of available REGs in the first OFDM symbol having index 0 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

9. The mobile station of claim **6**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the reference OFDM symbol is determined to be a second OFDM symbol having an index 1 in the subframe.

10. The mobile station of claim **9**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_1) \rfloor + m') \bmod n'_{l'_i} & i = 0 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_1) \rfloor + m' + \lfloor n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 1 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_1) \rfloor + m' + \lfloor 2n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'_i}$ denotes the number of available REGs in the OFDM symbol having index l'_i, in the subframe and n'_1 denotes the number of available REGs in the second OFDM symbol having index 1 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

11. A method of a base station for transmitting acknowledgement/negative-acknowledgement (ACK/NACK) signal through a physical automatic repeat request indicator channel (PHICH) mapped to resource element groups (REGs) in one or more orthogonal frequency division multiplexing (OFDM) symbols, the method comprising:

determining indexes of REGs to which the PHICH is mapped in the OFDM symbols;

mapping the PHICH to the REGs in the OFDM symbols according to the determined indexes; and

transmitting the ACK/NACK signal through the mapped PHICH,

wherein an index of REG to which the PHICH is mapped in an OFDM symbol having index l'_i in a subframe is determined based on a ratio of the number of available REGs in the OFDM symbol having index l'_i and the number of available REGs in a reference OFDM symbol, and

wherein the number of available REGs in a specific OFDM symbol denotes the number of REGs not assigned to a physical control format indicator channel (PCFICH) among a total REGs in the specific OFDM symbol.

12. The method of claim **11**, wherein when the PHICH is transmitted through one or three OFDM symbols in the subframe, the reference OFDM symbol is determined to be a first OFDM symbol having an index 0 in the subframe.

13. The method of claim **12**, wherein when the PHICH is transmitted through one or three OFDM symbols in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_0) \rfloor + m') \bmod n'_{l'_i} & i = 0 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_0) \rfloor + m' + \lfloor n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 1 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_0) \rfloor + m' + \lfloor 2n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'_i}$ denotes the number of available REGs in the OFDM symbol having index l'_i, in the subframe and n'_0 denotes the number of available REGs in the first OFDM symbol having index 0 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

14. The method of claim **11**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the reference OFDM symbol is determined to be a second OFDM symbol having an index 1 in the subframe.

15. The method of claim **14**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_1) \rfloor + m') \bmod n'_{l'_i} & i = 0 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_1) \rfloor + m' + \lfloor n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 1 \\ (\lfloor (N_{ID}^{cell} \cdot n'_{l'_i} / n'_1) \rfloor + m' + \lfloor 2n'_{l'_i} / 3 \rfloor) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'_i}$ denotes the number of available REGs in the OFDM symbol having index l'^{i}, in the subframe and n'_1 denotes the number of available REGs in the second OFDM symbol having index 1 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

16. A base station for transmitting acknowledgement/negative-acknowledgement (ACK/NACK) signal through a physical automatic repeat request indicator channel (PHICH) mapped to resource element groups (REGs) in one or more orthogonal frequency division multiplexing (OFDM) symbols, the base station comprising a processor configured to:

determine indexes of REGs to which the PHICH is mapped in the OFDM symbols;

map the PHICH to the REGs in the OFDM symbols according to the determined indexes; and

transmit the ACK/NACK signal through the mapped PHICH,

wherein an index of REG to which the PHICH is mapped in an OFDM symbol having index l'_i in a subframe is determined based on a ratio of the number of available REGs in the OFDM symbol having index l'_i and the number of available REGs in a reference OFDM symbol, and

wherein the number of available REGs in a specific OFDM symbol denotes the number of REGs not

assigned to a physical control format indicator channel (PCFICH) among a total REGs in the specific OFDM symbol.

17. The base station of claim **16**, wherein when the PHICH is transmitted through one or three OFDM symbols in the subframe, the reference OFDM symbol is determined to be a first OFDM symbol having an index 0 in the subframe.

18. The base station of claim **17**, wherein when the PHICH is transmitted through one or three OFDM symbols in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0\right)\right\rfloor + m'\right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0\right)\right\rfloor + m' + \left\lfloor n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_0\right)\right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'i}$ denotes the number of available REGs in the OFDM symbol having index l'_i, in the subframe and n'_0 denotes the number of available REGs in the first OFDM symbol having index 0 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

19. The base station of claim **16**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the reference OFDM symbol is determined to be a second OFDM symbol having an index 1 in the subframe.

20. The base station of claim **19**, wherein when the PHICH is transmitted through two OFDM symbols in the subframe, the indexes of REGs to which the PHICH is mapped are determined using the following equation:

$$\overline{n_i} = \begin{cases} \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m'\right) \bmod n'_{l'_i} & i = 0 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m' + \left\lfloor n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 1 \\ \left(\left\lfloor \left(N_{ID}^{cell} \cdot n'_{l'_i} / n'_1\right)\right\rfloor + m' + \left\lfloor 2n'_{l'_i} / 3\right\rfloor\right) \bmod n'_{l'_i} & i = 2 \end{cases}$$

wherein $n'_{l'i}$ denotes the number of available REGs in the OFDM symbol having index l'_i, in the subframe and n'_1 denotes the number of available REGs in the second OFDM symbol having index 1 in the subframe, and

wherein N_{ID}^{cell} denotes a cell ID, i denotes an index of repetition of the PHICH, and m' denotes an index related to a PHICH group in which the PHICH is included.

* * * * *

EXHIBIT C

[redacted]

US011659503B2

(12) **United States Patent**
Kwon et al.

(10) **Patent No.: US 11,659,503 B2**
(45) **Date of Patent: *May 23, 2023**

(54) **APPARATUS AND METHOD FOR ESTABLISHING UPLINK SYNCHRONIZATION IN A WIRELESS COMMUNICATION SYSTEM**

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(72) Inventors: **Kibum Kwon**, Seoul (KR); **Myungcheul Jung**, Seoul (KR)

(73) Assignee: **PANTECH CORPORATION**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 67 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/322,832**

(22) Filed: **May 17, 2021**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 16/733,106, filed on Jan. 2, 2020, now Pat. No. 11,012,954, which is a (Continued)

(30) **Foreign Application Priority Data**

Feb. 10, 2010 (KR) 10-2010-0012564
Mar. 26, 2010 (KR) 10-2010-0027230
Jan. 28, 2011 (KR) 10-2011-0008683

(51) **Int. Cl.**
H04W 88/08 (2009.01)
H04W 56/00 (2009.01)
H04W 76/27 (2018.01)
H04L 5/00 (2006.01)
H04W 74/00 (2009.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04W 56/0005*** (2013.01); ***H04L 5/001*** (2013.01); ***H04W 56/0045*** (2013.01); ***H04W 74/004*** (2013.01); ***H04W 76/27*** (2018.02); *H04B 1/7087* (2013.01); *H04L 5/0007* (2013.01); *H04W 88/08* (2013.01); *H04W 92/10* (2013.01)

(58) **Field of Classification Search**
CPC . H04W 56/0045; H04W 92/10; H04W 88/08; H04L 5/001; H04L 5/0007
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2009/0279495 A1* 11/2009 Yoo H04W 56/0045 455/552.1
2012/0008600 A1* 1/2012 Marinier H04W 74/0833 370/336

OTHER PUBLICATIONS

ZTE, "Impact analysis of multiple TA", 3GPP TSG RAN WG2#68bis, R2-100308, Valencia, Spain, Jan. 18-22, 2010 (Year: 2010).*

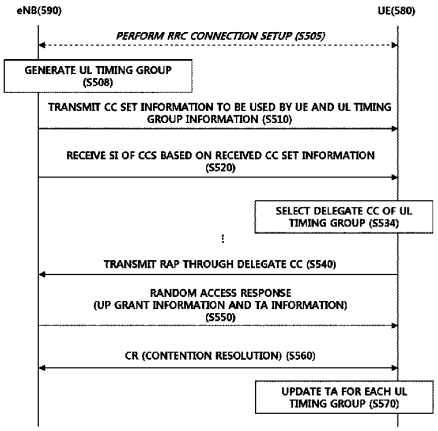
* cited by examiner

Primary Examiner — Lan-Huong Truong
(74) *Attorney, Agent, or Firm* — Ladas & Parry, LLP

(57) **ABSTRACT**

Uplink synchronization establishment in a base station which operates a plurality of component carriers according to one embodiment of the present description, is performed in that the base station is connected to a user equipment, sets component carrier aggregation information, generates an uplink timing groups in the set component carrier aggregation, and transmits information on the thus-generated uplink timing groups to the user equipment.

16 Claims, 11 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/820,980, filed on Nov. 22, 2017, now abandoned, which is a continuation of application No. 14/733,068, filed on Jun. 8, 2015, now Pat. No. 9,854,545, which is a continuation of application No. 13/578,531, filed as application No. PCT/KR2011/000909 on Feb. 10, 2011, now Pat. No. 9,054,835.

(51) **Int. Cl.**

H04W 92/10	(2009.01)
H04B 1/7087	(2011.01)

FIG. 1

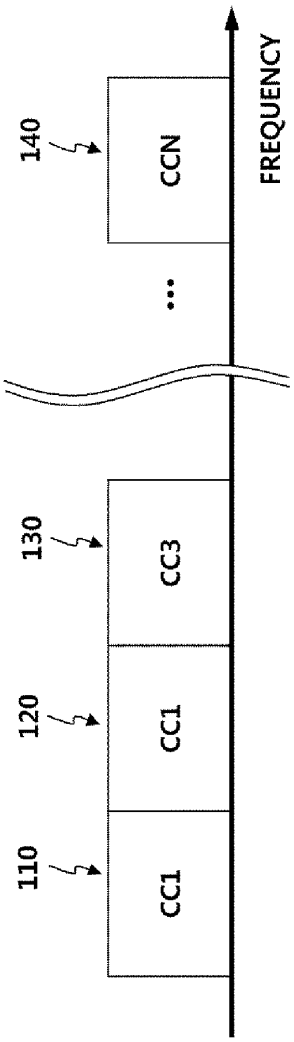


FIG.2

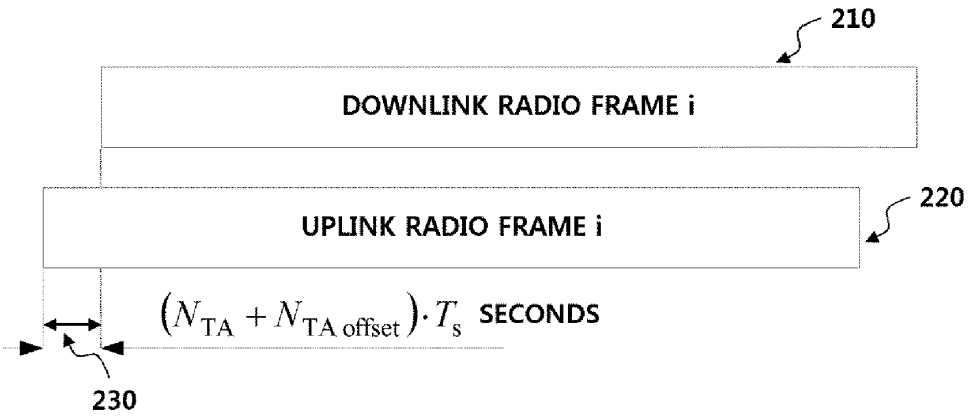

210
DOWNLINK RADIO FRAME i
UPLINK RADIO FRAME i
220
$(N_{TA} + N_{TA\ offset}) \cdot T_s$ SECONDS
230

FIG.3

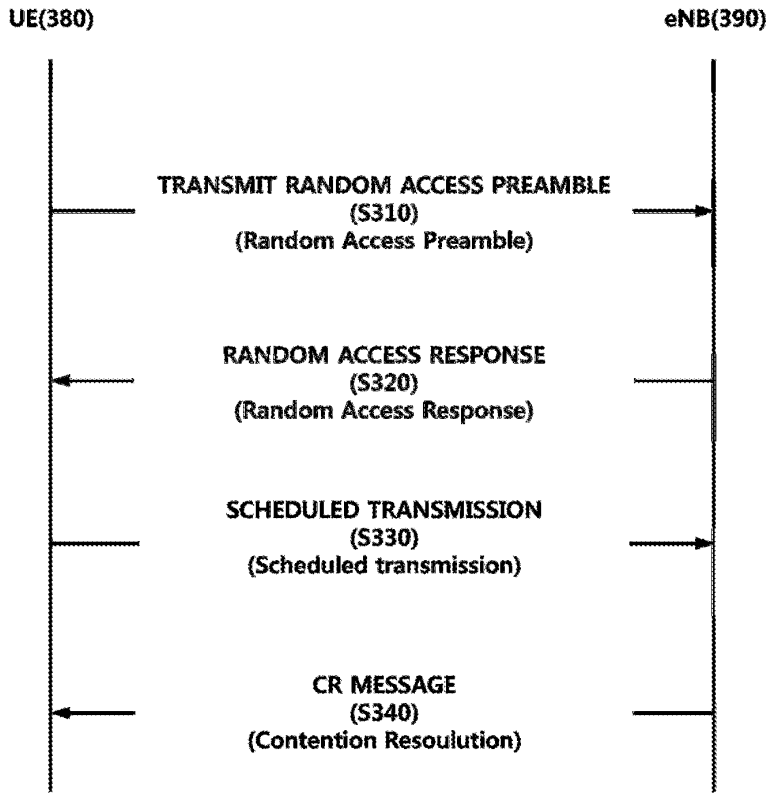

UE(380)
eNB(390)
TRANSMIT RANDOM ACCESS PREAMBLE
(S310)
(Random Access Preamble)
RANDOM ACCESS RESPONSE
(S320)
(Random Access Response)
SCHEDULED TRANSMISSION
(S330)
(Scheduled transmission)
CR MESSAGE
(S340)
(Contention Resoulution)

FIG. 4

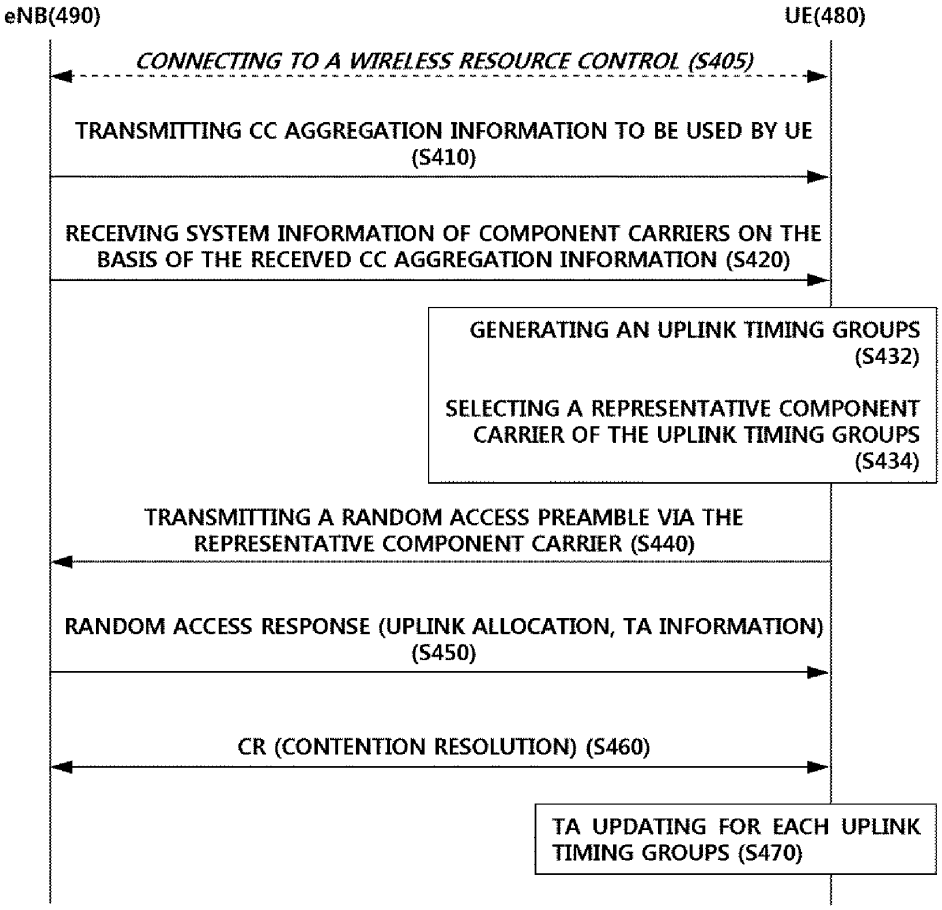

eNB(490)
UE(480)
CONNECTING TO A WIRELESS RESOURCE CONTROL (S405)
TRANSMITTING CC AGGREGATION INFORMATION TO BE USED BY UE (S410)
RECEIVING SYSTEM INFORMATION OF COMPONENT CARRIERS ON THE BASIS OF THE RECEIVED CC AGGREGATION INFORMATION (S420)
GENERATING AN UPLINK TIMING GROUPS (S432)
SELECTING A REPRESENTATIVE COMPONENT CARRIER OF THE UPLINK TIMING GROUPS (S434)
TRANSMITTING A RANDOM ACCESS PREAMBLE VIA THE REPRESENTATIVE COMPONENT CARRIER (S440)
RANDOM ACCESS RESPONSE (UPLINK ALLOCATION, TA INFORMATION) (S450)
CR (CONTENTION RESOLUTION) (S460)
TA UPDATING FOR EACH UPLINK TIMING GROUPS (S470)

FIG.5

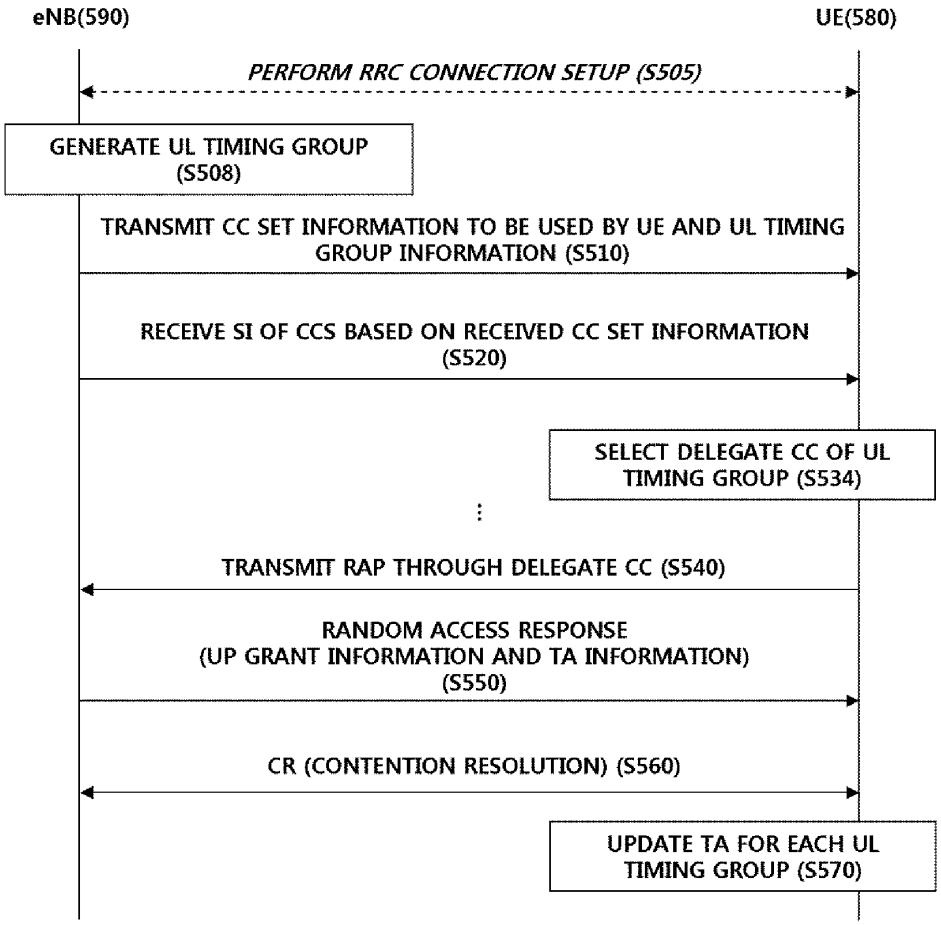

eNB(590)
UE(580)
PERFORM RRC CONNECTION SETUP (S505)
GENERATE UL TIMING GROUP (S508)
TRANSMIT CC SET INFORMATION TO BE USED BY UE AND UL TIMING GROUP INFORMATION (S510)
RECEIVE SI OF CCS BASED ON RECEIVED CC SET INFORMATION (S520)
SELECT DELEGATE CC OF UL TIMING GROUP (S534)
TRANSMIT RAP THROUGH DELEGATE CC (S540)
RANDOM ACCESS RESPONSE (UP GRANT INFORMATION AND TA INFORMATION) (S550)
CR (CONTENTION RESOLUTION) (S560)
UPDATE TA FOR EACH UL TIMING GROUP (S570)

FIG.6

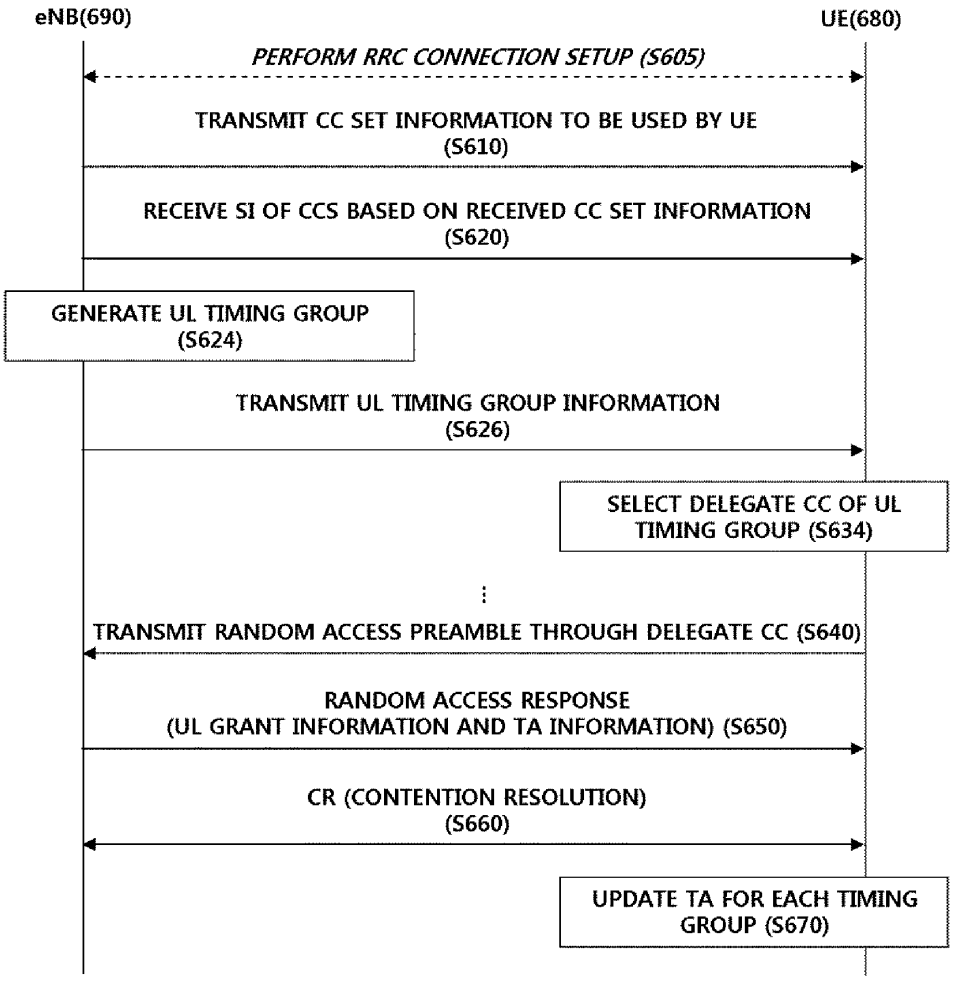

eNB(690)
UE(680)
PERFORM RRC CONNECTION SETUP (S605)
TRANSMIT CC SET INFORMATION TO BE USED BY UE (S610)
RECEIVE SI OF CCS BASED ON RECEIVED CC SET INFORMATION (S620)
GENERATE UL TIMING GROUP (S624)
TRANSMIT UL TIMING GROUP INFORMATION (S626)
SELECT DELEGATE CC OF UL TIMING GROUP (S634)
TRANSMIT RANDOM ACCESS PREAMBLE THROUGH DELEGATE CC (S640)
RANDOM ACCESS RESPONSE (UL GRANT INFORMATION AND TA INFORMATION) (S650)
CR (CONTENTION RESOLUTION) (S660)
UPDATE TA FOR EACH TIMING GROUP (S670)

FIG. 7

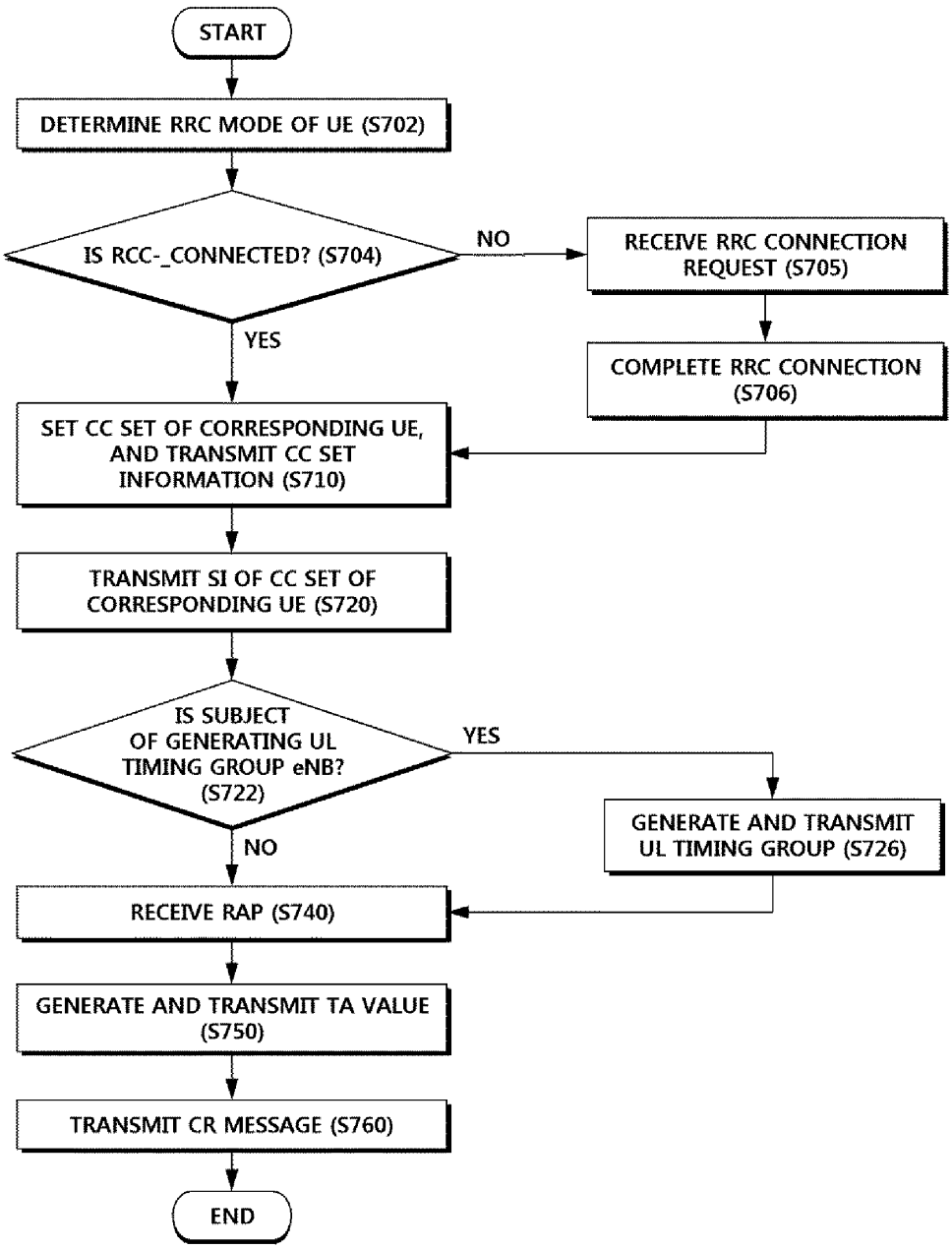

START
DETERMINE RRC MODE OF UE (S702)
IS RCC-_CONNECTED? (S704)
NO
RECEIVE RRC CONNECTION REQUEST (S705)
COMPLETE RRC CONNECTION (S706)
YES
SET CC SET OF CORRESPONDING UE, AND TRANSMIT CC SET INFORMATION (S710)
TRANSMIT SI OF CC SET OF CORRESPONDING UE (S720)
IS SUBJECT OF GENERATING UL TIMING GROUP eNB? (S722)
YES
GENERATE AND TRANSMIT UL TIMING GROUP (S726)
NO
RECEIVE RAP (S740)
GENERATE AND TRANSMIT TA VALUE (S750)
TRANSMIT CR MESSAGE (S760)
END

FIG.8

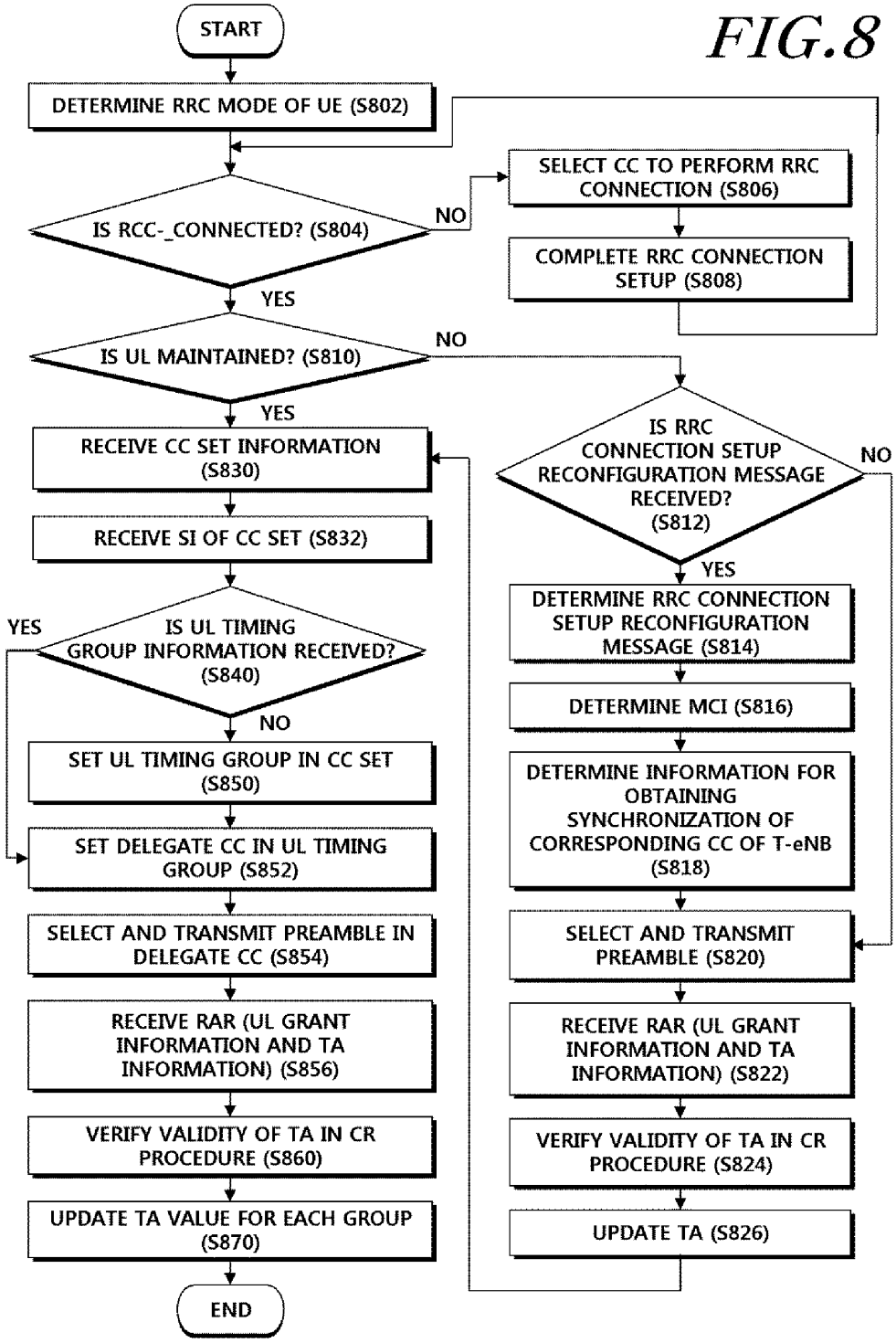

START
DETERMINE RRC MODE OF UE (S802)
IS RCC-_CONNECTED? (S804)
NO
SELECT CC TO PERFORM RRC CONNECTION (S806)
COMPLETE RRC CONNECTION SETUP (S808)
YES
IS UL MAINTAINED? (S810)
NO
YES
RECEIVE CC SET INFORMATION (S830)
RECEIVE SI OF CC SET (S832)
YES
IS UL TIMING GROUP INFORMATION RECEIVED? (S840)
NO
SET UL TIMING GROUP IN CC SET (S850)
SET DELEGATE CC IN UL TIMING GROUP (S852)
SELECT AND TRANSMIT PREAMBLE IN DELEGATE CC (S854)
RECEIVE RAR (UL GRANT INFORMATION AND TA INFORMATION) (S856)
VERIFY VALIDITY OF TA IN CR PROCEDURE (S860)
UPDATE TA VALUE FOR EACH GROUP (S870)
END
IS RRC CONNECTION SETUP RECONFIGURATION MESSAGE RECEIVED? (S812)
NO
YES
DETERMINE RRC CONNECTION SETUP RECONFIGURATION MESSAGE (S814)
DETERMINE MCI (S816)
DETERMINE INFORMATION FOR OBTAINING SYNCHRONIZATION OF CORRESPONDING CC OF T-eNB (S818)
SELECT AND TRANSMIT PREAMBLE (S820)
RECEIVE RAR (UL GRANT INFORMATION AND TA INFORMATION) (S822)
VERIFY VALIDITY OF TA IN CR PROCEDURE (S824)
UPDATE TA (S826)

FIG.9

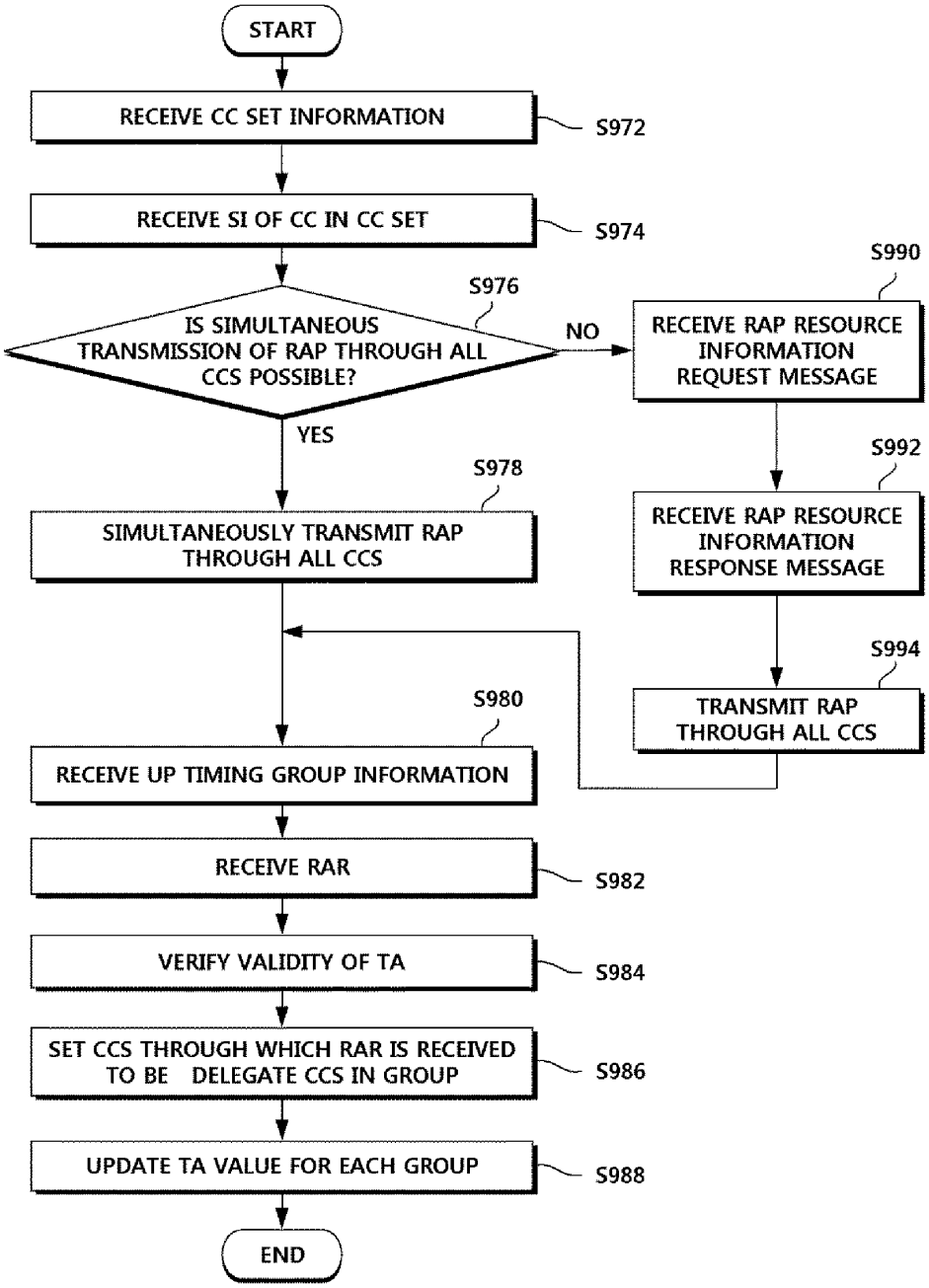

START
RECEIVE CC SET INFORMATION
S972
RECEIVE SI OF CC IN CC SET
S974
S976
IS SIMULTANEOUS TRANSMISSION OF RAP THROUGH ALL CCS POSSIBLE?
NO
YES
S990
RECEIVE RAP RESOURCE INFORMATION REQUEST MESSAGE
S992
RECEIVE RAP RESOURCE INFORMATION RESPONSE MESSAGE
S994
TRANSMIT RAP THROUGH ALL CCS
S978
SIMULTANEOUSLY TRANSMIT RAP THROUGH ALL CCS
S980
RECEIVE UP TIMING GROUP INFORMATION
RECEIVE RAR
S982
VERIFY VALIDITY OF TA
S984
SET CCS THROUGH WHICH RAR IS RECEIVED TO BE DELEGATE CCS IN GROUP
S986
UPDATE TA VALUE FOR EACH GROUP
S988
END

FIG.10

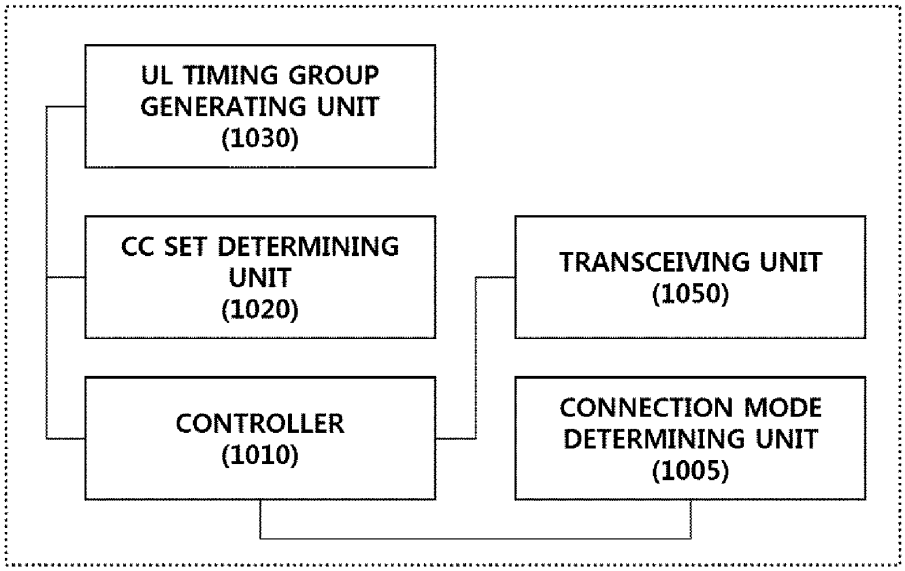
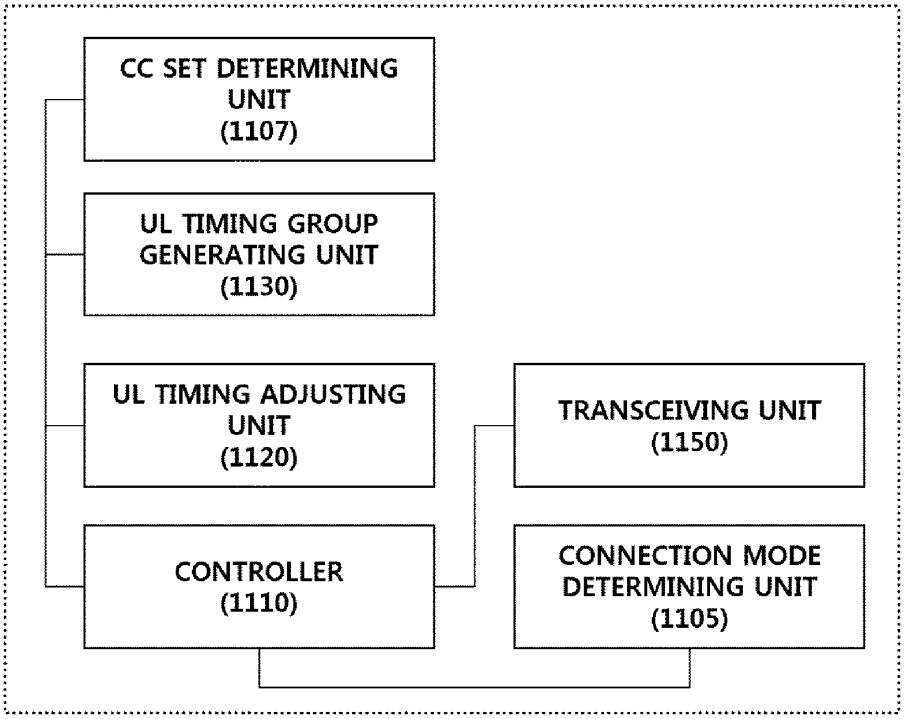

UL TIMING GROUP GENERATING UNIT (1030)
CC SET DETERMINING UNIT (1020)
TRANSCEIVING UNIT (1050)
CONTROLLER (1010)
CONNECTION MODE DETERMINING UNIT (1005)

FIG. 11


CC SET DETERMINING UNIT (1107)
UL TIMING GROUP GENERATING UNIT (1130)
UL TIMING ADJUSTING UNIT (1120)
TRANSCEIVING UNIT (1150)
CONTROLLER (1110)
CONNECTION MODE DETERMINING UNIT (1105)

APPARATUS AND METHOD FOR ESTABLISHING UPLINK SYNCHRONIZATION IN A WIRELESS COMMUNICATION SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 16/733,106, filed on Jan. 2, 2020, which is a continuation of U.S. patent application Ser. No. 15/820,980, filed on Nov. 22, 2017, which is a Continuation of U.S. patent application Ser. No. 14/733,068, filed on Jun. 8, 2015, now issued as U.S. Pat. No. 9,854,545, which is a Continuation of U.S. patent application Ser. No. 13/578,531, filed on Aug. 10, 2021, now issued as U.S. Pat. No. 9,054,835, which is the National Stage Entry of International Application No. PCT/KR2011/000909, filed on Feb. 10, 2011, and claims priority from and the benefit of Korean Patent Application No. 10-2010-0012564, filed on Feb. 10, 2010, Korean Patent Application No. 10-2010-0027230, filed on Mar. 26, 2010, and Korean Patent Application No. 10-2011-0008683, filed on Jan. 28, 2011, all of which are hereby incorporated by reference for all purposes as if fully set forth herein.

BACKGROUND

Field

The present invention relates to a method and apparatus for establishing an uplink (UL) synchronization in a wireless communication system, and more particularly, to a method and apparatus for configuring a UL synchronization with respect to at least one Component Carrier (CC).

Discussion of the Background

Synchronization between a user equipment (UE) and an evolved node B (eNB) is an important issue in a wireless communication system since transmission/reception of information between the UE and the eNB may not be performed without synchronization.

Current wireless communication system needs to satisfy a user demand through use of a plurality of CCs, unlike a conventional wireless communication system that supports a single component carrier (CC) or a single service band. However, a detailed scheme for synchronization with respect to the plurality of CCs has not been provided yet.

Accordingly, there is a desire for a scheme for effective synchronization in a wireless communication using a plurality of CCs since synchronization is a factor that has a great effect on an efficiency of a network.

SUMMARY

Therefore, the present invention has been made in view of the above-mentioned problems, and an aspect of the present invention is to provide a method and apparatus for effectively operating a synchronization process by configuring an uplink (UL) synchronization in a wireless communication network supporting a plurality of CCs of Carrier Aggregation system for efficiency of a network, and secures stability of transmission/reception.

Another aspect of the present invention is to provide a method and apparatus for establishing synchronization in a wireless communication system.

Another aspect of the present invention is to provide a method and apparatus for transmitting/receiving synchronization information to be used for establishing synchronization in a wireless communication system.

Another aspect of the present invention is to provide a method and apparatus for configuring a synchronization group with respect to a plurality of CCs in a wireless communication system.

Another aspect of the present invention is to provide a method and apparatus for configuring a synchronization group with respect to a plurality of CCs based on a connection mode of a UE in a wireless communication system.

Another aspect of the present invention is to provide a method and apparatus for configuring a synchronization group based on characteristics of a plurality of CCs available in a wireless communication system.

Another aspect of the present invention is to provide a method and apparatus of a UE that may configure a UL timing synchronization group with respect to a plurality of CCs in a wireless communication system.

Another aspect of the present invention is to provide a method and apparatus of a UE that may obtain synchronization information associated with a plurality of CCs through a random access procedure in a wireless communication system, and may establish and update synchronization with an eNB.

In accordance with an aspect of the present invention, there is provided a method for an eNB to establish an uplink (UL) synchronization in a wireless communication system, the method including: receiving a synchronization request message from a user equipment (UE) through one or more delegate CCs in a UL timing group; and transmitting UL synchronization information corresponding to the UL timing group to the UE through the one or more CCs, so as to establish the UL synchronization, and the one or more delegate CCs are selected by the UE based on a state of the UL timing group and characteristics of a plurality of CCs forming the UL timing group, so as to establish the UL synchronization.

In accordance with another aspect of the present invention, there is provided a method for a UE to establish a UL synchronization in a wireless communication system, the method including: transmitting a synchronization request message to an eNB through one or more delegate CCs in a UL timing group; receiving UL synchronization information corresponding to the UL timing group for establishing the UL synchronization, from the eNB through the one or more delegate CCs; and establishing synchronization by applying, to the UL timing group, the UL synchronization information received through the one or more delegate CCs, and the one or more delegate CCs are selected by the UE based on a state of the UL timing group and characteristics of a plurality of CCs forming the UL timing group, so as to establish the UL synchronization.

In accordance with another aspect of the present invention, there is provided an eNB to establish a UL synchronization in a wireless communication system, the eNB including: a controller to generate UL synchronization information corresponding to a UL timing group, so as to establish the UL synchronization; and a transceiving unit to receive a synchronization request message from a user equipment (UE) through one or more delegate CCs in the UL timing group, and to transmit the UL synchronization information to the UE through the one or more delegate CCs, and the one or more delegate CCs are selected by the UE based on a state of the UL timing group and character-

istics of a plurality of CCs forming the UL timing group, so as to establish the UL synchronization.

In accordance with another aspect of the present invention, there is provided a UE to establish a UL synchronization in a wireless communication system, the UE including: a transceiving unit to transmit a synchronization request message to an eNB through one or more delegate CCs in a UL timing group, and to receive UL synchronization information corresponding to the UL timing group through the one or more delegate CCs; a controller to determine the UL synchronization information received by the transceiving unit; and a UL timing adjusting unit to establish a UL synchronization of the UL timing group, based on the UL synchronization information determined by the controller, and the one or more delegate CCs are selected by the UE based on a state of the UL timing group and characteristics of a plurality of CCs forming the UL timing group, so as to establish the UL synchronization.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating an example of configuring a plurality of component carriers (CCs);

FIG. **2** is a diagram illustrating an example associated with a timing advance (TA) of a synchronization process;

FIG. **3** is a diagram illustrating a random access process performed between a user equipment (UE) and an evolved Node-B (eNB);

FIG. **4** is a diagram illustrating a process that obtains an uplink (UL) synchronization according to an embodiment of the present invention;

FIG. **5** is a diagram illustrating a process that obtains a Up Link (UL) synchronization according to another embodiment of the present invention;

FIG. **6** is a diagram illustrating a process that obtains a UL synchronization according to still another embodiment of the present invention;

FIG. **7** is a diagram illustrating a process in which an eNB enables the UE to obtain a UL synchronization in response to a request from the UE according to an embodiment of the present invention;

FIG. **8** is a diagram illustrating a process in which a UE obtains a UL synchronization through use of a UL timing group according to an embodiment of the present invention;

FIG. **9** is a diagram illustrating a process in which a UE obtains a UL synchronization through use of a UL timing group according to an embodiment of the present invention;

FIG. **10** is a block diagram of an eNB according to an embodiment of the present invention; and

FIG. **11** is a block diagram of a UE according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

Hereinafter, exemplary embodiments of the present invention will be described with reference to the accompanying drawings. In the following description, the same elements will be designated by the same reference numerals although they are shown in different drawings. Further, in the following description of the present invention, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear.

The specifications will describe a wireless communication system as an example, and operations performed in wireless communication may include all operations performed in a system that manages the wireless communication and a wireless communication device that transmits data. The wireless communication system may provide various communication services such as voice data, packet data, and the like. According to an embodiment, the wireless communication system may include, for example, a user equipment (UE) and an evolved Node-B (eNB).

The UE may be an inclusive concept indicating a user terminal utilized in a wireless communication, including a UE in Wideband Code Division Multiple Access (WCDMA), Long Term Evolution (LTE), High Speed Packet Access (HSPA), and the like, and a mobile station (MS), a user terminal (UT), a subscriber station (SS), a wireless device and the like in Global System for Mobile Communications (GSM).

The eNB or a cell may refer to a fixed station where communication with the UE is performed, and may also be referred to as a Node-B, a base transceiver system (BTS), an access point, and the like.

The eNB or the cell may be construed as an inclusive concept indicating a portion of an area covered by a radio network controller (RNC) in WCDMA, and the like, and the concept may include various cell coverage areas, such as a megacell, macrocell, a microcell, a picocell, a femtocell, and the like.

In the specifications, the UE and the eNB are used as two inclusive transceiving subjects to embody the technology and technical concepts described in the specifications, and may not be limited to a predetermined term or word.

A multiple access scheme applied to the wireless communication system may not be limited. The wireless communication system may utilize varied multiple access schemes, such as Code Division Multiple Access (CDMA), Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Orthogonal Frequency Division Multiple Access (OFDMA), Orthogonal Frequency Division Multiple Frequency Division Multiple Access (OFDM-FDMA), Orthogonal Frequency Division Multiple Time Division Multiple Access (OFDM-TDMA), Orthogonal Frequency Division Multiple Code Division Multiple Access (OFDM-CDMA), and the like. Uplink (UL) transmission and downlink (DL) transmission may be performed based on a time division duplex (TDD) scheme that performs transmission based on different times, or based on a frequency division duplex (FDD) scheme that performs transmission based on different frequencies.

An embodiment of the present invention may be applicable to an asynchronous wireless communication scheme that is advanced through GSM, WCDMA, and HSPA, to be LTE and LTE-advanced, and may be applicable to a synchronous wireless communication scheme that is advanced through CDMA and CDMA-2000, to be UMB. Embodiments of the present invention may not be limited to a specific wireless communication scheme, and may be applicable to all technical fields to which a technical idea of the present invention is applicable.

FIG. **1** illustrates an example of a wireless communication system that uses a plurality of CCs according to an embodiment of the present invention.

Referring to FIG. **1**, the wireless communication system may be a next generation communication system, including an LTE system and an LTE-A system.

The LTE/LTE-A system may extend a bandwidth to satisfy a high data transmission rate corresponding to a system requirement, and may use a plurality of component carriers (CCs) which are unit carriers. Here, a single CC may have a maximum bandwidth of 20 megahertz (MHz).

Resource allocation may be performed within a bandwidth of 20 MHz depending on a service. However, it is merely an example during a process of embodying a system. Depending on a configuration of a system, a single CC may be configured to have a bandwidth smaller than or equal to 20 MHZ. Also, a plurality of CCs may be bound and used as a single system band, and may be referred to as a carrier aggregation (CA).

As illustrated in FIG. **1**, when five CCs having a maximum bandwidth of 20 MHz are used, a bandwidth may be expanded up to 100 MHz to support a quality of service. In this example, an allocable frequency band, which may be determined by each CC, may be contiguous or non-contiguous based on a scheduling of the CA.

Throughout the specifications, a component carrier may be denoted by a CC and may be distinguished by names, for example, CC**0**, CC**1**, and the like. However, a number included in a name of each CC may not always match an order of a corresponding CC or a location of a frequency band of the corresponding CC.

Referring to FIG. **1**, the CA may be configured to include a first CC (CC**1**) **110**, a second CC (CC**2**) **120**, a third CC (CC**3**) **130**, and an N^{th} CC (CCN) **140**. A UL and a DL allocated to each CC may be different from each other, or may be the same as one another based on a scheduler.

In a wireless communication environment, an electric wave may experience a propagation delay while the electric wave is transferred from a transmitter to a receiver. Accordingly, although both the transmitter and the receiver are accurately aware of a time when the electric wave is transmitted from the transmitter, a time when the electric wave is received by the receiver may be affected by a distance between the transmitter and the receiver, an ambient propagation environment, and the like, and may vary over time when the receiver moves. When the receiver is not accurately aware of a point in time when a signal transmitted from the transmitter is to be received, the receiver may fail to receive the signal, or may receive a signal distorted due to the propagation delay and may fail to perform communication.

Accordingly, in the wireless communication system, synchronization between the eNB and the UE may be established first to receive a signal, irrespective of a UL and a DL. That is, a synchronization process is an essentially important process in a communication system, and maintaining the synchronization process may also significantly affect a stability of the system and a quality of communication.

There may be various types of synchronization, such as a frame synchronization, an information symbol synchronization, a sampling period synchronization, and the like. The sampling period synchronization may need to be obtained basically, so as to distinguish a physical signal.

In DL transmission corresponding to a communication link of transmission in a direction from the eNB to the UE, synchronization may be obtained in the UE based on a signal of the eNB. The eNB may transmit a predetermined signal that is mutually prearranged, so that the UE may readily obtain a DL synchronization, and the UE may need to accurately distinguish a time when the predetermined signal is transmitted from the eNB. In a case of a DL, a single eNB may simultaneously transmit the same synchronization signal to a plurality of UEs and thus, each UE may independently obtain synchronization based on the synchronization signal.

Conversely, in a case of a UL, the eNB may receive signals transmitted from the plurality of UEs and thus, the eNB may have difficulty in obtaining synchronization based on one of the UEs. Accordingly, a synchronization process that is different from the DL may be required.

When distances between the UEs and the eNB are different from each other, the UEs may have different transmission delay times. When each UE transmits UL information based on a corresponding DL synchronization, information transmitted from each UE may be received by the eNB at different times.

Although the uplink information transmitted from each UE is received at different times, the information may be received with a complexity being increased when a transmission scheme adopted by the wireless communication system, such as CDMA, is capable of separately receiving the information. However, in a wireless communication system that is based on OFDMA or FDMA, uplink transmission information of all the UEs may be simultaneously received by the eNB and may be demodulated and thus, a reception performance may increase as the uplink transmission information is received at an accurate time, and a reception performance may be rapidly deteriorated as a reception time difference of each UE signal received in the eNB is increased.

Accordingly, in a wireless communication system that utilizes OFDMA or SC-FDMA as a UL transmission scheme, such as LTE, a timing alignment value may be calculated for each UE based on a random access scheme and the like, to obtain a transmission delay time in a DL and a transmission delay time in a UL, and each UE may be informed of the calculated TA value, so that a UL synchronization is obtained.

FIG. **2** illustrates an example associated with a timing advance (TA) in a synchronization process according to an embodiment of the present invention.

In general, a UL radio frame i **220** may need to be transmitted at the same point in time as a point in time when a DL radio frame i **210** is transmitted, so as to perform communication between an eNB and a UE. However, a time difference may exist between the UE and the eNB due to propagation delay and the like.

Accordingly, a TA may be applied to enable the UE to transmit the UL radio frame i **220** a little earlier than the DL frame i **210** by taking the propagation delay into consideration, so that synchronization between the eNB and the UE may be obtained. An equation to calculate the TA may be expressed by Equation 1.

$$TA=(N_{TA}+N_{TA\ offset})\cdot T_s \text{ seconds} \quad \text{[Equation 1]}$$

Here, N_{TA} denotes a value to be variable based on TA command information transmitted from the eNB, and $N_{TAoffset}$ denotes a value set based on a frame structure. T_s denotes a sampling period. As shown in FIG. **2**, to obtain a UL synchronization, the UE may receive the TA command information provided by the eNB, and may proceed with a TA based on the received TA command information so that UE may obtain synchronization with the eNB for wireless communication.

FIG. **3** illustrates a random access process performed between a UE and an eNB according to an embodiment of the present invention.

To perform transmission and reception of data with an eNB **390**, a UE **380** may need to obtain a UL synchronization. To obtain the UL synchronization, the UE **380** may proceed with a process of receiving information required for synchronization, from the eNB **390**. FIG. **3** shows a random access procedure for receiving information required for synchronization. The random access procedure may be applicable when a UE is newly coupled to a network through

a handover and the like. Also, upon completing the coupling, the UE may proceed with the random access procedure even under a circumstance such as synchronization, a state change, for example, from an RRC_IDLE to an RRC_CONNECTED, and the like.

The UE **380** may randomly select a preamble signature so as to generate a random access preamble (RAP). Subsequently, the UE **380** may transmit the selected preamble to the eNB **390** (step S**310**). The process of selecting the preamble signature may be contention-based selection or contention-free selection. In this example, the eNB may inform the UE of a previously reserved RAP, and the UE may transmit, to the eNB **390**, a preamble selected based on received information (step S**310**). Also, according to the contention-free selection, a procedure associated with a contention resolution (CR) message, which is required in the contention-based selection, may not need to be performed.

Here, the UE **380** may recognize random access-radio network temporary identifier (RA-RNTI) based on a transmission time and a frequency resource temporarily selected for selecting a preamble or for random access channel (RACH) transmission.

The eNB **390** may perform random access response (RAR) with respect to the preamble received from the UE **380**. In this example, the eNB **390** may transmit an RAR message through a physical downlink shared channel (PDSCH).

Information transmitted through the RAR message may include, for example, identification information of the UE preamble received by the eNB, an identifier (ID) of the eNB, a temporary cell radio network temporary identifier (C-RNTI), information associated with a time slot where the preamble is received, TA information, and the like. Timing information for a UL synchronization may be received through the RAR message and thus, the UE **380** may perform the UL synchronization with the eNB **390**. The UE **380** may perform a scheduled transmission that transmits data at a scheduled time determined based on the TA information received in step S**320** (step S**330**). In this example, the UE **380** may transmit synchronized data through a physical uplink shared channel (PUSCH), and may perform hybrid automatic repeat request (HARD).

Examples of a message transmitted in step S**330** may include a radio resource control (RRC) connection request, a tracking area update, a scheduling request, and the like. Also, one of the messages may include a temporary C-RNTI, a C-RNTI (if the UE already has one), UE identification information, and the like.

In steps S**310** through **330**, collision may occur and thus, when the eNB **390** transmits a CR message (step S**340**), the UE **380** may i) determine whether a received message corresponds to the UE **380**, and may transmit an acknowledgement (ACK) when the received message corresponds to the UE **380** or ii) may not transmit response data when the received message corresponds to another UE. Also, the UE **380** may not transmit the response data when the UE **380** misses DL allocation or fails to decode the message. Also, the CR message may include a C-RNTI, UE identification information, and the like.

Unlike a process of obtaining a TA when a single carrier is utilized, in a wireless system that uses a plurality of CCs, TA values of the CCs may have a high probability of being different from each other when locations of center frequencies of the CCs are significantly distant from each other as shown in FIG. **1**, when the CCs are supported by different devices in a network, or the like.

Accordingly, when a synchronization obtaining scheme used for a single carrier is applied as is, the CCs may have difficulty in obtaining the UL synchronization for the CCs. Accordingly, the UE may perform stable UL communication for a few CCs that obtain UL synchronization from among available CCs.

When the UE transmits, based on the same UL synchronization standard, information through CCs of which UL synchronization standards are different from each other, a probability of transmission error may be significantly high, and a time and resources for restoring the error may be wasted. In this example, it is difficult to satisfy a UL quality of service (QoS) for an application program required by a system.

When the wireless communication uses a plurality of CCs, a transmission delay time may be different in a DL based on a supporting scheme in a radio network and a characteristic of each CC with respect to a single UE. Accordingly, when CCs or CCs having the same TA value are configured as a set, a UL synchronization standard may be different for each CC set and thus, UL performance may be deteriorated.

Therefore, embodiments of the present invention for a wireless communication system supporting a plurality of CCs, are provided so that the UE obtains a UL synchronization of a corresponding CC or a group of CCs based on a type of each CC, a location of a center frequency, a network service type, and the like when CCs or groups including at least one CC have different UL synchronization standards.

Hereinafter, a user terminal may be referred to as a UE and a base station may be referred to as an eNB.

FIG. **4** illustrates a process that obtains a UL synchronization according to an embodiment of the present invention.

FIG. **4** shows a process in which a UE configures a group associated with a timing from among a plurality of CCs and performs RAP through a delegate CC when an eNB transmits information associated with the CCs to the UE.

Referring to FIG. **4**, when an RRC connection mode is an RRC_CONNECTED mode indicating that a UE **480** and an eNB **490** are connected, step S**410** may be performed. When the RRC connection mode is an IDLE mode or requires resetting, step S**405** may be performed first, and then step S**410** may be performed.

In step S**405**, RRC connection may be performed. When the RRC connection mode between the eNB **490** and the UE **480** is the IDLE mode or requires resetting, the eNB **490** may have difficulty in defining a CC set of the corresponding UE and transmitting CC set information in the IDLE mode UE. Therefore, the CC set information may be formed by selecting at least one CC to perform RRC connection so that the RRC connection is performed (step S**405**). At least one CC to perform the RRC connection may be selected based on one of the following methods.

i) select a CC that is most appropriate for attempting RRC connection based on information measured by the UE **480**

ii) attempt RRC connection based on information fixedly set in a system and stored in an internal memory of the UE **480**

iii) attempt RRC connection based on information transmitted to the UE **480** from the eNB **490** through system information

iv) attempt RRC connection through CCs corresponding to system information of the available CCs stored in an internal memory of the UE **480**

For example, a UE in an IDLE mode may select a single DL CC for the RRC connection based on the conditions, and may receive system information via a broadcasting channel

that is transmitted through the selected CC. Based on the received system information, the selected DL CC and a UL CC having a linkage with the DL CC may be configured as a primary serving cell (PCell). The UE may transmit, to an eNB, an RRC connection request message through the PCell. In this example, the UE may transfer the RRC connection request message to the eNB through an RACH procedure.

Here, the DL CC corresponding to the PCell may be referred to as a DL primary CC (DL PCC), and the UL CC corresponding to the PCell may be referred to as a UL primary CC (UL PCC). Also, a CC corresponding to a secondary serving cell (SCell) **920** in a DL may be referred to as a DL secondary CC (DL SCC), and a CC corresponding to the SCell in a UL may be referred to as a UL secondary CC (UL SCC).

The PCell and the SCell have characteristics as follows.

First, the PCell may be used for PUCCH transmission.

Second, the PCell is always activated, whereas the SCell **920** is activated or deactivated based on a predetermined condition.

Third, when the radio link failure (RLF) is detected via PCell, RRC reconnection PCell may be triggered. When the RLF is detected via SCell **920**, RRC reconnection on SCell may not be triggered.

Fourth, the PCell may be changed by a change of a security key or by a handover procedure accompanying the RACH procedure. In a case of an MSG4 (contention resolution), only a PDCCH that indicates the MSG4 may be transmitted through the PCell, and MSG4 information may be transmitted through the PCell or the SCell.

Fifth, non-access stratum (NAS) information may be received through the PCell.

Sixth, the PCell may be configured as a pair of a DL PCC and a UL PCC.

Seventh, each UE sets a different CC as the PCell.

Eighth, a procedure such as, reconfiguration, adding, and removal of the SCell may be performed by an RRC layer. To add a new SCell, RRC signaling may be used to transmit system information associated with a dedicated SCell.

Technical concept of the PCell and the SCell in embodiments of the present invention may not be limited to the descriptions provided in the foregoing, and may include further examples.

When RRC connection setup is completed through one of the methods, and the RRC connection mode between the eNB **490** and the UE is the RRC_CONNECTED mode, step S**410** may be performed.

The eNB **490** may allow the UE **480** to use a plurality of CCs based on a performance of hardware of the UE **480**, available frequency resources of the eNB **490**, and the like, and may define the plurality of CCs to be a CC set. The eNB **490** may transmit, to the UE **480**, CC set information associated with the CC set that is allowed to the UE **480** (step S**410**).

As described in the foregoing, the UE **480** and the eNB **490** maintain the RRC_CONNECTED mode from step S**405** or before. That is, a UL synchronization of a UL CC through which the RRC connection of the UE **480** is set up is maintained. The UE **480** may receive the CC set information determined based on the above condition, from the eNB **490**.

According to a scheme of transmitting and receiving the CC set information, the eNB **490** may include the CC set information in an RRC reconfiguration message for transmission to the UE **480**, or may use another message for transmission.

Also, the CC set information may be configured by adding/removing each CC. For example, when initial CC set information is transmitted, the CC set information configured of DL CC**1**, DL CC**2**, and DL CCN may be configured as an added DL CC list and the list may include CC**1**, CC**2**, and CCN. In the same manner, UL CC set information may be configured as an added UL CC list.

As another example, when the CC set information is changed, that is, when the configured DL CC set is changed into CC**1**, CC**3**, and CCN, the DL CC set information may be transmitted by configuring CC**2** as a removed DL CC list and CC**3** as an added DL CC list.

The UE **480** may receive system information (SI) associated with CCs in the CC set, based on the received CC set information (step S**420**).

When a CC that is incapable of transmitting SI to a corresponding CC exists from among the CCs in the CC set, for example, an extension CC (ECC), or a CC that is incapable of receiving SI transmitted via a broadcasting channel (for example, a DL CC that belongs to an SCell) exists, the SI may be received by a CC that is capable of receiving the SI or may be received by a CC that is capable of receiving SI that is transformed in a form of control information.

The transformed SI may be transmitted to the UE together with the CC set information included in the RRC reconfiguration message transmitted by the eNB, or may be transmitted to the UE through the RRC reconfiguration message after the CC set information is received. Also, the current stage may be performed without receiving the SI associated with the corresponding CC.

The UE **480** may configure a UL timing group including CCs in the CC set as elements of the UL timing group, based on the received SI (step S**432**). When the UL timing group is configured, considerations may be as follows.

First, whether a plurality of CCs is assigned to different groups may be determined based on the following conditions. That is, a CC that satisfies at least one of the conditions may be configured to be a different group.

a-i) CCs of which a difference in center frequency values is greater than or equal to a threshold, are assigned to different groups. When a difference in the center frequency values is high, delay occurring in a wireless signal propagation process may be changed and thus, a difference in TA values may also increase.

a-ii) CCs to which different beamforming schemes are applied are assigned to different groups. TA values are highly likely to be different from each other when the beamforming schemes are different from each other.

a-iii) CCs that are set to be updated every time a UL synchronization update request exists are assigned to different groups. The setting may be included in SI set by the eNB **490** for transmission, or may be included in other messages for transmission.

a-iv) CCs that do not provide services in a macrocell or CCs that provide services in a space superposed on the macrocell by a femtocell, a picocell, a microcell, a relay, a repeater, and the like may have different characteristics from CCs that provide services by the macrocell and thus, the CCs are configured to be different groups.

a-v) a CC that has a UL synchronization update request from the eNB **490** may be a CC that has a changed synchronization and thus, the CC may be assigned to a different group.

As described in the foregoing, examples of a condition for setting CCs to be a UL timing group may be a-i) through a-v). In addition, CCs are configured to be a single group or

to be different groups based on a wireless propagation characteristic, a predetermined measurement value, and the like.

When one of the following conditions are satisfied, CCs may be configured to be a single group.

b-i) CCs of which a difference in center frequency values is within a threshold range may have similar propagation characteristic and thus, the CC may be configured to be a single group.

b-ii) CCs to which the same beamforming scheme is applied may be configured to be a single group

b-iii) CCs used in devices in the same radio network may be configured to be a single group

b-iv) CCs that do not satisfy conditions a-I through a-v for assigning CCs to different groups may be configured to be a single group

A method for the UE **480** to generate a group may include two schemes, that is, a scheme of generating groups by distinguishing CCs that belong to different groups and a scheme of generating a group by distinguishing CCs to be included in the same group. The two schemes may be used together or one of the two schemes may be used. Conditions to be used in a process of applying each scheme have been described in the foregoing.

When the UL timing group is generated, the UE **480** may select a delegate CC for each group (step S**434**). In this example, the delegate CC may be selected based on following conditions, from among CCs that are capable of obtaining a TA value to be used for obtaining a UL synchronization.

c-i) a CC having a lowest center frequency value

c-ii) a CC having a center frequency value that is closest to a mean value

c-iii) a CC having a highest center frequency value

c-iv) a CC having a broadest frequency band

c-v) a CC that is set to be used for monitoring DL quality

A CC satisfying one of the conditions may be selected as a delegate CC.

Here, a CC may be defined to include a DL CC or both the DL CC and a UL CC, and may be defined to be a cell or a serving cell. In other words, the cell may be defined by only DL frequency resources (for example, a CC) through which a wireless signal recognized by a UE reaches a predetermined area, and may be defined to be a pair of the DL frequency resources that is used by the UE to receive a signal from the eNB and UL frequency resources that is used by the UE to transmit a signal to the eNB.

Therefore, with respect to only a UE that is able to form a plurality of CCs, the eNB may be able to form a plurality of serving cells to perform transmission and reception of data with the UE

In this example, a PCell may indicate a single serving cell that provides a security input and NAS mobility information in an RRC establishment state or re-establishment state. Also, based on the capabilities of the UE, at least one cell may be configured to form a serving cell set with the PCell, and the at least one cell may be referred to as an SCell.

Accordingly, a serving cell set configured for a single UE may be configured of a single PCell or of a single PCell and at least one SCell. An adjacent cell in a frequency of the PCell and/or an adjacent cell in a frequency of the SCell may be in the same carrier frequency, and adjacent cells in frequencies of the PCell and the SCell may be in different carrier frequencies.

Here, a CC set for monitoring the DL quality may include an SCell to which a radio link monitoring (RLM) is defined. In particular, the RLM may include a process in which a UE monitors DL quality based on a cell-specific reference (CRS) signal so as to detect DL quality of a serving cell set between the UE and an eNB.

In this example, the UE may predict the DL quality based on predetermined parameters which are defined by a ratio of the measured CRS to energy of control channels.

The RLM may be set based on following conditions. To predict the DL quality through the RLM, a value that expresses a ratio of reception energy of an RE (single sub-carrier in a single OFDM symbol) through which a PDCCH/physical control format indicator channel (PCFICH) is transmitted, to an average RE energy of the CRS based on a dB unit may be used as a criterion.

From among the parameters, a parameter Q_{out} that is a criterion to determine an out-of-sync state may be configured based on a parameter set for transmitting a PDCCH/PCFICH and a value of which a block error rate (BER) of hypothetical PDCCH (based on a DCI format 1A) transmission based on an error of the PCFICH is greater than or equal to 10%. The value may be changed based on a number of antenna ports through which the CRS is transmitted.

For example, when the CRS is transmitted through a single antenna port, a ratio of energy between the PDCCH and the CRS to be determined as Q_{out} may be based on 4 dB, and when the CRS is transmitted through two or more antenna ports, Q_{out} may be based on 1 dB. From among the parameters, a parameter Q_{in} that is a criterion to determine synchronization restoration or in-sync state may be determined based on a value having a sufficiently large reliability when compared to Q_{out}.

That is, a parameter set for transmitting the PDCCH/PCFICH and a value of which a BER of hypothetical PDCCH (based on a DCI format 1C) transmission based on an error of the PCFICH is greater than or equal to 2% may be used. The value may be changed based on a number of antenna ports through which the CRS is transmitted.

For example, when the CRS is transmitted through a single antenna port, a ratio of energy between the PDCCH and the CRS to be determined as Q_{in} may be based on 0 dB, and when the CRS is transmitted through two or more antenna ports, Q_{in} may be based on −3 dB.

A reason that an energy ratio used for determining Q_{in} is lower than Q_{out}, is that the energy ratio is based on the parameter set for transmitting the PDCCH/PCFICH and the BER of the hypothetical PDCCH transmission. The parameters set for transmitting the PDCCH/PCFICH may include a DCI format of a PDCCH, a number of OFDM symbols through which control information of a subframe is transmitted, an aggregation level indicating a self-duplication rate of the PDCCH, and the like. The parameters may be affected by a bandwidth of a DL. Q_{out} and Q_{in} may be affected based on whether a UE performs discontinuous reception (DRX) with respect to a corresponding cell.

Therefore, the UE or the eNB may select a delegate CC in each group. In this example, the UE or the eNB may select the delegate CC by selecting an SCell including the delegate CC. In this example, the delegate CC or the SCell may be selected based on the conditions c-i) through c-v), from among CCs that are capable of obtaining a TA value to be used for obtaining a UL synchronization. That is, one of the c-i) through c-v) may be selected as a delegate CC.

In this example, according to a method of selecting a delegate CC for each UL timing group, the same criterion may be used for all groups or a different criterion may be used for each timing group. That is, the delegate CC may be selected based on a network state of each group, characteristics of CCs forming each group, and the like.

After completing steps S432 and S434 for setting a UL timing group and a corresponding delegate CC, to obtain a UL synchronization, the UE **480** may set an RAP through a delegate CC of each group, and may transmit the set preamble by selecting one of the resources defined in SI of each CC (step S440). The preamble may be included in a synchronization request message through which the UE requests synchronization. Transmission of the corresponding preamble may include a case in which the UE **480** sequentially, simultaneously, or randomly transmits a preamble through a selected CC in time/frequency resources set by the eNB **490**.

Cases that require obtaining a UL synchronization may be as follows. Although a condition does not satisfy one of the cases described below, when the UE **480** determines that it is required, the UE **480** may generate an RAP and may transmit the RAP to the eNB **490**.

d-i) a case in which the eNB **490** requires re-establishment of the entire DL synchronization

d-ii) a case that initializes and retries all UL data transmission

d-iii) a case in which a time alignment timer of the UE **480** expires

The UE **480** may transmit a preamble to be used for obtaining a UL synchronization with respect to total available CC groups.

Also, the UE **480** may need to obtain a UL synchronization with respect to a few available CC groups. Relevant cases will be described as follows.

e-i) a case in which a CC set is initially set and a TA value does not exist in a corresponding group

e-ii) a case in which a response is not obtained in response to UL transmission data transmitted through CCs in a group of the UE **480**

e-iii) a case in which an RRC connection between the eNB **490** and the UE **480** is reconfigured

e-iv) a case in which the UE **480** performs handover of a predetermined CC group to an eNB **490** that is physically different from the UE **480**

e-v) a case in which the eNB **490** requests reconfiguration with respect to a predetermined CC group associated with a DL synchronization.

e-vi) a case in which a CC time alignment timer expires (the timer is set for each CC or for each group). When a condition satisfies one of the cases, a process for obtaining a UL synchronization with respect to a CC group including a corresponding CC may be performed.

For example, in steps S432 and S434, CC1, CC2, CC3, CC4, and CC5 exist, and CC1 and CC2 are configured to be group **1**, and CC3, CC4, and CC5 are configured to be group **2**. A delegate CC of group **1** is CC1, a delegate CC of group **2** is CC3. In this example, when a UL synchronization for the total available CC groups is required, the UE **480** may transmit an RAP through CC1 and CC3. When synchronization needs to be obtained for a few CC groups, that is, when synchronization needs to be obtained for group **2**, the UE **480** may transmit an RAP through CC3.

When a UL synchronization needs to be re-established while data is transmitted through a UL, the UE **480** may perform the following operation first, for example, initializing UL data transmission, and then may perform initializing HARQ buffers, releasing a physical uplink control channel (PUCCH)/releasing sounding reference signal (SRS), initializing semi-persistent scheduling allocation/allowance, and the like, as a procedure to obtain a UL synchronization.

The eNB **490** may calculate a TA value for each group with respect to each CC group (each delegate CC) based on the received RAP signal. The eNB **490** may transmit, to the UE **480**, UL grant information and a TA value of a UL timing group (a delegate CC) through an RAR message (step S450). The TA value may be an example of UL synchronization information required when the UE adjusts a UL transmission time.

Subsequently, when the UE **480** determines that the TA value received in a CR procedure (step S460) is valid, the UE **480** may apply the TA value to another CC in the group for updating (step S470).

As described in the foregoing, when a procedure of obtaining a UL synchronization is performed with respect to all the groups, TA values associated with CC1 and CC3 may be applied to CCs each included in group **1** and group **2**. When a TA value of CC3 is received for group **2**, the TA value may be applied to CCs included in group **2**.

FIG. **5** illustrates a process that obtains a UL synchronization according to another embodiment of the present invention. Here, FIG. **5** shows that an eNB **590** configures a UL timing group.

Referring to FIG. **5**, the eNB **590** determines a mode (RRC_CONNECTED/RRC IDLE) of a UE before transmitting UL timing information. When the eNB **590** is not connected to the UE, the eNB **590** may proceed with RRC connection (step S505), and may use a PCell for RRC connection, which will be performed in the same manner as step S405 of FIG. **4**.

A scheme of generating a group in the eNB **590** may be performed based the conditions a-i) through a-v) or b-i) through b-iv) of FIG. **4**.

Accordingly, the eNB **590** may transmit CC set information of the UE **580** and UL timing group information of the set UL timing group to the UE **580** (step S510). Here, the UL timing group information may be included in a CC set information message for transmission to the UE **580**, or a separate other message may be used for transmission. A case that uses a separate message will be described with reference to FIG. **6**. The CC set information message provided for each UE may be an RRC (L3) message, an L1 signaling, or an L2 signaling.

The UE **580** may receive SI of CCs in a set, based on the received CC set information (step S520). In this example, the UE **580** may use the UL timing group generated by the eNB **590** in step S508 as it is, or may slightly change the UL timing group based on a current network state as shown in step S432 of FIG. **4**. This may indicate that the UE **580** may change the UL timing group when the UL timing group generated by the eNB **590** is inappropriate for an environment of the UE **580**.

That is, after receiving a UL timing group or after changing or newly generating a UL timing group, the UE **580** may select a delegate CC for each UL timing group (step S534). The conditions taken into consideration when a delegate CC is selected for each UL timing group have been described in step S434 of FIG. **4**.

After completing selection of a delegate CC for each UL timing group in step S534, when a UL synchronization needs to be obtained, the delegate CC in each group may set an RAP, and may transmit the selected preamble by selecting one of the resources defined in SI of each CC (step S540). The preamble may be included in a synchronization request message through which the UE requests synchronization.

Here, the UE **580** may transmit an RAP transmit message and the like for obtaining the UL timing information. Also, the corresponding preamble may be sequentially, simulta-

neously, or randomly selected and transmitted by the UE **580** in time/frequency resources set by the eNB **590**.

A case that requires the UE **580** to obtain a UL synchronization may be associated with conditions d-i) through d-iii). Also, the UE **580** may transmit a preamble to obtain a UL synchronization with respect to available total CC groups. The UE **580** may need to obtain a UL synchronization with respect to a few available CC groups.

The eNB **590** may calculate a TA value for each group with respect to each CC group (each delegate CC) based on the received RAP signal, and may include the corresponding TA value together with UL grant information in RAR information for transmission to UE **580** (step S**550**). The TA value may be an example of UL synchronization information required when the UE adjusts a UL transmission time.

For example, the eNB **590** may calculate a TA value based on the UL timing group set in step S**508**, and may transmit the calculated TA value. Also, the eNB **590** may transmit the RAR message through a predetermined CC, and may transmit the RAR message through all CCs in the corresponding UL timing group.

When the UE **580** determines that a TA value received in a CR procedure (step S**560**) is valid, the UE **580** may apply the TA value to remaining CCs in a group so as to update a TA value for each UL timing group (step S**570**).

FIG. **6** illustrates a process that obtains a UL synchronization according to still another embodiment of the present invention. Here, FIG. **6** shows that an eNB **690** configures a UL timing group and transmits group information through a separate message.

Referring to FIG. **6**, the eNB **690** determines a mode (RRC_CONNECTED/RRC IDLE) of a UE **680**. When the eNB **690** is not connected to the UE **680**, the eNB **690** may proceed with an RRC connection setup (step S**605**), and may use a PCell for RRC connection, which will be performed in the same manner as step S**405** of FIG. **4** and step S**505** of FIG. **5**.

The eNB **690** may allow the UE **680** to use a plurality of CCs based on a performance of hardware of the UE **680**, available frequency resources of the eNB **690**, and the like, and may define the plurality of CCs to be a CC set. The eNB **690** may transmit CC set information of the UE **680** to the UE **680** (step S**610**). A CC set information message provided for each UE may be a message used for an RRC (L3) message and the like or may be an L1 signaling or an L2 signaling.

As described in the foregoing, the UE **680** and the eNB **690** maintain the RRC_CONNECTED mode from step S**605** or before. That is, a UL synchronization of a UL CC through which the RRC connection of the UE **680** is set up is maintained. The UE **680** may receive the CC set information determined based on the above condition, from the eNB **690**. As one of the schemes of receiving the CC set information, the eNB **690** may include the CC set information in an RRC reconfiguration message for transmission, and other messages may be used for transmission.

The UE **680** may receive SI of CCs in a set based on the received CC set information (step S**620**).

The eNB **690** may set a UL timing group with respect to CCs assigned to the UE **580** (step S**624**). In the process of configuring the UL timing group in the eNB **690**, CCs may be configured to be different groups of at least two or to be the same group. The conditions a-i) through a-v) or b-i) through b-iv) may use to set a UL timing group.

A method for the eNB **690** to generate a group may include two schemes, that is, a scheme of generating groups by distinguishing CCs that belong to different groups and a scheme of generating a group by distinguishing CCs to be included in the same group. The two schemes may be used together or one of the two schemes may be used. Conditions to be used in a process of applying each scheme have been described in the foregoing.

The eNB **690** may transmit the UL timing group information to the UE **680** (step S**626**). The UL timing group information may not be included in the CC set information message and the like for transmission, and The UL timing group information may be transmitted independently with the CC set information through use of a separate message. The UL timing group information may be transmitted through a channel, such as a PDCCH channel, an RRC signaling, and a broadcasting channel, and may be transmitted through an L2 (MAC element control) message.

The UE **680** that receives the CC set information message may use the received UL timing group as it is, or may slightly change the UL timing group based on a current network state. This may include a case in which the UE **680** changes the UL timing group when the UL timing group generated by the eNB **690** is inappropriate for an environment of the UE **680**. After receiving the UL timing group or after changing or newly generating the UL timing group, the UE **680** may select a delegate CC for each UL timing group (step S**634**). The conditions taken into consideration when a delegate CC is selected for each UL timing group have been described in step S**434** of FIG. **4**, and step S**534** of FIG. **5**.

After completing selection of a delegate CC for each UL timing group in step S**634**, when a UL synchronization needs to be obtained, the delegate CC in each group may set an RAP, and may transmit the selected preamble by selecting one of the resources that are allocated for random access and defined in SI of each CC (step S**640**). The preamble may be sequentially, simultaneously, or randomly selected and transmitted by the UE **680** in time/frequency resources set by the eNB **690**. The preamble may be included in a synchronization request message through which the UE requests synchronization.

The eNB **690** may calculate a TA value for each CC group (each delegate CC) based on the received RAP signal, and may include the corresponding TA value together with UL grant information in RAR information for transmission to UE **680** (step S**650**). For example, the eNB **690** may calculate a TA value based on the UL timing group set in step S**624**, and may transmit the calculated TA value in advance. Also, the eNB **690** may transmit the RAR message through a predetermined CC, and may transmit the RAR message through all CCs in the corresponding UL timing group. The TA value may be an example of UL synchronization information required when the UE adjusts a UL transmission time.

When the UE **680** determines that a TA value received in a CR procedure (step S**660**) is valid, the UE **680** may apply the TA value to remaining CCs in a group so as to update a TA value for each UL timing group (step S**670**).

As described in FIG. **6**, the UE **680** may receive a set UL timing group from the eNB **690**, and may perform a random access procedure based on a representative value of a corresponding group. Subsequently, the UE **680** may receive a TA value of the timing group based on a preamble associated with the random access procedure, and may adjust a UL timing for obtaining synchronization.

FIG. **7** illustrates a process in which an eNB supports the UE to obtain a UL synchronization in response to a request from the UE according to an embodiment of the present invention.

Referring to FIG. **7**, the eNB determines an RRC mode of the UE (step S**702**). When the RRC mode between the eNB and the UE is an RRC_CONNECTED mode (step S**704**), the eNB may proceed with step S**710**.

When the RRC mode is different from the RRC_CONNECTED mode, the eNB may proceed with step S**705**. The eNB may determine whether an RRC connection request from the UE exists in step S**705**. The eNB may receive the RRC connection request from the UE (step S**705**), and may complete RRC connection (step S**706**). In this example, the eNB may receive an RRC connection request message from the UE, may transmit an RRC connection setup message, and may receive an RRC connection setup complete message from the UE so as to complete RRC connection. As described in steps S**405**, S**505**, and S**605**, a PCell may be used for RRC connection.

The eNB may set a CC set including at least one available CC with respect to an RRC_CONNECTED UE, and may transmit CC set information associated with the CC set to the UE (step S**710**).

The eNB may transmit SI associated with at least one predetermined CC in the CC set, based on the CC set information of the UE (step S**720**). Here, the CC set information may be transmitted through an RRC message. Also, the SI of the CC set may be transmitted through a broadcasting channel.

The eNB may determine whether a subject of generating a UL timing group is the eNB (step S**722**). When the UL timing group is generated by the eNB, the eNB may generate a UL timing group based on the CC set information of the UE, and may transmit information associated with the generated UL timing group to the UE (step S**726**). Here, the UL timing group information may be generated at the same point in time when the CC set information is generated and transmitted in step S**710**, or may be transmitted together with the CC set information.

The eNB may receive an RAP from the UE (step S**740**). The preamble may be included in a synchronization request message through which the UE requests synchronization. Step S**740** may include a case in which the subject of generating the UL timing group is the UE. That is, the UE may generate a UL timing group based on available CC set information of step S**710** and SI of a corresponding CC of step S**720**, may set a delegate CC for each timing group, and may transmit an RAP through a corresponding delegate CC. Therefore, the eNB may receive the preamble transmitted from the UE. Here, the eNB may receive a synchronization request message, for example, the preamble, simultaneously through a plurality of delegate CCs, or at separated time, that is, sequentially through a delegate CC for each UL timing group.

Subsequently, the eNB may transmit an RAR message with respect to the received preamble. In this example, the eNB may transmit UL grant information for the UE and TA information for each UL timing group along with the RAR message (step S**750**).

The TA value may be an example of UL synchronization information required when the UE adjusts a UL transmission time. Also, the TA information for each UL timing group may be transmitted through a plurality of delegate CCs, simultaneously or at separated time. Here, the TA information for each UL timing group may be transmitted in a form of a table including a TA value corresponding to a group index. Also, the TA information for each UL timing group may be transmitted in a form including a unit error for each timing group based on a reference TA value. In this example, the error for each group may be expressed by an integer-multiple of a predetermined unit value, or may be specified in detail. The TA information for each UL timing group may be transmitted in a form of an indicator indicating a TA based on a predetermined rule.

The eNB may transmit a CR message to the UE (step S**760**). This may include an operation that enables the UE to determine the validity of the received TA value and to update a TA value of a corresponding group.

FIG. **8** illustrates a process in which a UE obtains a UL synchronization through use of a UL timing group according to an embodiment of the present invention.

Referring to FIG. **8**, the UE may determine an RRC mode (step S**802**). When the RRC mode is different from an RRC_CONNECTED mode, that is, when the RRC mode is an IDLE mode, the UE may perform RRC connection setup.

Accordingly, the UE may select a predetermined CC through which RRC connection is performed (step S**806**), may transmit an RRC connection request message to the selected predetermined CC, may receive an RRC connection setup message from the eNB through the selected predetermined CC, and may transmit an RRC connection setup complete message to the eNB so as to complete RRC connection setup (step S**808**).

When the UE corresponds to the RRC_CONNECTED mode (step S**804**), whether a UL is continuously maintained may be determined (step S**810**).

When the UL is not maintained, step S**812** may be performed. In step S**812**, the UE may determine whether an RRC connection setup reconfiguration message is received from the eNB (step S**812**).

Here, when the RRC mode of the UE is the IDLE mode, or when the RRC connection setup reconfiguration is performed, the eNB may have difficulty in defining a CC set and transmitting CC set information. Accordingly, the UE may f-i) select a CC that is most appropriate for attempting RRC connection based on information measured by the UE, or may select at least one CC to perform RRC connection through use of one of f-ii) information fixedly set in a system and stored in an internal memory of the UE, f-iii) information transmitted to the UE from the eNB through SI, or f-iv) SI of available CCs stored in an internal memory of the UE and thus, may form the CC set information. When the mode of the UE is changed to the RRC_CONNECTED mode after completing RRC connection setup, step S**830** may be performed.

When the UE performs handover, the UE may determine the received RRC connection setup reconfiguration message (step S**814**), and determine mobility control information (MCI) (step S**816**). The UE may determine information to be used for obtaining synchronization of a corresponding CC from a target eNB (T-eNB), based on the MCI information. That is, the UE may obtain a UL synchronization from the T-eNB. When the UE does not perform handover, the UE may merely determine the received RRC connection setup reconfiguration message (step S**814**), and may not proceed with steps S**816** and S**818**.

In other words, when the UE does not perform handover in the process of obtaining a UL synchronization, the UE may proceed with a procedure for obtaining a UL synchronization between a source eNB (S-eNB) and a corresponding CC so as to obtain the UL synchronization. As another example, when the UE performs handover, the UE may proceed with a procedure for obtaining a UL synchronization of a corresponding CC based on SI of a CC of a T-eNB received from an S-eNB, so as to obtain the UL synchronization. Desirably, a random access procedure may be used, and other procedures may also be applicable.

Subsequently, to obtain synchronization with the S-eNB or the T-eNB, the UE may select a preamble and may transmit the preamble to the S-eNB or the T-eNB (step S820). The preamble may be included in a synchronization request message through which the UE requests synchronization. The UE may receive an RAR message from the S-eNB or the T-eNB in response to transmission of the preamble. In the RAR message, UL grant information for the UE and TA information for each group including at least one CC to be used for obtaining a UL synchronization may be included (step S822).

The UE may verify whether the TA received through a CR procedure in step S822 is valid (step S824), and the UE may update a UL timing group including at least one CC based on the received TA value (step S826) when the UE determines that the TA is valid.

When the RRC connection setup reconfiguration message is not received, step S820 may be performed.

When a UL is maintained or when the UE obtains a UL synchronization, the UE may receive CC set information from the eNB (step S830). Also, the UE may receive SI of the received CC set (step S832).

Subsequently, the UE may determine whether UL timing group information is received (step S840). In this example, when the UL timing group information is generated by the eNB, the UE may receive the UL timing group through the CC set information receiving process or through a separate message. The UL timing group information may include delegate CC information for each group. When the delegate CC information for each group is included in the UL timing group, step S852 may not be performed. When the delegate CC information for each group is not included in the UL timing group, the UE may determine the received UL timing group, and may set a delegate CC for the corresponding UL timing group (step S852). The delegate CC may be set based on the conditions c-i) through c-v) of FIG. 4. Also, the delegate CC used for adjusting a TA value of each UL timing group may be set by applying the same criterion to all groups, or by applying a different criterion based on a characteristic of each UL timing group.

When the UL timing group information is not received or when the received timing group is inappropriate for a radio network state where the UE is located or inappropriate for the UE, the UE may set UL timing group information based on the received CC set information (step S850). Also, the UE may set a predetermined CC in the set UL timing group, as a delegate CC for the timing group (step S852).

The UE may select a preamble and may transmit the preamble through the delegate CC (step S854). This may also be applicable when a TA needs to be updated after the delegate CC is set.

The UE may receive an RAR message from the eNB. In this example, the UE may receive UL grant information for the UE and the TA information for each UL group (step S856). Here, the UE may determine a TA value in a form of a table corresponding to a group index of each UL timing group. Also, the UE may determine a TA difference value in a form including a unit error for each timing group based on a predetermined reference TA value. Also, the UE may determine an error for each UL timing group that has a size of an integer-multiple of a predetermined unit value, and may also determine an error for each UL timing group that is specified in detail. Also, the UE may determine a TA indicator determined to be an indicator based on a predetermined rule.

Subsequently, the UE may verify the validity of a TA through a CR procedure (step S860).

When the UE determines that the TA is valid, the UE may update a TA value for each UL timing group (step S870).

Here, the UE may transmit the updated TA value for each UL timing group to the eNB through a delegate CC. That is, a procedure of determining the TA value may be additionally performed to obtain accurate synchronization with the eNB.

FIG. 9 illustrates operations of a UE according to an embodiment of the present invention. Here, FIG. 9 shows the operations of the UE when setting of an initial UL timing group is performed in an eNB.

Referring to FIG. 9, the UE may receive CC set information from the eNB (step S972). The CC set information may be received via a PCC or a Pcell. The PCC may correspond to the PCell as described in the foregoing. A UE in an IDLE mode may select a single DL CC based on the condition described in the foregoing, for RRC connection, and may receive SI through a broadcasting channel transmitted through the selected CC. The CC set information may be transmitted through an RRC message.

The UE may receive SI associated with CCs in the CC set, based on the received CC set information (step S974). The SI may be transmitted to a plurality of UEs in common through a broadcasting channel or may be transmitted through an RRC message in a form of a dedicated channel. The SI may be transmitted through the PCC. Accordingly, the UE may configure UL CCs in the CC set based on the SI.

In step S974, the UE may receive an RAP of each CC or information associated with time/frequency resources to be used by the UE, from the eNB. The UE may configure an initial UL timing group based on the received RAP of each CC or the information associated with the time/frequency resources. The RAP or the information associated with the time/frequency resources may be included in the SI for transmission through the PCC, or may be transmitted in a form of an RRC message.

The UE may determine whether simultaneous transmission of the RAP through all UL CCs configured for obtaining a UL synchronization is possible, based on CC parameters and RACH information included in the received SI (step S976).

Here, the UE may determine a UE-specific RACH parameter from among RACH parameters of the UL CCs configured by the eNB.

In this example, when RAP information is set in the UE-specific RACH parameter, the UE may determine the RAP information of the UE and may set an RAP to be transmitted through each of the configured UL CCs. Here, the RAP information may be preamble information set to be different for each UE for distinguishing the UEs.

When time/frequency resource information is set in the UE-specific RACH parameter, the UE may determine the time/frequency resource information of the UE, and may set an RAP to be transmitted to the configured UL CCs. Here, the time/frequency resource information may be set by the eNB to be different for each UE.

When simultaneous transmission of the RAP through all the configured UL CCs is possible in step S976, the UE may simultaneously transmit the RAP (step S978).

Conversely, when it is determined that the UE is incapable of simultaneously transmitting the RAP through all the UL CCs in step S976, the UE may proceed with step S990.

With respect to the simultaneous transmission of the RAP, the UE may determine RACH parameters included in SI of each of a plurality of UL CCs, and determine a plurality of time/frequency resources defined in the RACH parameters, and may select a RAP transmission time (rach_t) for trans-

mitting the RACH at the same time. The RAP transmission time (rach_t) may correspond to a time when the RAPs are simultaneously transmitted by the UE through all the UL CCs.

When the UE is incapable of setting the RAP transmission time (rach_t), that is, when the UE is incapable of transmitting the RAP through all the configured UL CC at the same time, the UE may transmit an RAP resource information request message to the eNB (step **S990**).

For example, it is assumed that a time for determining the RACH parameters of all the UL CCs and transmitting RAP is limited to t**0** and t**1**. When the UE determines that transmitting RAP through CC**1**, CC**3**, and CCN is allowed at t**0**, and is not allowed at t**1**, and the UE determines that transmitting RAP through CC**2** is allowed at t**1**, and is not allowed at t**0**, the UE may transmit an RAP resource information request message to the eNB.

Subsequently, in response to the RAP resource information request, the UE may receive an RAP resource information response message from the eNB (step **S992**). Here, the eNB that receives the RAP resource information request message may determine that the UE is incapable of simultaneously transmitting the RAP through all the CCs. Therefore, the eNB may include transmission time/frequency resource to be used for RAP transmission of the UE and a type of a preamble in the RAP resource information response message for transmission to the UE.

Accordingly, the UE may transmit the RAP through all UL CCs configured based on information included in the RAP resource information response message (step **S994**). When the RAP resource information does not exist in the RAP resource information response message received from the eNB, a time that is closest to the time when the RAP needs to be transmitted may be selected so that the RAP may be simultaneously transmitted through all the UL CCs. In this example, the same RAP may be selected from all the CCs and may be simultaneously transmitted.

Subsequently, the UL timing group information may be received from the eNB through a PCC. That is, the eNB may determine RAPs transmitted from the UE, may determine that the UE requests configuration of a UL timing group, may calculate a TA value based on the preambles received through the RAPs, and may generate the UL timing group of the UE based on the calculated TA. The UL timing group information of the generated UL timing group may be transmitted to the UE.

The UL timing group information may be received through the PCC (PCell) in a form of a PDCCH or control information of a MAC message, or may be received through an RRC message.

The UE may simultaneously receive RAR from the eNB through a few or all of DL CCs having linkages with all the configured UL CCs (step **S982**). The linkage may be set fixedly in a wireless communication system, or may be set for each eNB based on SI, or may be set for each UE or for each UE group based on an RRC message.

The RAR message may include, for example, identification information of the UE preamble received by the eNB, an identifier (ID) of the eNB, a temporary C-RNTI, information associated with a time slot where the UE preamble is received, UL grant information, TA information for obtaining a UL synchronization, and the like.

Accordingly, the UE may transmit data through a PUSCH through use of time/frequency resource information included in the UL grant information at a scheduled time determined based on the received TA information, and may perform HARQ.

The UE may simultaneously verify the validity of the TA with respect to CCs through which the RAR is received (step **S984**). In this example, when RAP information is set in the UE-specific RACH parameter, the UE may omit verifying the validity of the TA.

As described in the foregoing, the UE may determine whether C-RNTI, T_C-RNTI, or UE identity included in an ACK message received from the eNB is identical to C-RNTI, T_C-RNTI, or UE identity assigned to the UE, so as to simultaneously verify the validity of the TA. Here, the UE may transmit an L2/L3 message including the C-RNTI, the T_C-RNTI, or the UE identity to the eNB, and may receive an L1/L2 message from the eNB since the ACK message is based on the HARQ operation.

The UE may recognize that the eNB sets UL CCs having linkages with the received DL CC through which the RAR is received as delegate CCs in a group, and may set the UL CCs as the delegate CCs in the group (step **S986**).

The UE may apply a TA value of the delegate CC received in step **S972** to remaining CCs in each group for updating (step **S988**).

FIG. **10** illustrates a configuration of a transmitting apparatus according to an embodiment of the present invention.

Referring to FIG. **10**, a transmitting apparatus **1000** may include a connection mode determining unit **1005** to determine an RRC mode of a UE, a CC set determining unit **1020** to determine a CC set including at least one CC available to the UE, a UL timing group generating unit **1030** to generate a UL timing group, a transceiving unit **1050**, and a controller **1010** to control the above component elements.

The controller **1010** may generate UL synchronization information corresponding to the UL timing group, so as to establish a UL synchronization. The transceiving unit **1050** may receive a synchronization request message from the UE through at least one delegate CC in the UL timing group, and may transmit the UL synchronization information to the UE through the at least one delegate CC. The at least one delegate CC may be selected by the UE based on a state of the UL timing group and characteristics of a plurality of CCs forming the UL timing group, so as to obtain the UL synchronization. In particular, the at least one delegate CC may correspond to at least one of c-i) through c-v). The CC may be included in the serving cell as described in the foregoing.

In particular, the RRC mode determining unit **1005** may determine a connection mode between the UE and the eNB, and when the UE and the eNB are not connected, that is, when the connection mode is an RRC_IDLE mode or UL synchronization is not established, the RRC mode determining unit **1005** may change the connection mode of the UE to an RRC_CONNECTED mode or may enable the UL synchronization to be established. In this example, RRC connection setup may be performed through use of the UE and a PCC as described in the foregoing.

For example, the RRC mode determining unit **1005** may operate the transceiving unit **1050** to receive an RRC connection request transmitted from the UE, and to transmit an RRC connection setup message to the UE. Also, the RRC mode determining unit **1005** may receive an RRC connection setup complete message from the UE, may complete the RRC connection setup, and may determine an UE RRC_CONNECTED mode.

The CC set determining unit **1020** may determine at least one CC available to the UE, and may set a CC set of the UE. In this example, the CC set for the UE may be set based on a difference in UL synchronization times of the available (configurable) CCs, type information of each CC, a center

frequency location of each CC, a service type of each CC, a network service for each CC, and the like.

The controller **1010** may set the CC set determined by the CC set determining unit **1020** as a CC set to be used by the UE, and the transceiving unit **1050** may transmit information associated with the set CC set to the UE through a PCell or a primary CC, before receiving the synchronization request message.

The UL timing group generating unit **1030** may generate the UL timing group of the UE based on the CC set determined by the CC set determining unit **1020**. Here, the UL timing group may be generated to satisfy at least one of the conditions a-i) through a-v) or b-i) through b-iv), and may be determined by comparing a difference in center frequency values of CCs with a threshold, determining whether the CCs have the same beamforming scheme or different beamforming schemes, determining whether the CCs are updated in response to a UL synchronization update request, or determining whether the CCs correspond to CCs that are incapable of providing services in a macrocell but are capable of providing services in a space superposed by a cell smaller than the macrocell, such as a femtocell, a picocell, a microcell, a relay, a repeater, and the like.

The transceiving unit **1050** may transmit the CC set information and UL timing group information to the UE. In this example, the transceiving unit **1050** may transmit the UL timing group information together with the CC set information as shown in FIG. **5**, or may transmit the UL timing group information and the CC set information separately as shown in FIG. **6**. Also, the transceiving unit **1050** may additionally transmit SI after transmitting the CC set information. Therefore, the UE may be able to configure the UL timing group based on the CC set information and the SI.

The transceiving unit **1050** may receive, from the UE, the synchronization request message requesting synchronization, for example, a message including an RAP. That is, the RAP transmitted through the delegate CC determined by the UE for the UL timing group may be determined, and a TA value for each UL timing group may be transmitted. The synchronization request message may be received through at least one delegate CC, simultaneously or sequentially at separated time.

The transceiving unit **1050** may change a portion or all of the UL timing group determined by the UL timing group generating unit **1030**, based on the RAP message transmitted from the UE.

The controller **1010** may control the transceiving unit **1050** to generate information associated with synchronization based on the received RAP, for example, a message including UL grant information, TA information associated with the synchronization, and the like, and to transmit the generated information to the UE. In this example, the message including the TA information may include an RAR message. The information associated with the synchronization may include TA information required to move up a UL transmission time. Therefore, the controller **1010** may control the transceiving unit **1050** to generate and transmit synchronization information with respect to the UL timing group.

Here, the controller **1010** may generate TA information for each UL timing group in a form of a table including a TA value corresponding to a group index, in a form of a TA value including a unit error for each timing group. The error for each timing group may have a size of an integer-multiple of a predetermined unit value, or may be specified in detail. Also, the controller **1010** may control the transceiving unit **1050** to transmit the TA information for each UL timing group as an indicator indicating a TA based on a predetermined rule. The TA value may be an example of the UL synchronization information required when the UE adjusts a UL transmission time, and the synchronization information for the UL timing group may be transmitted through one or more delegate CCs, simultaneously or at separated time.

The UL synchronization information, as described in the foregoing, may be calculated by comparing, with a predetermined threshold, a difference in center frequency values of a plurality of CCs in the CC set configured for the UE, or may be calculated to enable the CCs to have different transmission times by determining whether the CCs correspond to CCs having the same beamforming scheme, correspond to CCs updated in response to a synchronization update request, or correspond to CCs that do not provide services in a macrocell but provide services in a space superposed by a coverage cell smaller than the macrocell.

Also, the controller **1010** may control all component elements, and a few component elements may independently operate. The component elements of FIG. **10** may be configured as a single module or two or more modules, or may be configured to perform a single function in two or more modules.

FIG. **11** illustrates a configuration of a receiving apparatus according to an embodiment of the present invention.

Referring to FIG. **11**, a receiving apparatus **1110** may include a connection mode determining unit **1105**, a CC set determining unit **1107**, a controller **1110**, a UL timing adjusting unit **1120**, a UL timing group generating unit **1130**, and a transceiving unit **1150**.

The transceiving unit **1150** may transmit a synchronization request message to an eNB through one or more CCs in a UL timing group, and may receive UL synchronization information through the one or more CCs. The controller **1110** may control the transceiving unit. The controller **1110** may determine the UL synchronization information received through the transceiving unit. The UL timing adjusting unit **1120** may establish a UL synchronization of the UL timing group based on the UL synchronization information determined by the controller. That is, the UL timing adjusting unit **1120** may establish the UL synchronization of the UL timing group based on the UL synchronization information received through the transceiving unit. Here, the controller **1110** may determine UL grant information and a TA value calculated to adjust a UL transmission time for each group corresponding to the UL timing group, through an RAR message received in response to the synchronization request message transmitted through the transceiving unit. The UL timing adjusting unit **1120** may establish a UL synchronization based on the UL synchronization information determined by the controller. In this example, the UL timing adjusting unit **1120** may establish the UL synchronization based on a TA value distinguished based on the UL timing group, based on a unit error distinguished based on the UL timing group, or based on an error distinguished based on the UL timing group and having a size of an integer-multiple of a determined unit value, or using an indicator associated with a rule determined based on the UL timing group. The UL synchronization information may be distinguished based on a group index of the UL timing group.

Here, the one or more delegate CCs may be selected by the UE based on a state of the UL timing group and characteristics of a plurality of CCs forming the UL timing group, so as to obtain the UL synchronization. In particular, the one or more delegate CCs may correspond to at least one of c-i) through c-v). The CCs may be included in a serving cell as described in the foregoing.

In particular, the connection mode determining unit **1105** may determine a connection mode with the eNB. That is, when the connection mode is an UE RRC_IDLE mode or UL synchronization with the eNB is not established, the connection mode determining unit **1105** may enable the UE to change the connection mode to an RRC_CONNECTED mode or enable the UL synchronization to be established. In this example, RRC connection setup may be performed through use of the UE and a PCC as described in the foregoing.

For example, the connection mode determining unit **1005** may transmit an RRC connection request message to the eNB through use of the transceiving unit **1050**, may receive an RRC connection setup message from the eNB, and may complete RRC connection setup through use of an RRC connection setup complete message.

The transceiving unit **1150** may perform transmission and reception of information with the eNB. For example, the transceiving unit **1150** may receive CC set information and information associated with synchronization from the eNB. In particular, the transceiving unit **1150** may receive the CC set information from the eNB through a PCell or a primary CC, before transmitting the synchronization request message. After receiving the CC set information, the transceiving unit **1150** may receive SI associated with the CCs in the CC set, from the eNB. The SI may include frequency band information of a CC, information associated with an available frequency magnitude, and the like.

The CC set determining unit **1107** may determine at least one CC available to the UE, from the CC set information. The CC set may be determined based on a difference in UL synchronization times of the CCs available to the UE, type information of each CC, a center frequency location of each CC, a service type of each CC, a network service for each CC, and the like.

The UL timing group generating unit **1130** may generate a UL timing group of the UE based on the CC set determined by the CC set determining unit **920**. Here, the UL timing group may be configured by the UE based on the conditions described in FIG. **10** (at least one of conditions a-i) through a-v) or b-I through b-iv)). Also, the UL timing group generating unit **1130** may select a delegate CC of the UL timing group.

For example, when the UL timing group generating unit **1130** receives, from the eNB, UL timing group information of CCs together with the CC set information, the UL timing group generating unit **1130** may select a delegate CC from the received UL timing group. Also, the UL timing group generating unit **1130** may receive, through the transceiving unit **1150**, the UL timing group information separately from the CC set information, through a separate signaling.

Therefore, when the transceiving unit **1150** does not receive the UL timing group information of CCs or the UL timing group information generated by the eNB is inappropriate for a network state of the UE, the UL timing group generating unit **1130** may configure a new UL timing group.

Also, the controller **1110** may control the transceiving unit **1150** to transmit a synchronization request message requesting synchronization to the eNB through the delegate CC, and to receive information associated with synchronization from the eNB through the delegate CC.

For example, the controller **1110** may control the transceiving unit **1150** to transmit a message including a RAP selected by the UE, and to receive an RAR message transmitted from the eNB. Also, the controller **1110** may control the transceiving unit **1150** to perform, with the eNB, transmission and reception of a message for RRC reconfiguration and synchronization. The synchronization request message may be transmitted through one or more delegate CCs simultaneously or at separated time.

Also, the controller **1110** may control the UL timing group generating unit **930** to change a portion or all of the determined UL timing group, based on the RAR message.

In particular, the controller **1110** may perform controlling so as to determine a TA value associated with each UL timing group based on the set UL timing group included in the RAR message. Also, the controller **1110** may perform controlling so as to determine frequency resource information assigned for UL transmission of the UE.

The UL timing adjusting unit **1120** may determine the TA value determined by the controller **1110**, and may apply the TA value to all CCs of the corresponding UL timing group where the delegate CC is included. That is, the TA value may be applied to the corresponding UL timing group for synchronization with the eNB. Here, TA information for each UL timing group may be in a form of a table including a TA value corresponding to a group index, in a form of a TA value including a unit error for each timing group, in a form of an error having a size of an integer-multiple of a predetermined unit value, for each timing group, in a form of an error specified in detail for each timing group, or in a form of an indicator indicating a TA based on a predetermined rule. Therefore, the UL timing adjusting unit **1120** may obtain synchronization by applying a determined TA to each UL timing group. The TA value may be an example of UL synchronization information required when the UE adjusts a UL transmission time, and the synchronization information for the UL timing group may be received through one or more delegate CCs simultaneously or at separated time.

For example, when the TA information is included in the synchronization information, the TA information may be set equally to all CCs in the UL timing group.

As described in the foregoing, the controller **1110** may control all component elements, and a few component elements may independently operate. The component elements of FIG. **11** may be configured as a single module or two or more modules, and may be configured to perform a single function in two or more modules.

Based on the descriptions of FIG. **9**, the transceiving unit **1150** may receive SI of CCs in the CC set based on the CC set information, and the controller **1110** may control the transceiving unit **1105** to simultaneously transmit the synchronization request message to the eNB through all UL CCs in the CC set, based on the received SI.

Subsequently, the transceiving unit **1105** may receive UL timing group information from the eNB, and simultaneously receive UL synchronization information through a few or all of DL CCs associated with the received UL timing group, and the controller **1110** may set a UL CC associated with a CC through which the UL synchronization information is received as a delegate CC of the received UL timing group.

Therefore, according to an embodiment of the present invention, when a plurality of CCs is used, a different UL synchronization may be obtained for each CC or for each CC group and thus, when the UE transmits information in a UL through a plurality of CCs, data transmission error due to an error in obtaining synchronization and delay in receiving information in the eNB may be effectively reduced.

Also, when a UL synchronization standard is different for each of the plurality of CCs, the UE may obtain a UL synchronization based on a type of each CC, a center frequency location, and a service type.

What is claimed is:

1. A communication method for a user equipment (UE) comprising:

receiving, at the UE, a Radio Resource Control (RRC) message through a primary Component Carrier (CC), wherein the primary CC belongs to a first uplink (UL) timing group, the RRC message comprises information related to a second UL timing group, which has been set by an evolved Node B (eNB), the second UL timing group includes a secondary CC;

receiving, at the UE, information indicating a random access preamble;

transmitting, at the UE, the random access preamble according to a non-contention selection, through one or more CCs, each of the one or more CCs transmitting the random access preamble being set as a delegate CC for a respective second UL timing group;

receiving, at the UE, a random access response through the primary CC, the random access response includes a Timing Advanced (TA) value that is calculated to adjust a UL transmission time for the second UL timing group in response to the transmitted the random access preamble, together with UL grant information for the UE, wherein each TA value is transmitted from the eNB for the respective second UL timing group based on the transmitted random access preamble associated with the delegate CC of the respective second UL timing group; and

applying each TA value to the secondary CC for the respective second UL timing group.

2. The method of claim 1, wherein the one or more delegate CCs correspond to at least one of i) a CC having a lowest center frequency value, ii) a CC having a center frequency value that is closest to a mean value, iii) a CC having a highest center frequency value, iv) a CC having a broadest frequency band, and v) a CC that is set to be used for monitoring downlink (DL) quality, from among a plurality of CCs forming the second UL timing group; and the CC is included in one or more serving cells.

3. The method of claim 1, wherein the second UL timing group is configured of i) at least one CC having a difference in a center frequency value within a threshold range, ii) at least one CC to which a same beamforming scheme is applied, iii) at least one CC used in devices in a same radio network, or iv) at least one CC that does not belong to another second UL timing group, from among a plurality of CCs; and the second UL timing group is generated by the UE or the eNB.

4. The method of claim 1, wherein the random access response is configured to include the TA value distinguished based on the second UL timing group, to include a unit error distinguished based on the second UL timing group, or to include an error distinguished based on the second UL timing group and having a size of an integer-multiple of a predetermined unit value, or is configured as an indicator associated with a rule determined based on the second UL timing group, and the random access response is distinguished based on a group index of the second UL timing group.

5. A communication apparatus for a user equipment (UE) comprising:

a memory; and

a processor operably coupled to the memory;

wherein the processor, when executing program instructions stored in the memory, is configured to:

cause the apparatus to receive a Radio Resource Control (RRC) message through a primary Component Carrier (CC), wherein the primary CC belongs to a first uplink (UL) timing group, the RRC message comprises information related to a second UL timing group, which has been set by an evolved Node B(eNB), the second UL timing group includes a secondary CC;

cause the apparatus to receive information indicating a random access preamble;

cause the apparatus to transmit the random access preamble according to a non-contention selection, through one or more UL CCs, each of the one or more UL CCs transmitting the random access preamble being set as a delegate CC for a respective second UL timing group;

cause the apparatus to receive a random access response through the primary CC, the random access response includes a Timing Advanced(TA) value that is calculated to adjust a UL transmission time for the second UL timing group in response to the transmitted the random access preamble, together with UL grant information for the UE, wherein each TA value is transmitted from the eNB for the respective second UL timing group based on the transmitted random access preamble associated with the delegate CC of the respective second UL timing group; and

cause the apparatus to apply each TA value to the secondary CC for the respective second UL timing group.

6. The UE of claim 5, wherein the one or more delegate CCs correspond to at least one of i) a CC having a lowest center frequency value, ii) a CC having a center frequency value that is closest to a mean value, iii) a CC having a highest center frequency value, iv) a CC having a broadest frequency band, and v) a CC that is set to be used for monitoring downlink (DL) quality, from among a plurality of CCs forming the second UL timing group; and the CC is included in one or more serving cells.

7. The UE of claim 5, wherein the second UL timing group is configured of i) at least one CC having a difference in a center frequency value within a threshold range, ii) at least one CC to which a same beamforming scheme is applied, iii) at least one CC used in devices in a same radio network, or iv) at least one CC that does not belong to another second UL timing group, from among a plurality of CCs; and the second UL timing group is generated by the UE or the eNB.

8. The UE of claim 5, wherein the random access response is configured to include the TA value distinguished based on the second UL timing group, to include a unit error distinguished based on the second UL timing group, or to include an error distinguished based on the second UL timing group and having a size of an integer-multiple of a predetermined unit value, or is configured as an indicator associated with a rule determined based on the second UL timing group, and the random access response is distinguished based on a group index of the second UL timing group.

9. A communication method for an evolved Node-B (eNB) comprising:

transmitting, to a user equipment (UE), a Radio Resource Control (RRC) message through a primary Component Carrier (CC), wherein the primary CC belongs to a first uplink (UL) timing group, the RRC message comprises information related to a second UL timing group, the second UL timing group includes a secondary CC;

transmitting, to the UE, information indicating a random access preamble;

receiving, from the UE, the random access preamble according to a non-contention selection, through one or more UL CCs, each of the one or more UL CCs

transmitting the random access preamble being set as a delegate CC for a respective second UL timing group; and

transmitting, to the UE, a random access response through the primary CC, the random access response includes a Timing Advanced (TA) value to adjust a UL transmission time for the second UL timing group in response to the transmitted the random access preamble, together with UL grant information for the UE,

wherein each TA value is calculated by the eNB for the respective second UL timing group based on the received random access preamble associated with the delegate CC of the respective second UL timing group, and

wherein the TA value is configured to be applied to the secondary CC for respective second UL timing group.

10. The method of claim **9**, wherein the one or more delegate CCs correspond to at least one of i) a CC having a lowest center frequency value, ii) a CC having a center frequency value that is closest to a mean value, iii) a CC having a highest center frequency value, iv) a CC having a broadest frequency band, and v) a CC that is set to be used for monitoring downlink (DL) quality, from among a plurality of CCs forming the second UL timing group; and the CC is included in one or more serving cells.

11. The method of claim **9**, wherein the second UL timing group is configured of i) at least one CC having a difference in a center frequency value within a threshold range, ii) at least one CC to which a same beamforming scheme is applied, iii) at least one CC used in devices in a same radio network, or iv) at least one CC that does not belong to another second UL timing group, from among a plurality of CCs; and the second UL timing group is generated by the UE or the eNB.

12. The method of claim **9**, wherein the random access response is configured to include the TA value distinguished based on the second UL timing group, to include a unit error distinguished based on the second UL timing group, or to include an error distinguished based on the second UL timing group and having a size of an integer-multiple of a predetermined unit value, or is configured as an indicator associated with a rule determined based on the second UL timing group; and the random access response is distinguished based on a group index of the second UL timing group.

13. A communication apparatus for an evolved Node-B (eNB) comprising:

a memory; and

a processor operably coupled to the memory;

wherein the processor, when executing program instructions stored in the memory, is configured to:

cause the apparatus to transmit, to a user equipment (UE), a Radio Resource Control (RRC) message through a primary Component Carrier (CC), wherein the primary CC belongs to a first uplink (UL) timing group, the RRC message comprises information related to a second UL timing group, the second UL timing group includes a secondary CC;

cause the apparatus to transmit, to the UE, information indicating a random access preamble;

cause the apparatus to receive, from the UE, the random access preamble according to a non-contention selection, through one or more UL CCs, each of the one or more UL CCs transmitting the random access preamble being set as a delegate CC for a respective second UL timing group; and

cause the apparatus to transmit, to the UE, a random access response through the primary CC, the random access response includes a Timing Advanced (TA) value to adjust a UL transmission time for the second UL timing group in response to the received the random access preamble, together with UL grant information for the UE,

wherein each TA value is calculated by the eNB for the respective second UL timing group based on the received random access preamble associated with the delegate CC of the respective second UL timing group, and

wherein the TA value is configured to be applied to the secondary CC for respective second UL timing group.

14. The eNB of claim **13**, wherein the one or more delegate CCs correspond to at least one of i) a CC having a lowest center frequency value, ii) a CC having a center frequency value that is closest to a mean value, iii) a CC having a highest center frequency value, iv) a CC having a broadest frequency band, and v) a CC that is set to be used for monitoring downlink (DL) quality, from among the plurality of CCs forming the second UL timing group; and the CC is included in one or more serving cells.

15. The eNB of claim **13**, wherein the second UL timing group is configured of i) at least one CC having a difference in a center frequency value within a threshold range, ii) at least one CC to which a same beamforming scheme is applied, iii) at least one CC used in devices in a same radio network, or iv) at least one CC that does not belong to another UL timing group, from among the plurality of CCs; and the second UL timing group is generated by the UE or the eNB.

16. The eNB of claim **13**, wherein the random access response is configured to include the TA value distinguished based on the second UL timing group, to include a unit error distinguished based on the second UL timing group, or to include an error distinguished based on the second UL timing group and having a size of an integer-multiple of a predetermined unit value, or is configured as an indicator associated with a rule determined based on the second UL timing group; and the random access response is distinguished based on a group index of the second UL timing group.

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EXHIBIT D TO REMAIN UNDER SEAL

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
TEXARKANA DIVISION

PANTECH CORPORATION and PANTECH WIRELESS, LLC, Plaintiffs, v. ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD., Defendant.	C.A. No. 5:22-cv-00069-RWS-JBB **JURY TRIAL DEMANDED** [redacted]

ORDER GRANTING DEFENDANT
ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD.'S
RULE 50(B) MOTION FOR JUDGMENT AS A MATTER OF LAW

This matter has come before Court on Defendant OnePlus Technology (Shenzhen) Co., Ltd.'s ("OnePlus") Rule 50(b) Motion for Judgment as a Matter of Law ("Motion"). The Court being familiar with the Motion, the applicable law, and the relevant facts, finds that the Motion should be **GRANTED**. It is hereby **ORDERED, ADJUDGED, and DECREED** that the Motion is **GRANTED**.