

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD., AND
SAMSUNG ELECTRONICS AMERICA, INC.,

Petitioners,

v.

HANNIBAL IP LLC,

Patent Owner.

Case IPR2025-01189
U.S. Patent No. 11,368,911

DECLARATION OF APOSTOLOS K. KAKAES, PH.D.

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I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. and Samsung Electronics America, Inc., (collectively “Petitioners”) as a technical expert in connection with a petition for *inter partes* review (“IPR”) of U.S. Patent No. 11,368,911 (“the ’911 patent,” Ex. 1001). I understand that the ’911 patent is assigned to Hannibal IP, LLC (“Hannibal” or “Patent Owner”).

2. I am over 21 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein.

3. I am being compensated for my time in this matter at an hourly rate. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this matter. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this matter. I have no personal or financial stake or interest in the outcome of the present proceeding.

4. I understand that this proceeding involves U.S. Patent No. 11,368,911 (“the ’911 patent,” Ex. 1001). The application for the ’911 was filed April 27, 2020, as U.S. Patent Application No. 16/859,945 (“the ’945 application”). The ’911 patent claims priority to U.S. Provisional application No. 62/840,451, filed on April 30, 2019. Ex. 1001, Cover.

5. I have been asked, by counsel for Petitioners, to provide opinions based on my experience with and expertise in wireless communication technologies. In particular, I have been asked to offer opinions regarding the patentability of claims 1-18 of the '911 patent (the "Challenged Claims") in view of certain prior art references and the knowledge of a person of ordinary skill in the art ("POSITA"). My opinions are set forth below.

6. I have been asked by Petitioners to provide my opinion whether the Challenged Claims of the '911 patent were anticipated and/or would have been obvious to a POSITA at the time of the earliest priority date of the '911 patent. In performing my analysis, I have been asked to assume that the earliest priority date of the Challenged Claims of the '911 patent is the earliest claimed priority date, namely April 30, 2019.

7. Throughout this declaration, I refer to specific pages, figures, and/or line numbers of various exhibits. These citations are illustrative and are not intended to suggest that they are the only support for the propositions for which they are cited.

II. SUMMARY OF OPINIONS

8. This declaration considers claims 1-18 of the '911 patent. Below, I set forth the opinions I have formed, the conclusions I have reached, and the bases for

these opinions and conclusions. I believe the statements contained in this declaration to be true and correct to the best of my knowledge.

9. Based on my experience, knowledge of the art at the time of the applicable priority date (I was told to assume a priority date of April 30, 2019), it is my opinion that claims 1-18 of the '911 patent would have been anticipated and/or obvious based on the asserted grounds discussed below.

10. I am being compensated for my time at my normal hourly rate. My compensation is in no way contingent upon the nature of my findings, the presentation of my findings in testimony, or the outcome of this proceeding.

III. QUALIFICATIONS AND PROFESSIONAL BACKGROUND

11. I believe that I am well qualified to serve as a technical expert in this matter based upon my qualifications, discussed in detail below. A copy of my curriculum vitae is included as Exhibit 1004.

12. I am competent to write this Declaration.

13. I have personal knowledge and expertise concerning the relevant technologies based upon my education, training, or experience. My relevant experience includes a deep understanding of the systems that we broadly refer to as “1G,” “2G,” “3G,” “4G,” “LTE,” and “5G” communications systems, as well as other wireless communication technologies, including those based on the IEEE

802.11 set of standards (often referred to as WiFi) as well as those related to IEEE 802.16 set of standards (often referred to as WiMAX).

14. I am an expert in the field of communication engineering and specifically, among others, the field of wireless communications. I have over 40 years of experience in electrical engineering and computer science and in fixed and mobile communications networks. I attended the University of Colorado from 1974 to 1980, during which I earned a Bachelor of Science (B.S.) and a Master of Science (M.S.) in applied mathematics with a minor in electrical engineering. I attended the Polytechnic Institute of New York between 1982 and 1988, during which I earned a Doctor of Philosophy (Ph.D.) in electrical engineering, with a minor in applied mathematics. My Ph.D. thesis was titled “Topological Properties and Design of Multihop Packet Radio Networks.” While pursuing my Ph.D. degree, I held a joint appointment as Special Research Fellow and Adjunct Instructor at the Polytechnic Institute of New York between 1985 and 1986 teaching graduate-level courses in Electrical Engineering.

15. Between 1982 and 1987, I worked at AT&T Bell Laboratories in Holmdel, New Jersey. While at AT&T Bell Laboratories, I worked on modeling, analysis, design, and performance evaluation of voice and data networks. I developed algorithms for DNHR (Dynamic, Non-Hierarchical Routing) used in the telephone network. I also analyzed advanced data services and formulation of

long-term plans for development of enhanced data services and network design tools to support such services.

16. I was an Assistant Professor of Electrical Engineering and Computer Science at The George Washington University (GWU) in Washington, D.C., between 1987 and 1994. During my association with GWU, I taught graduate courses in the area of communication engineering, including communication theory, coding theory, voice and data networking, and mobile communications. In the early 1990s I developed and taught the first course on Mobile Communications at GWU to Electrical Engineering graduate students. I also received several research awards/grants, including the prestigious NSF Research Initiation Award.

17. In 1988, I founded Cosmos Communications Consulting Corporation (“Cosmos”), which is a private communications engineering consulting firm specializing in mobile communications, and I have been the President of the company since its founding. Since 1994, I have worked full-time at Cosmos. At Cosmos, among various activities, I have consulted on high level technology-related issues and trends to corporate entities, governmental agencies, and international organizations, such as the United Nations.

18. I have provided technical consultancy to engineering firms, operators, and equipment vendors on issues related to existing or evolving technologies for mobile communications, and to the investment community on issues related to

both fixed and wireless communications technologies. I developed and taught hundreds of courses to thousands of engineers around the world in the area of communication engineering, mostly in the area of mobile, wireless communications.

19. Over the course of my career, I have authored and co-authored some thirty (30) publications on various aspects of fixed and mobile communications, as noted in my curriculum vitae. I am a life member of the Institute of Electrical and Electronics Engineers (IEEE) and have been actively involved in the Communications Society and the Information Theory Society of the IEEE. Between 1991 and 1992, I served as the Secretary of IEEE Communications Society National Capital Area Chapter. Between 1992 and 1993, I was the Vice-Chair of IEEE Communications Society National Capital Area Chapter. I was the Vice-Chair of the Communication Theory Technical Committee of the Communications Society of the IEEE for the 1993–1996 term, and Treasurer of the Communication Theory Technical Committee of the Communications Society of the IEEE for the 1996–1999 term.

20. I have served as a reviewer for the IEEE, book editors, other technical publications, and various National Science Foundation (NSF) Panels. I have organized technical sessions in technical conferences, including the IEEE International Conference on Communications (ICC) and IEEE Global

Communications Conference (Globecom). I served as the Technical Program Chair for the Communication Theory Mini-Conference in 1992.

21. During the past 35+ years, I have been lucky enough to be part of the community of engineers that have contributed to the astounding growth of the mobile communications industry. It started from a niche industry that was thought of as being something for the “rich and the famous” to becoming one of the most widespread household concepts, providing useful tools to all segments of the global society.

22. My involvement in this industry included providing consulting services to company executives who needed to make deployment plans, taking into consideration the strengths and weaknesses of the technology, economics, user value, etc. As such, I have developed a deep understanding of all aspects of a given technology, its features, added value, and the like. In addition, my consulting services included developing courses for the companies that were at the forefront of this developing technology. By definition, this previously non-existent technology was not taught in university courses, as it was too new. Having developed hundreds of courses over the years and taught thousands of engineers (and non-engineers alike), I have a solid understanding and knowledge of the technical developments and how their importance fits in the larger puzzle of a fast-developing technology.

23. My consulting included providing training to engineers in the field that were deploying the various networks. For example, I developed courses and provided training and consulting to the engineers deploying some of the earliest GSM networks in Germany and France, to be followed by many countries in Europe and around the world, including the United States when it was decided that GSM would be used in the U.S. Successful deployments of the initial GSM systems were followed by deployments of GPRS and EDGE, which was then followed by deployments of 3G UMTS systems worldwide. Of course, the 3G systems were followed by the currently most widespread deployments of 4G systems, also referred to as LTE, worldwide and most recently deployments of 5G networks. Thus, as I explain above, my experience includes a deep understanding of the entirety of each system that we broadly refer to as “1G,” “2G,” “3G,” “4G,” “LTE,” and “5G.”

24. Similarly, I developed courses and provided training and consulting to engineers deploying and/or enhancing wireless local area networks using one or more of the IEEE 802.11 set of standards (often referred to as WiFi) as well as networks using the IEEE 802.16 set of standards (often referred to as WiMax).

25. As an expert consultant, I have served on both civil and criminal legal cases, including several patent infringement cases both at the ITC and in district courts, as well as in support of IPR petitions, such as the one in this case. I have

also participated as a technical expert consultant in the analysis of large patent portfolios for the purposes of due diligence, sales, and merger and acquisition activities for some of the largest companies in the mobile communications space. These projects span a multidimensional spectrum of technologies in both fixed and mobile communications as they have evolved over the past more than 30 years.

IV. MATERIALS CONSIDERED

26. In forming my opinions, I have reviewed the following documents, and any other document cited in this declaration.

Exhibit	Description
Ex. 1001	U.S. Patent No. 11,368,911 to Tsai et al. (“the ’911 patent”)
Ex. 1002	File History for U.S. Patent No. 11,368,911
Ex. 1005	International Patent Application Publication No. WO 2020/130930 A1 to <i>Nimbalker</i> et al. (“ <i>Nimbalker</i> ”)
Ex. 1006	Certified copy of U.S. Provisional Application No. 62/784,114 to <i>Nimbalker</i> et al., filed December 21, 2018 (“ <i>Nimbalker Provisional</i> ”)
Ex. 1007	3GPP TSG-RAN WG1 #96bis R1-1905031 (“PDCCH-based power saving channel design”) (Apr. 2019) (“ <i>R1-1905031</i> ”)
Ex. 1008	3GPP TSG-RAN WG1 #96 R1-1903016 (“Potential Techniques for UE Power Saving”) (Feb. 2019) (“ <i>R1-1903016</i> ”)
Ex. 1009	International Patent Application Publication No. WO 2019/135654 A1 to Anil et al. (“ <i>Anil</i> ”)
Ex. 1010	3GPP TS 36.321 v15.4.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification (Release 15)”) (Dec. 2018) (“ <i>TS 36.321</i> ”)

Exhibit	Description
Ex. 1011	3GPP TS 38.300 v15.5.0 (“Technical Specification Group Radio Access Network; NR; NR and NG-RAN Overall Description; Stage 2 (Release 15)”) (Mar. 2019) (“ <i>TS 38.300</i> ”)
Ex. 1012	3GPP TS 38.331 v15.4.0 (“Technical Specification Group Radio Access Network; NR; Radio Resource Control (RRC) protocol specification (Release 15)”) (Dec. 2018) (“ <i>TS 38.331</i> ”)
Ex. 1013	3GPP TSG RAN WG1 #96bis R1-1904738 (“Discussion on power saving signal triggering UE adaptation”) (Apr. 2019) (“ <i>R1-1904738</i> ”)
Ex. 1014	3GPP TSG RAN WG1 #96bis R1-1905384 (“PDCCH-based power saving signal/channel”) (Apr. 2019) (“ <i>R1-1905384</i> ”)
Ex. 1015	3GPP TSG-RAN WG1 Meeting #96bis Tdoc R1-1905466 (“Design of PDCCH-based power saving signal/channel”) (Apr. 2019) (“ <i>R1-1905466</i> ”)
Ex. 1016	3GPP TSG RAN Meetings #83 RP-190727 (“New WID: UE Power Saving in NR”) (Mar. 2019) (“ <i>RP-190727</i> ”)
Ex. 1017	Excerpts from Stefania Sesia et al., <i>LTE – The UMTS Long Term Evolution from Theory to Practice</i> (John Wiley & Sons, Ltd. 2d ed. 2011) (“ <i>Sesia LTE</i> ”)
Ex. 1018	Excerpts from Chris Johnson, <i>Long Term Evolution in Bullets</i> (Chris Johnson 2d ed. 2012) (“ <i>LTE in Bullets</i> ”)
Ex. 1019	U.S. Patent Application Publication No. US 2017/0171818 A1 to Agarwal et al. (“ <i>Agarwal</i> ”)
Ex. 1020	3GPP TS 36.211 v14.9.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (Release 14)”) (Dec. 2018) (“ <i>TS 36.211</i> ”)
Ex. 1021	3GPP TS 38.211 v15.4.0 (“Technical Specification Group Radio Access Network; NR; Physical channels and modulation (Release 15)”) (Dec. 2018) (“ <i>TS 38.211</i> ”)

Exhibit	Description
Ex. 1022	3GPP TS 38.321 v.15.4.0 (“Technical Specification Group Radio Access Network; NR; Medium Access Control (MAC) protocol specification (Release 15)”) (Dec. 2018) (“ <i>TS 38.321</i> ”)
Ex. 1023	Michel Mouly and Marie-Bernadette Pautet, <i>The GSM System for Mobile Communications</i> (Bay Foreign Language Books 1992) (“ <i>Mouly</i> ”)
Ex. 1024	Martin Sauter, <i>From GSM to LTE; An Introduction to Mobile Networks and Mobile Broadband</i> (John Wiley & Sons, Ltd. 2011) (“ <i>Sauter</i> ”)
Ex. 1025	3GPP TS 36.331 v.15.4.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 15)”) (Dec. 2018) (“ <i>TS 36.331</i> ”)
Ex. 1026	Declaration of Friedhelm Rodermund

27. I have also relied on my education, experience, research, training, and knowledge in the relevant art, and my understanding of any applicable legal principles described in this declaration.

28. All of the opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my understanding of how a person of ordinary skill in the art would have understood the claims of the '911 patent at the time of the earliest claimed priority date.

29. I reserve the right to supplement and amend any of my opinions in this declaration based on documents, testimony, and other information that becomes available to me after the date of this declaration.

V. LEGAL STANDARDS

30. I am not a lawyer. For purposes of this Declaration, I have been asked to provide my opinions on issues regarding unpatentability. My understanding of the legal standards to apply in reaching the conclusions in this declaration is based on discussions with counsel for Petitioners, my experience applying similar standards in other patent-related matters, and my reading of the documents submitted in this proceeding. In preparing this declaration, I have tried to faithfully apply these legal standards to the challenged claims.

31. I have been informed that there are two ways in which prior art may render a patent claim unpatentable. First, I have been informed that the prior art can “anticipate” a claim. Second, I have been informed that the prior art can render a claim “obvious” to a person of ordinary skill in the art. I understand that a claim is patentable if it was not anticipated and would not have been obvious by the prior art at the effective filing date of the patent.

32. I have been informed that a dependent claim is a patent claim that refers back to another patent claim. I have been informed that a dependent claim includes all of the limitations of the claim to which it refers.

33. I have been asked to provide my opinions as to whether the cited prior art teaches or renders obvious claims 1-18 of the '911 patent from the perspective of a person of ordinary skill in the art at the '911 patent's earliest claimed priority date in 2019, as described in more detail below.

34. I have been informed that in *inter partes* review proceedings, such as this one, the party challenging the patent bears the burden of proving unpatentability by a preponderance of the evidence. I understand that a preponderance of the evidence means "more likely than not."

35. For purposes of this declaration, I have been asked to provide my opinions on issues regarding unpatentability. I have been informed of the following legal standards, which I have applied in forming my opinions.

A. Level of Ordinary Skill

36. I have been informed a person of ordinary skill in the art is determined by considering several factors, including the (i) type of problems encountered in the art; (ii) prior art solutions to those problems; (iii) rapidity with which innovations are made; (iv) sophistication of the technology; and (v) educational level of active workers in the field.

37. I have been instructed to assume a person of ordinary skill in the art is not a specific real individual, but rather a hypothetical individual having the qualities reflected by the factors discussed above.

B. Prior Art

38. I have been advised and understand the information used to evaluate whether an invention was new and not obvious when made is generally referred to as “prior art.” I understand that prior art includes patents and printed publications that existed before the earliest claimed priority date or the earliest filing date of the patent (which I have been informed is also called the “effective filing date”). I have been informed and understand that a patent or published patent application is prior art if it was filed before the earliest filing date of the claimed invention and that a printed publication is prior art if it was publicly available before the earliest filing date.

C. Anticipation

39. I have been informed that under 35 U.S.C. § 102, a patent claim is unpatentable for anticipation if the claimed subject matter was patented or described in a printed publication before the effective filing date of the claimed invention. I have been informed that this is referred to as unpatentability by anticipation. I have been informed that a patent claim is anticipated under § 102 if a single prior art reference discloses all limitations of the claimed invention.

D. Obviousness

40. I have been informed that obviousness under 35 U.S.C. § 103, a patent claim is unpatentable if the differences between the subject matter sought to be

patented and the prior art are such that the subject matter as a whole would have been obvious to a person having ordinary skill in the art to which said subject matter pertains at the time the invention was made. I have been informed that this is referred to as unpatentability by obviousness.

41. I have been informed that a proper obviousness analysis includes the following:

- a. Determining the scope and content of the prior art;
- b. Ascertaining the differences between the prior art and the claims at issue;
- c. Resolving the level of ordinary skill in the pertinent art; and
- d. Considering evidence of secondary indicia of non-obviousness (if available).

42. I have been informed that the relevant time for considering whether a claim would have been obvious to a person of ordinary skill in the art is the time of invention. For my obviousness analysis, counsel for Petitioners instructed me to assume that the date of invention for the Challenged Claims is April 30, 2019. My opinions would not change if I assumed a later date of invention.

43. I have been informed that a reference may be modified or combined with other references or with a person of ordinary skill in the art's own knowledge if the person would have found the modification or combination obvious. I have

also been informed that a person of ordinary skill in the art is presumed to know all the relevant prior art, and the obviousness analysis may take into account the inferences and creative steps that a person of ordinary skill in the art would employ.

44. I have been informed that whether a prior art reference renders a patent claim obvious is determined from the perspective of a person of ordinary skill in the art. I have also been informed that, while there is no requirement that the prior art contain an express suggestion to combine known elements to achieve the claimed invention, and while a suggestion to combine known elements to achieve the claimed invention may come from the prior art as a whole or individually and may consider the inferences and creative steps a person of ordinary skill in the art would employ, as filtered through the knowledge of one skilled in the art, obviousness grounds cannot be sustained by mere conclusory statements and must include some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.

45. In determining whether a prior art reference could have been combined with another prior art reference or other information known to a person having ordinary skill in the art, I have been informed that the following principles may be considered:

- a. A combination of familiar elements according to known methods is likely to be obvious if it yields predictable results;
- b. The substitution of one known element for another is likely to be obvious if it yields predictable results;
- c. The use of a known technique to improve similar items or methods in the same way is likely to be obvious if it yields predictable results;
- d. The application of a known technique to a prior art reference that is ready for improvement to yield predictable results;
- e. Any need or problem known in the field and addressed by the reference can provide a reason for combining the elements in the manner claimed;
- f. A person of ordinary skill often will be able to fit the teachings of multiple references together like a puzzle; and
- g. The proper analysis of obviousness requires a determination of whether a person of ordinary skill in the art would have a “reasonable expectation of success”—but not “absolute predictability” of success—in achieving the claimed invention by combining prior art references.

46. I have been informed that, when a work is available in one field, design alternatives and other market forces can prompt variations of it, either in the

same field or in another. I have been informed that if a person of ordinary skill in the art could have implemented a predictable variation and would have seen the benefit of doing so, that variation is likely to have been obvious. I have been informed that, in many fields, there may be little discussion of obvious combinations, and in these fields market demand—not scientific literature—may drive design trends. I have been informed that, when there was a design need or market pressure and there are a finite number of predictable solutions, a person of ordinary skill in the art would have had a good reason to pursue those known options.

47. I have been informed that the law permits the application of “common sense” in examining whether a claimed invention would have been obvious to a person skilled in the art. For example, I have been informed that combining familiar elements according to known methods and in a predictable way may suggest obviousness when such a combination would yield nothing more than predictable results. I understand, however, that a claim is not obvious merely because every claim element is disclosed in the prior art and that a party asserting obviousness must still provide a specific motivation to combine or modify the references as recited in the claims and explain why one skilled in the art would have reasonably expected to succeed in doing so.

48. I have been informed that there is no rigid rule that a reference or combination of references must contain a “teaching, suggestion, or motivation” to combine references. But I also understand that the “teaching, suggestion, or motivation” test can be a useful guide in establishing a rationale for combining elements of the prior art. I have been informed that this test poses the question as to whether there is an express or implied teaching, suggestion, or motivation to combine prior art elements in a way that realizes the claimed invention, and that it seeks to counter impermissible hindsight analysis.

49. I am not aware of any evidence of secondary considerations that would support a determination of non-obviousness of the claimed subject matter in the '911 patent.

50. I have been informed that, in an obviousness analysis, prior art must be analogous prior art to the patent being considered. I have been informed that a prior art reference is considered to be analogous, or in the same field of art, if the reference is either (1) in the same field of endeavor as the challenged patent, regardless of the problems the challenged patent and the prior art address, or (2) reasonably pertinent to the particular problem being solved by the challenged patent.

VI. TECHNOLOGY BACKGROUND AND STATE OF THE PRIOR ART

51. For this Declaration, I have assumed that the priority date of the challenged claims is April 30, 2019, as this is the earliest possible priority date. Thus, for purposes of this analysis, I assume that the time of the purported invention of the '911 patent was April 30, 2019, and have provided an overview of the background of the relevant technology at that time.

A. Field of Technology

52. As is explained in the “FIELD” section of the '911 patent, the relevant field of technology is wireless communication in general and to physical downlink control channel (PDCCH) monitoring. Ex 1001, 1:16-21. In the “BACKGROUND” section, the '911 patent explains that “UE [user equipment] battery life is an important aspect of the user’s experience, which will influence the adoption of 5G handsets and/or services.” Ex. 1001, 1:26-28.

53. In the same “BACKGROUND” section, the '911 patent explains that Discontinuous Reception (DRX) operation was “introduced as conventional UE power saving” and provides an illustration of “DRX operation according to the related art” in FIG. 1. Ex. 1001, 2:23-29. The '911 patent further explains the characteristics of prior art DRX operation included the concepts of:

- “**on-duration**” as “duration that the UE waits after waking up, to receive PDCCHs”;

- **“inactivity-timer,”** which is the “duration that the UE waits to successfully decode a PDCCH, from the last successful decoding of a PDCCH”;
- **“retransmission-timer,”** which is the “duration until a retransmission can be expected”;
- **“DRX cycle,”** which “specifies the periodic repetition of the on-duration followed by a possible period of inactivity”; and
- **“active-time,”** which is the “total duration that the UE monitors PDCCH” and “includes the "on-duration" of the DRX cycle, the time UE is performing continuous reception while the inactivity timer has not expired, and the time when the UE is performing continuous reception while waiting for a retransmission opportunity.”

Ex. 1001, 2:29-59.

54. The '911 patent acknowledges that, for prior art LTE and 5G (NR) devices, “[o]ne efficient UE power saving mechanism is to trigger the UE for network access from a power efficient mode” where the “UE would stay in the power efficient mode, such as micro sleep or OFF period in the long Discontinuous Reception (DRX) cycle, unless it is informed of network access through a UE power saving framework,” which includes a “wake-up/go-to-sleep mechanism.”

Ex. 1001, 1:25-49. The '911 patent also acknowledges that, for prior art DRX user equipment, a “power saving signal/channel/procedure is used” in which the “power

saving signal/channel” is used to “trigger[] the UE to achieve reduction in PDCCH monitoring [that] is related to using the power saving signal/channel to trigger UE to skip PDCCH monitoring” Ex. 1001, 2:1-18. These prior art DRX operations have known parameters, including: “on-duration” timer (e.g., “drx-onDurationTimer”) and “inactivity-timer,” which refer to the “duration that the UE waits after waking up, to receive PDCCHs” and the “duration that the UE waits to successfully decode a PDCCH, from the last successful decoding of a PDCCH,” respectively. Ex. 1001, 2:29-41, 2:61-65. The DRX “active-time” describes the “total duration that the UE monitors PDCCH,” which “includes the ‘on-duration’ of the DRX cycle, the time [the] UE is performing continuous reception while the inactivity timer has not expired, and the time when the UE is performing continuous reception while waiting for a retransmission opportunity.” Ex. 1001, 2:46-51.

55. The '911 patent explains that “FIG. 2 is a schematic diagram illustrating a WUS [wake-up signaling] mechanism, in accordance with related art.” Ex. 1001, 3:5-6. In this prior art WUS mechanism, “the UE may increase the power to monitor a WUS on a WUS occasion.” Ex. 1001, 3:12-14. “If the UE receives the WUS signal on the WUS occasion, the UE may spend a time to decode the WUS signal, and then wake up to monitor the PDCCH on the upcoming (or next) on-duration time of the DRX cycle.” Ex. 1001, 3:14-17. But, “if the UE

does not receive the WUS signal on the WUS occasion, the UE could switch to the sleep state, namely not wake up to monitor the PDCCH for a period (until the next WUS occasion or on-duration time).” Ex. 1001, 3:18-21. This prior art DRX wake-up signaling is shown below in FIG. 2. I provide an annotated version of FIG. 2 below, summarizing this prior art wake-up DRX operation.

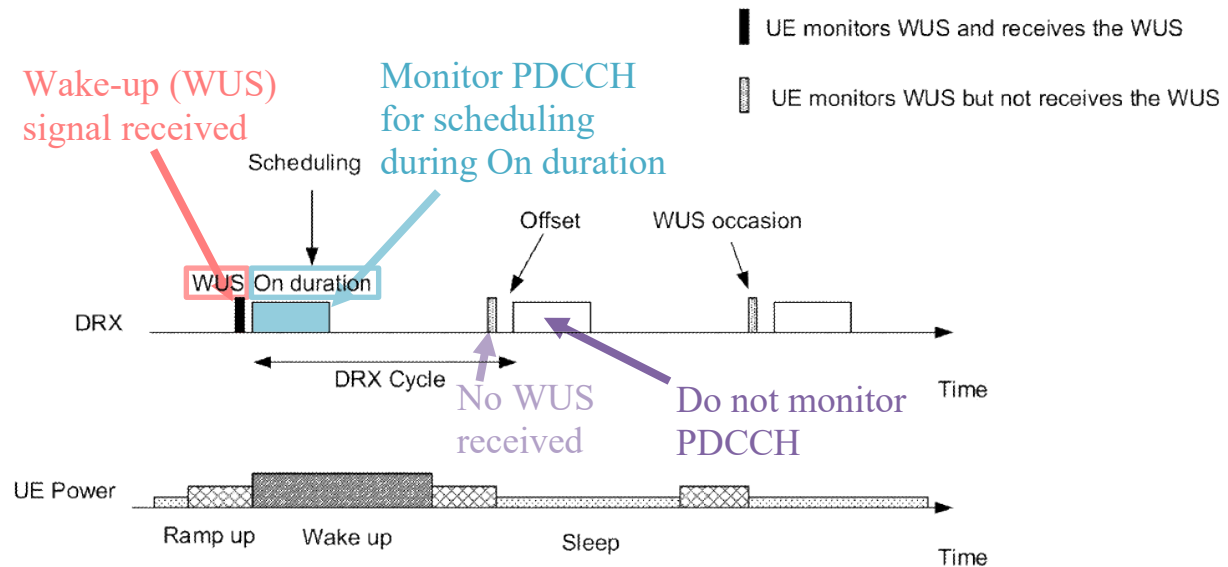


**FIG. 2
(RELATED ART)**

Ex. 1001, FIG. 2 (annotated¹).

56. The '911 patent also explains that “[t]he WUS occasion may be indicated by a control resource set (CORESET) or search space configuration. For

¹ All color annotations have been added unless otherwise noted.

example, the CORESET or search space configuration of the WUS could be configured along with the DRX configuration. In addition, as shown in FIG. 3, the CORESET or search space may be a specific CORESET or search space for the purpose of WUS monitoring (e.g., time and/or frequency resource for monitoring the WUS).” Ex. 1001, 3:23-34. As shown in prior art FIG. 3, both the WUS monitoring occasion and PDCCH scheduling monitoring occasion are indicated by “CORESET[s] (or search space[s]).” Ex. 1001, 3:31-34, FIG. 3.

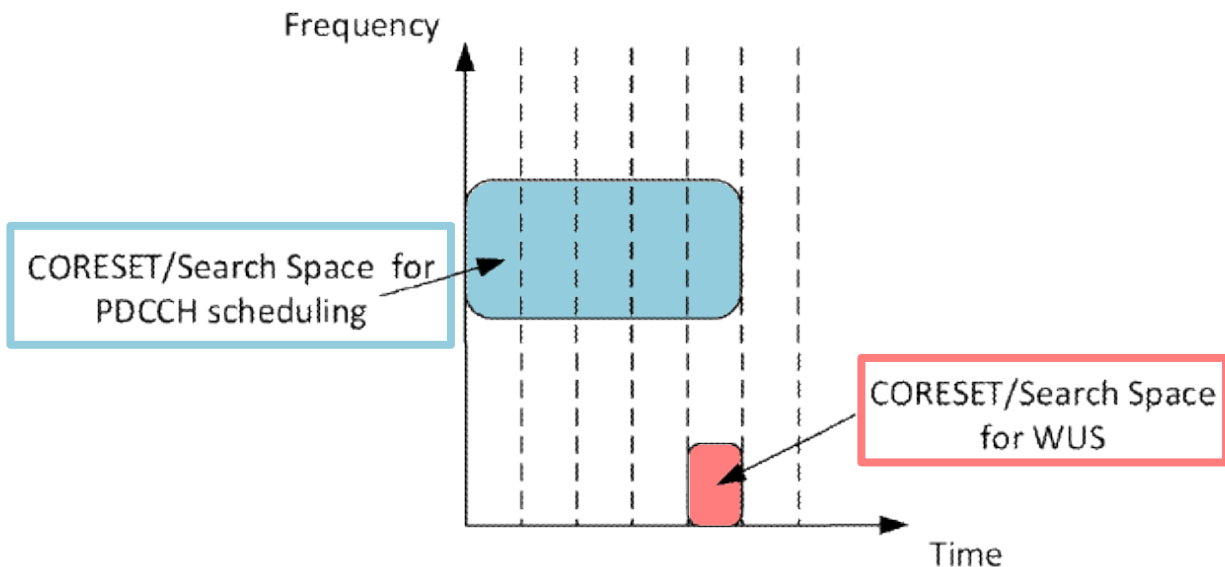


FIG. 3
(RELATED ART)

Ex. 1001, FIG. 3.

57. In the interest of clarity and completeness, I will review the development of wireless communications since the early days and the working procedures and work product of the 3GPP in Section VI.B, below, before I discuss the relevant state of the prior art in Section VI.C.

B. Third Generation Partnership Project (3GPP)

58. “Wireless communications” necessarily implies that information is transmitted without the use of “wires.” This is accomplished by transmitting electromagnetic waves from some point of origin A with the intent that the electromagnetic waves will be successfully received at some intended destination point B.

59. The “Advanced Mobile Phone System” (“AMPS”) was the first nationwide wireless communications system standardized in the USA and was released in the 1980s and was an analog, as opposed to digital, system. AMPS is sometimes referred to as a first generation or “1G” cellular communication technology. A subsequent short-lived system, referred to as IS-54, was developed and then quickly replaced by a better system referred to as IS-136 in the early 1990s. IS-54 and IS-136 are now commonly referred to as second generation or “2G” technologies. Around the same time that these 2G systems were released, Qualcomm began developing a different system to replace AMPS in direct competition with IS-54/IS-136. This new system was standardized in what is called

the “IS-95 standard,” or simply just “IS-95.” IS-95 was the first ever code division multiple access (“CDMA”) based digital cellular technology. CDMA allows multiple access to digital radio signals for transmission of voice, data, and signaling data. IS-95 was first published in 1995 and adopted as a wireless communications standard in the USA by the Telecommunications Industry Association.

60. Around this same time period that the IS-95 was being developed in the US, the European Telecommunications Standard Institute (“ETSI”) developed the Global System for Mobile Communications (“GSM”) technical specifications. Unlike IS-95, GSM is based on a time division multiple access (“TDMA”) technology. Similar to IS-54 and IS-136, IS-95 and GSM are also commonly referred to as “2G” technologies because they were the first viable cellular systems to use digital transmission techniques, as opposed to the analog techniques used in AMPS.

61. GSM continued to evolve with the development of GPRS (which stands for General Packet Radio Service) and EDGE (which stands for Enhanced Data rates for GSM Evolution). GPRS and/or EDGE have sometimes been referred to as “2.5G” systems, even though there is no general agreement as to what exactly “2.5G” does or does not include. Over time, GSM developed greater market share globally than its IS-95 CDMA-based competitor. In the late 1990s, IS-95 showed

that an air interface based on CDMA was viable. GSM had developed the necessary superior networking protocols. The industry then converged by merging the best aspects of the TDMA GSM system with the best aspects of the CDMA IS-95 system to create an improved worldwide system. As part of that effort, a new organization was formed in 1998 called the “3rd Generation Partnership Project,” or “3GPP.” The 3GPP was tasked with developing new wireless communication specifications for this system, which was referred to as a “3rd Generation” or “3G” specification.

62. 3GPP is a global joint undertaking by national and regional telecommunication standards organizations and member companies focused on defining interoperable telecommunications networks and user equipment. 3GPP was tasked with an initial objective to produce technical specifications for a third generation (“3G”) cellular communication system, called the Universal Mobile Telecommunications Service (“UMTS”). UMTS is a 3G mobile cellular system for networks based on the second generation (2G) GSM standard in conjunction with the best CDMA aspects of the IS-95 air interface, as I mentioned above.

63. While 3GPP is not formally a standards-setting organization, it operates as one from a practical perspective. 3GPP develops technical specifications that are then typically adopted by the respective standards-setting bodies of a given country or region. At the core of 3GPP’s organization are seven

“Organizational Partners,” each of which is a standards-setting organization in a different country or region:

- The Association of Radio Industries and Businesses, or ARIB (Japan);
- Telecommunication Technology Committee, or TTC (Japan);
- The Alliance for Telecommunications Industry Solutions, or ATIS (US);
- China Communications Standards Association, or CCSA (China);
- The European Telecommunications Standards Institute, or ETSI (Europe);
- Telecommunications Standards Development Society, or TSDSI (India); and
- Telecommunications Technology Association, or TTA (Korea).

See, e.g., “About 3GPP,” available at <https://www.3gpp.org/about-us/partners>.

64. 3GPP employs a model similar to one that had been used earlier by ETSI, which had developed GSM. This includes a hierarchical structure in which Working Groups (“WGs”) are the source of technical contributions, some of which ultimately mature into Technical Specifications. In addition, several WGs are part of a given Technical Specification Group, or TSG. There are several Technical Specification Groups, each one having a number of WGs and covering technical

subject matter that is defined and follows a logical, hierarchical structure. In the 2019 time period, the three active 3GPP TSGs are the Radio Access Network (“RAN”), Service and System Aspects (“SA”), and Core Network and Terminals (“CT”) TSGs. The RAN TSG is the TSG responsible for the standards and proposals relevant to 5G patent.

65. The RAN TSG, in turn, consists of several Working Groups, referred to, for example, as RAN1 and RAN2 or RAN WG1 and RAN WG2. Each WG holds periodic meetings in which technical documents (or “TDocs”) are presented and discussed for possible inclusion in the Technical Specifications (“TS”), which are sometimes also referred to as Technical Standards. These meetings are numbered and referred to as, for example, TSG-RAN WG2 Meeting #50, which refers to Meeting #50 of Working Group 2 of the RAN TSG. At these meetings, different proposals are discussed, their pros and cons considered, and ultimately some of them, or some hybrid of one or more of them, get approved and included in the TS.

66. In the late 1990s, 3GPP successfully developed UMTS, which enjoyed worldwide success. A few years later, around 2004, 3GPP initiated the “Long Term Evolution”, or “LTE,” project, which is also referred to as “4G.” Around 2017, 3GPP began work on what has come to be known as “New Radio,”

or “NR,” and also referred to as “5G.” As mentioned above, the ’911 patent refers to NR and 5G as being developed by 3GPP. Ex. 1001, 1:25-35.

67. The NR project had several goals for a 5G cellular standard, including increased data rates, improved quality of service, and decreased complexity. 3GPP released the first “5G” Technical Specifications (TS) in late 2017 or early 2018, in what was called “Release 15.”

C. State of the Art

68. In this section, I will discuss search spaces and CORESETS and then how the state of the art recognized configuring UEs for discontinuous reception (“DRX”) operation by configuring the UE with (1) PDCCH search spaces for monitoring scheduling information during a ON duration time of the DRX cycle and (2) wake-up signaling (“WUS”) PDCCH search spaces to monitor for WUS to determine whether the UE should wake up to monitor the ON duration scheduling PDCCH.

1. Search Spaces, Time/Frequency Domains, and PDCCH

69. As acknowledged in the Background section and FIG. 3 of the ’911 patent, a “search space” is defined by a set of time and frequency resources. Ex. 1001, 3:23-30, FIG. 3. Such search spaces describe merely conventional prior art set of resource elements that were previously known for configuring UEs to perform PDCCH monitoring.

70. The organization of radio resources in LTE was established in the early days of the LTE development, at least a decade before the earliest priority date of the '911 patent. Although these concepts were implemented at least as early as March 2009, with TS 36.211, v8.6.0, I discuss versions of TS 36.211 and TS 38.211 from late-2018 and early-2019 because they are closer to the filing date of the '911 patent.

71. TS 36.211 v14.9.0 ("*TS 36.211*"; Ex. 1020) shows an exemplary "[d]ownlink resource grid" at FIG. 6.2.2-1.

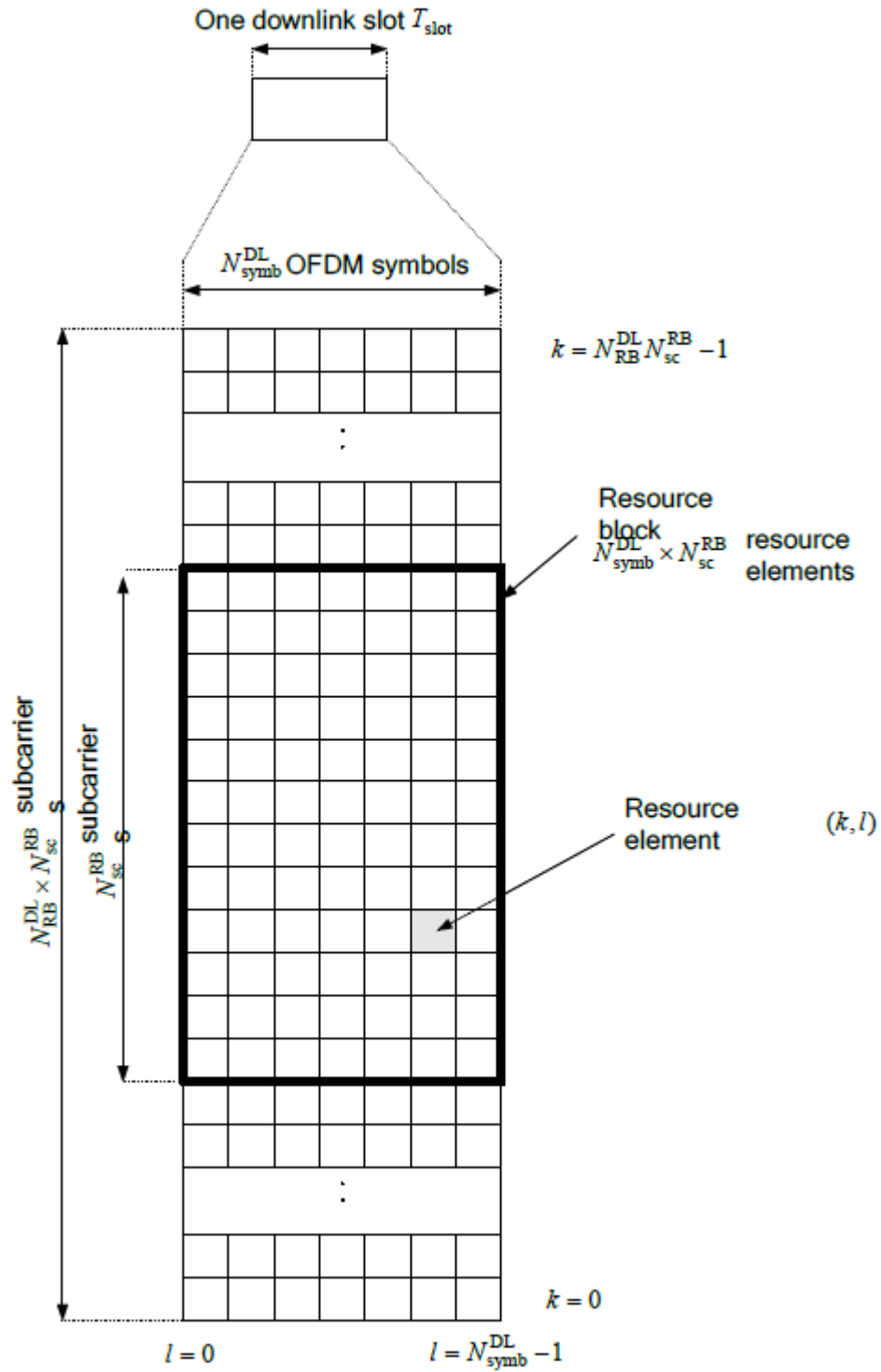


Figure 6.2.2-1: Downlink resource grid

Ex. 1020, *TS 36.211*, FIG. 6.2.2-1.

72. The downlink resource grid consists of a number of “resource blocks” (only one of which is shown in FIG. 6.2.2-1, highlighted by the heavy bolded rectangle) as shown by the vertical dots above and below the one highlighted resource block. *TS 36.211*, 76-77. Within the resource block are a number of “resource element[s],” each “uniquely identified by the index pair (k, l) ,” which “are the indices in the frequency and time domains, respectively.” *TS 36.211*, 76. In other words, each such resource element corresponds to a specific OFDM symbol (in FIG. 6.2.2-1, that would be one of seven symbols as shown by the seven columns of the resource block) and a specific subcarrier (in FIG. 6.2.2-1, one of the twelve subcarriers shown by the twelve rows of the resource block). *TS 36.211*, 76-77. The Figure above shows one such resource element highlighted in grey. Each OFDM symbol represents a time resource (e.g., index l) and each subcarrier represents a frequency resource (e.g., index k). This resource block structure is explained in *TS 36.211* Section 6.2.3 and “are used to describe the mapping of certain physical channels to resource elements.” Thus, each resource element (k, l) is one particular symbol-subcarrier combination.

73. One of the “certain physical channels” in *TS 36.211*, Section 6.2.3 is the PDCCH, or Physical Downlink Control Channel. *TS 36.211*, 77. PDCCH is discussed in *TS 36.211*, Section 6.8, and “carries scheduling assignments and other control information.” *TS 36.211*, 99.

74. *Sesia LTE* explains some uses for PDCCH, including that “[e]ach PDCCH carries a message known as Downlink Control Information (DCI), which includes resource assignments and other control information for a UE or a group of UEs.” *Sesia LTE*, 26. PDCCH DCI format 1 (and also formats 1A, 1B, 1C, 1D, 2, 2A, 2B, 2C) provides “resource assignments” (“resource grants” or scheduling information) to the UE for downlink data transmissions using PDSCH. *Sesia LTE*, 28. PDCCH DCI format 0 which provides resource assignments (“resource grants” or scheduling information) to the UE for uplink data transmissions using PUSCH. *Sesia LTE*, 28.

75. *Sesia LTE* discusses the structure and contents of PDCCH messages in Section 9.3.5.5, then asks “how these transmissions are organized so that a UE can locate the PDCCHs intended for it, while at the same time making efficient use of the resources allocated for PDCCH transmission.” *Sesia LTE*, 35-36. *Sesia LTE* explains that a “simple approach” would be “to allow the eNodeB to place any PDCCH anywhere in the PDCCH resources (or CCEs^[2]) indicated by the PCFICH.” *Sesia LTE*, 35. *Sesia LTE* further explains that requiring the UE to

² CCE stands for “Control Channel Element” and one or more CCE(s) are aggregated to form one PDCCH. Further details about CCEs is not relevant to the issues related to the claims of the ’911 patent.

“check all possible PDCCH locations, PDCCH formats and DCI formats” for scheduling information “would require the UE to make many PDCCH decoding attempts in every subframe” and “would become a significant burden, leading to excessive power consumption in the UE receiver.” *Sesia LTE*, 35. *Sesia LTE* explains that an “alternative approach adopted for LTE is to define for each UE a limited set of CCE locations where a PDCCH may be placed.” *Sesia LTE*, 35. This limited “set of CCE locations in which the UE may find its PDCCHs can be considered as a ‘**search space**.’” *Sesia LTE*, 35 (emphasis added). In short, “search space[s]” consist of specific time and frequency resources (e.g., resource elements) for different PDCCHs.

76. Additional discussion on search spaces, as related to downlink control and scheduling, is provided by *Sauter* (Ex. 1024). *Sauter* explains that “a mechanism is required to indicate to each mobile device [UE] as to when, where[,] and what kind of data is scheduled for them” and “[t]his is done via Physical Downlink Control Channel (PDCCH) messages.” *Sauter*, 10. “When downlink data is scheduled via the PDCCH, the scheduling grant message has to describe the modulation and coding” that the UE uses to receive the message. *Sauter*, 17, 22 (describing “search spaces” for UEs that include “PDCCH messages” for the UE). Furthermore, “[t]o reduce the processing requirements and power consumption of mobile devices for decoding the control information [PDCCH], the control region

is split into search spaces” to limit the number of control messages the UE must decode. *Sauter*, 10.

77. To identify which PDCCH search spaces a UE should listen to, the base station transmits a PCFICH message that identifies the portions or subframes of the control region from which the UE “computes the search space in which it has to look for assignment messages.” *Sauter*, 23. More specifically,

the allocation of downlink resources from the mobile device’s point of view works as shown in Figure 4.15. At the beginning of each subframe, the mobile device first reads the PCFICH to detect the ***number of columns of the subframe that are reserved for the control region in which the PDCCH messages are sent***. On the basis of its ID, ***it then computes the search space in which it has to look for assignment messages***. It then decodes these areas to see if it can find messages for which it can successfully calculate the CRC checksum, which implicitly contains the device’s ID. If a downlink assignment message is found, the resource allocation type then determines how the information is given (bitmap or a starting point with length). With this information, the mobile device can now go ahead and ***attempt to decode all areas of the subframe in which its data is transmitted***.

Sauter, 23 (emphases added). If the UE finds “a downlink assignment message” in the PDCCH search space, the UE will “go ahead and attempt to decode all areas of the subframe in which its data is transmitted.” *Sauter*, 23-24, FIG. 4.15. “Uplink

scheduling grants are sent as PDCCH message in the same way” as downlink messages just described. *Sauter*, 25.

78. “PCFICH” was a well known acronym for “Physical Control Format Indicator Channel” and, as explained above, was used to assign PDCCH search spaces for the UE to monitor for assignment messages (scheduling messages). A POSITA would have known that the reception of the PCFICH provided configuration information to configure the UE to monitor the PDCCH search space by allowing the UE to “compute[] the search space in which it has to look for assignment messages.” *Sauter*, 23.

2. Discontinuous Reception (“DRX”) and Power Conservation

79. Power consumption, and thus the desire to conserve power, in mobile phones is as old as mobile phones themselves, dating back to the legendary Motorola “brick phone,” an analog “1G” phone. It went on public sale under the name Motorola Dynatac 8000X and had a battery that “took 10 hours to charge, providing **30 minutes** of use.” *See* <https://www.bbc.co.uk/bitesize/articles/z62gjfr> (emphasis added). From these beginnings, although the industry has come a long way in battery technology, the ultimate underlying concern of maximizing battery life remains.

80. Various solutions for conserving battery life have emerged over the years, with various implementations of discontinuous reception (DRX) being one of the focal points.

81. It was recognized in the art, even well prior to 2019, that most of the time a UE does not have incoming calls or messages, but in order to receive an incoming call or message, the device would have to be listening to, receiving, and processing the received signal to determine if any part of the signal was intended for it. While originally devices were involved in continuous listening, this resulted in poor power consumption and a lot of wasted energy. Thus, DRX was developed and implemented in the “2G” GSM system discussed above.

82. DRX stands for discontinuous reception and was recognized in the early 1990s as a power saving method for UEs. *See, e.g.,* Ex. 1023, *Mouly*, 19 (“a system allows mobile stations to restrict their monitoring of paging messages to their own paging sub-channel, thereby increasing significantly the lifetime of their battery, at the expense of a small increase in delay for the setting up of incoming calls. Such a feature is referred to as **discontinuous reception, or DRX**”). Since the original GSM system was generally voice-centric, DRX functionality was not, at the time, applied to transmitting or receiving data, thus the above specific reference to “setting up of incoming calls.”

83. This changed with both 3G and 4G no longer being voice-centric and focusing more on data. Several reference materials from the 2010-2012 timeframe, *Sauter*, *Sesia LTE*, and *LTE in Bullets* show that, almost a decade before the '911 patent, DRX functionality was well known for LTE systems.

84. *Sauter* similarly explains that, in 4G, “[t]o reduce the power consumption of a mobile device, the network can thus **configure discontinuous reception (DRX) periods** during which the control channel does not have to be observed.” *Sauter*, 23, 37-38 (emphasis added). As explained above, “a mechanism is required to indicate to each mobile device [UE] as to when, where and what kind of data is scheduled for them” and “[t]his is done via Physical Downlink Control Channel (PDCCH) messages.” *Sauter*, 10. “When downlink data is scheduled via the PDCCH, the scheduling grant message has to describe the modulation and coding” that the UE uses to receive the message. *Sauter*, 17, 22. The US identifies which PDCCH search spaces a UE should listen to for downlink scheduling information based on configuration information from the base station. *Sauter*, 237. Then, in DRX periods, the UE is “configure[d] ... to only periodically check for scheduling assignments” on the PDCCH. *Sauter*, 37. The system “defines the value for a timer that starts running after each data block has been sent.” *Sauter*, 37. “If new data is sent” during the timer, “the timer is restarted,” but “[i]f no data was sent by the time the timer expires,” the device may go to sleep. *Sauter*, 37.

85. The POSITA's knowledge of DRX transmissions is further described in other well known textbooks, such as *Sesia LTE* (Ex. 1017) and *LTE in Bullets* (Ex. 1018) as well as relevant 3GPP 4G/LTE Technical Specifications discussing this functionality.

86. *LTE in Bullets*, for example, explains that “[b]oth UMTS and LTE networks use Discontinuous Reception (DRX)” and that “LTE networks can use Discontinuous Reception (DRX) in RRC Connected mode to help conserve UE battery power.” *LTE in Bullets*, 11. In DRX, the “DRX cycle determines the subframes during which the UE monitors for a PDCCH addressed using its C-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI or SPS C-RNTI,” which are identifiers so that the UE knows that a particular scheduling is for the UE. *LTE in Bullets*, 11. *Sesia LTE* similarly explains that “[a] DRX cycle consists of an ‘On Duration’ during which the UE should monitor the PDCCH and a ‘DRX period’ during which a UE can skip reception of downlink channels for battery saving purposes.” *Sesia LTE*, 23. Both *LTE in Bullets* and *Sesia LTE* further describe the operation of a DRX cycle, consistent with *Sauter*.

87. As shown in the figures from *LTE in Bullets* and *Sesia LTE*, below, DRX has periods of “On duration” where the UE monitors the PDCCH for the period of an “on duration timer” for scheduling information. *LTE in Bullets*, 11; *Sesia LTE*, 24. At the beginning of each DRX cycle, “[t]he UE checks for

scheduling messages (indicated by its C-RNTI on the PDCCH) during the ‘On Duration’ period of either the long DRX cycle or the short DRX cycle depending on the currently active cycle.” *Sesia LTE*, 24. This is done by monitoring the PDCCH search space during the “onDurationTimer” corresponding to the “On” duration period where the UE monitors the PDCCH scheduling search spaces for a specified number of subframes. *LTE in Bullets*, 11-12. Indeed, it was well known for both LTE and NR that the length of the ON duration monitoring period of a DRX cycle was specified by the *drx-onDurationTimer* parameter. Ex. 1012, *TS 38.331*, 216-218 (identifying “***drx-onDurationTimer***” as a “DRX-Config” parameter); Ex. 1025, *TS 36.331*, 470, 473 (identifying “onDurationTimer” as a “DRX-Config” parameter that specifies a “[t]imer for DRX in TS 36.321 [6]” having a “[v]alue in number of PDCCH sub-frames”); Ex. 1010, *TS 36.321*, 9, 53, 123 (“***onDurationTimer***: Specifies the number of consecutive PDCCH-subframe(s) at the beginning of a DRX Cycle”; “the [DRX] Active Time includes the time while: *onDurationTimer* or *drx-InactivityTimer* ... is running”; “onDurationTimer” is when “[t]he MAC entity monitors PDCCH in PDCCH-subframes during the subframes [n, n+m-1]”); Ex. 1022, *TS 38.321*, 38 (“***drx-onDurationTimer***” specifies “the duration at the beginning of a DRX Cycle” as part of “the UE’s PDCCH monitoring activity” and is part of “Active Time”); Ex. 1013, *R1-1904738*, 2 (“That is the power saving signal used before DRX cycle

hav[ing] two functions[:] one is to wake up UE in current DRX cycle to receive or transmit data, and another is to trigger a CSI report before the beginning of drx-onDurationTimer.”; “Power saving signal is transmitted before DRX cycle, if UE successfully detects power saving signal, UE measures and reports CSI before drx-onDurationTimer and monitors PDCCH when drx-onDurationTimer is running as R15 DRX operation.”); Ex. 1014, *R1-1905384*, 7 (“When DRX is configured, UE is required to monitor PDCCH only during *onDuration* of the DRX cycle. Network is able to control the UE PDCCH monitoring requirement using the parameters such as *OnDuration-timer*, *inactivity timer*[,] and *DRX cycle length*.”); *Anil*, [226]-[227] (“When a DRX cycle is configured, the Active Time includes the time while: []*drx-onDurationTimer* or *drx-InactivityTimer* or *drx-RetransmissionTimerDL* or *drx-RetransmissionTimerUL* or *ra-ContentionResolutionTimer* is running ...”); Ex. 1018, *LTE in Bullets*, 11-12 (describing “onDurationTimer” for ON duration period of DRX PDCCH monitoring); *see also* Ex. 1001, 2:31-34 (acknowledging on-duration timer known in prior art).

88. Next, if “a scheduling message is received during an ‘On Duration’ [period], the UE starts a ‘DRX Inactivity Timer’ and monitors the PDCCH in every subframe while the DRX Inactivity Timer is running.” *Sesia LTE*, 24. As shown in the figures below, the “timer” at the start of each DRX cycle is the

onDuration timer, which can be present at the start of either “short” or “long” DRX cycles. *Sesia LTE*, 23-24; *LTE in Bullets*, 11-12.

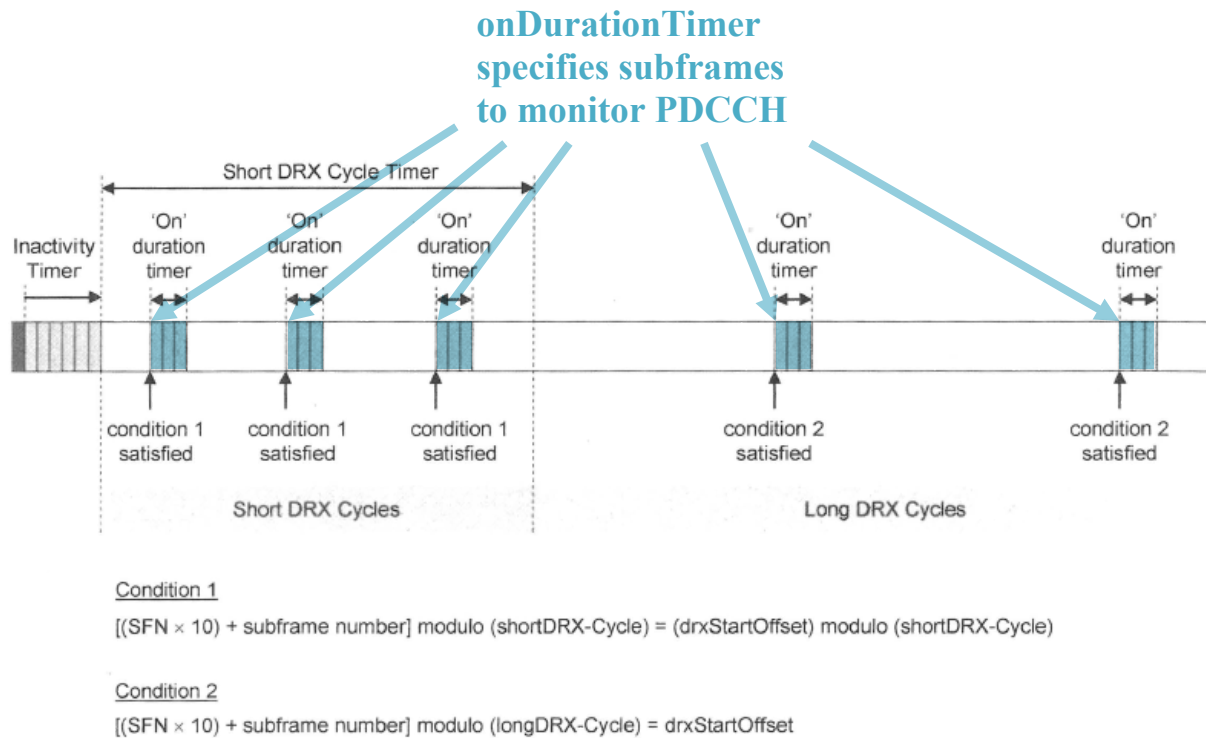
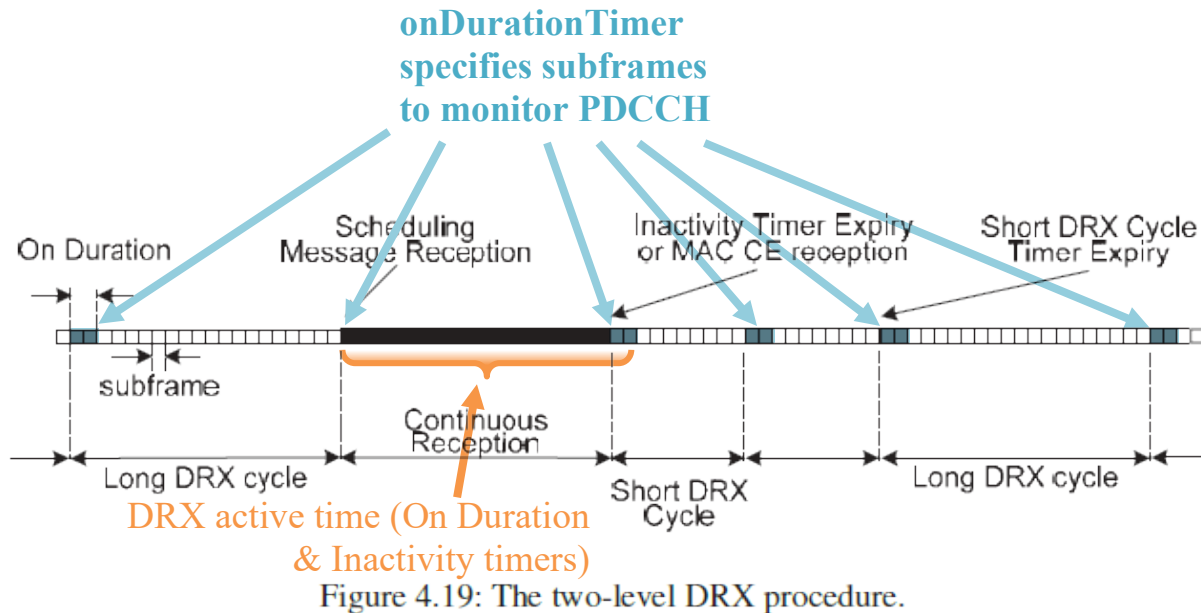


Figure 227 – DRX pattern (both short and long DRX cycles configured)

LTE in Bullets, FIG. 227; see also *LTE in Bullets*, 12, Table 279 (identifying “onDurationTimer” specification of PDCCH monitoring for DRX).



Sesia LTE, FIG. 4.19.

89. These references describe the DRX operation that 3GPP adopted in several of its technical specifications prior to the '911 patent's earliest claimed priority date.

90. TS 36.321 v15.4.0 ("TS 36.321"; Ex. 1010), for example, relates to the Medium Access Control (MAC) protocol, including DRX functionality. Under the "Definitions" section, TS 36.321 provides the following DRX-related definitions:

Active Time: Time related to DRX operation, as defined in subclause 5.7, during which the MAC entity monitors the PDCCH. ...

DRX Cycle: Specifies the periodic repetition of the On Duration followed by a possible period of inactivity (see figure 3.1-1 below).

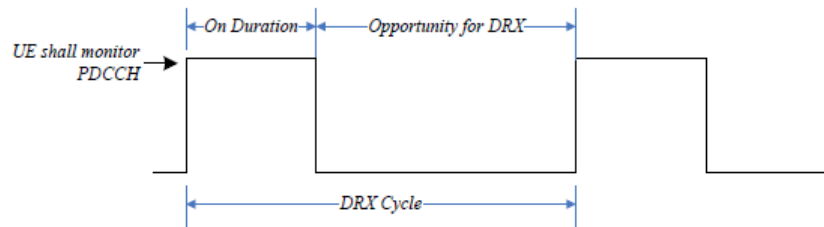


Figure 3.1-1: DRX Cycle

drx-InactivityTimer: Except for NB-IoT UEs, BL UEs or UEs in enhanced coverage, it specifies the number of consecutive PDCCH-subframe(s) after the subframe in which a PDCCH indicates an initial UL, DL or SL user data transmission for this MAC entity. ...

onDurationTimer: Specifies the number of consecutive PDCCH-subframe(s) at the beginning of a DRX Cycle.

TS 36.321, 8-9.³

91. Section 5.7 of *TS 36.321* describes “Discontinuous Reception (DRX)” generally. *TS 36.321*, 53-56. *TS 36.321* explains that

³ A number of subframes can also be specified as a period of time (e.g., 10ms for 10 subframes each corresponding to 1ms). See Ex. 1021, *TS 38.211*, 9 (describing “ten subframes,” each being “1ms duration”); Ex. 1012, *TS 38.331*/216-218 (specifying *drx-onDurationTimer* in milliseconds).

The *MAC entity [UE] may be configured by RRC* with a DRX functionality that controls the UE's PDCCH monitoring activity for the MAC entity's C-RNTI [identifier⁴] When in RRC_CONNECTED, if DRX is configured, the MAC entity [UE] is allowed to *monitor the PDCCH discontinuously* using the DRX operation specified in this subclause; otherwise the MAC entity monitors the PDCCH continuously. ... *RRC controls DRX operation by configuring the timers onDurationTimer, drx-InactivityTimer, ...*

When a DRX cycle is configured, the Active Time includes the time while:

- *onDurationTimer* or *drx-InactivityTimer* ... is running

When DRX is configured, the MAC entity [UE] shall monitor for each [PDCCH] subframe: ...

- if the Long DRX Cycle is used ... : ...

- *start onDurationTimer.*

- *if the PDCCH indicates a new transmission* (DL, UL, or SL):

⁴ See TS 38.300, 36 (“UE identities ... – C-RNTI: unique UE identification used as an identifier of the RRC Connection and for scheduling”).

– except for an NB-IoT UE configured with a single DL and UL HARQ process, ***start or restart drx-InactivityTimer***.

TS 36.321, 53-55 (emphases added). Annex C of *TS 36.321* provides the “[i]ntended UE behaviour for DRX Timers,” explains that, “[w]hen a DRX timer is set to a value of X, and n denotes the subframe in which the related event is triggered according to the subclause 5.7, the intended behaviours of each DRX timer are presented in the Table C-1 below:

Table C-1: Intended UE behaviour for DRX timers

DRX Timers	Intended UE behaviour ([x, y] means including subframe x and y)
drx-InactivityTimer	The MAC entity monitors PDCCH in PDCCH-subframes during the subframes [n+1, n+m]. The MAC entity starts or restarts drxShortCycleTimer, and uses Short DRX Cycle in the subframe n+m+1, if configured.
...	...
onDurationTimer or onDurationTimerSCPTM	The MAC entity monitors PDCCH in PDCCH-subframes during the subframes [n, n+m-1].
...	...

TS 36.321, Annex C (Table C-1) (excerpted).

92. As shown above, *TS 36.321* provides for the same basic DRX operational steps as described in *Sesia LTE* and *LTE in Bullets*.

93. TS 38.300 v15.5.0 (“*TS 38.300*”; Ex. 1011) and TS 38.331 (“*TS 38.331*”; Ex. 1012) provide additional descriptions and details related to DRX configurations. For example, *TS 38.300* further explains in Section 5.2.3 that PDCCH is used to schedule downlink and uplink transmissions with the UE by providing scheduling information. *TS 38.300*, 19. *TS 38.300* explains that “[t]he Physical Downlink Control Channel (PDCCH) can be ***used to schedule DL transmissions*** on PDSCH and UL transmissions on PUSCH, where the Downlink Control Information (DCI) on PDCCH includes: – Downlink assignments containing at least ***modulation and coding format, resource allocation***, and hybrid-ARQ information related to DL-SCH” *TS 38.300*, 19 (emphases added). To achieve this scheduling, the “***UE monitors a set of PDCCH candidates*** in the configured monitoring occasions ***in one or more configured Control Resource Sets (CORESETs) according to the corresponding search space configurations***” where “[a] CORESET consists of a set of PRBs [Physical Resource Blocks] with a time duration of 1 to 3 OFDM symbols.” *TS 38.300*, 19 (emphases added). *TS 38.300* explains that “Downlink Scheduling” occurs when “the gNB [base station] ... dynamically allocate[s] resources to UEs via the C-RNTI on PDCCH(s). A ***UE always monitors the PDCCH(s)*** in order to find ***possible assignments when its downlink*** reception is enabled (activity ***governed by DRX*** when configured).” *TS 38.300*, 61. The DRX functionality for UE behavior is

the same in *TS 38.300* as described in *TS 36.321*. See *TS 38.300*, 64, FIG. 11-1 (describing “UE Power Saving” for DRX, “on-duration,” “inactivity-timer,” DRX “cycle,” and “active-time” the same as *TS 36.321*). A POSITA would have expected this same DRX behavior for *TS 38.300*, *TS 38.321*, and *TS 36.321* because they are relevant specifications that describe DRX operations.

94. *TS 38.331* provides a more specific level of operation at the configuration level. See, e.g., *TS 38.331*, 216-218, 227, 250, 319-322 (describing DRX configuration, CORESET, and search space parameters). For example, the “*DRX-Config*” information element “is used to configure DRX related parameters,” such as “drx-onDurationTimer” and “drx-InactivityTimer.” *TS 38.331*, 216-218 (describing value parameters for timers in DRX-Config fields). *TS 38.331* cross-references *TS 38.321* (Ex. 1022), which provides substantially the same descriptions of the DRX parameters as *TS 36.321*, as shown below.

The ***MAC entity [UE] may be configured by RRC*** with a DRX functionality that controls the UE’s PDCCH monitoring activity for the MAC entity’s C-RNTI When using DRX operation, the MAC entity [UE] shall also monitor PDCCH according to requirements found in other subclauses of this specification. When in RRC_CONNECTED, if DRX is configured, for all the activated Serving Cells, the MAC entity may monitor the PDCCH discontinuously using the DRX operation

specified in this subclause; otherwise the MAC entity shall monitor the PDCCH continuously.

RRC controls DRX operation by configuring the following parameters:

- ***drx-onDurationTimer: the duration at the beginning of a DRX Cycle; ...***
- *drx-InactivityTimer*: the duration after the PDCCH occasion in which a PDCCH indicates a new UL or DL transmission for the MAC entity;

When a ***DRX cycle*** is configured, the ***Active Time*** ***includes*** the time while:

- ***drx-onDurationTimer*** or ***drx-InactivityTimer ... is running***

TS 38.321, 38 (emphases added).

95. *TS 38.331* also explains that the CORESET/search space may be configured by the network (e.g., base station) to appropriately allocate resources among the UEs. *TS 38.331*, 250, 319-322. As explained in *TS 36.621* and *TS 38.321*, the base station uses RRC signaling to configure the UE with search spaces for PDCCH monitoring. *TS 36.321*, 53; *TS 38.321*, 38. For example, *TS 38.331* explains that the “SearchSpace” information element (“IE”) is contained in “PDCCH-Config” as part of an “RRCSetup” message received from base station, and “is used to configure UE specific PDCCH parameters such as control resource

sets (CORSET), search spaces and additional parameters for acquiring the PDCCH” and “defines how/where to search for PDCCH candidates.” Ex. 1012, *TS 38.331*, 248, 319, 322.⁵

3. Wake-Up Signals for DRX Cycles

96. 3GPP, recognizing that the transition from 4G/LTE to 5G/NR would provide an opportunity to develop further power-saving operations, also conducted several studies to further improve power consumption of UEs. This was considered in several TSG-RAN working group meetings, such as meeting #96 and meeting #96bis, held February 25 – March 1, 2019, and April 8-12, 2019, respectively. Both of these meetings occurred before the earliest priority date of the '911 patent. One of the focuses of the #96 and #96bis meetings was the development of a “power saving signal/channel” that was also referred to as a “wake-up signal[]” or “WUS.” *See, e.g., R1-1905031; R1-1903016*. Although several TDocs were discussed at these meetings, I discuss *R1-1903016* (Ex. 1008), *R1-1904738*

⁵ The “PDCCH-Config” IE is contained in the “BWP-DownlinkDedicated” IE (*TS 38.331*, 173), which is contained in the “ServingCellConfig” IE (*TS 38.331*, 325), which is contained in the “CellGroupConfig” IE (*TS 38.331*, 178), which is contained in the “RRCSetup” message transmitted from the network (base station) to the UE (*TS 38.331*, 139).

(Ex. 1013); *R1-1905031* (Ex. 1007); *R1-1905384* (Ex. 1014); and *R1-1905466* (Ex. 1015) as exemplary of the POSITA's knowledge prior to the '911 patent's earliest claimed priority date.

97. In *R1-1903016*, titled "Potential Techniques for UE Power Saving," a "PDCCH-based Wake-Up Signaling" ("PDCCH-based WUS" or "PDCCH-WUS") is discussed. Ex. 1008, *R1-1903016*, 1-2. *R1-1903016* explains the "[d]esign principles" of the PDCCH-WUS:

At first, [the] UE wakes up from sleep (i.e., C-DRX off periods) and tries PDCCH-WUS decoding. When PDCCH-WUS is not decoded in the 1st wake-up (i.e., WUS occasion), the UE can go back to sleep immediately, skipping the 2nd stage wake-up (i.e., ON duration); otherwise, UE continues with the 2nd stage wake-up and to the ON duration for DL assignment and data reception.

R1-1903016, 1. *R1-1903016* acknowledges that this "may sound counter-intuitive," but explains that the "UE's power consumption for ON duration and for [a] WUS occasion can be very different, even if the signaling scheme for both is based on PDCCH" because "during [a] WUS occasion, a low power implementation can be achieved." *R1-1903016*, 1. The PDCCH-WUS notifies the UE whether to wake up and monitor PDCCH during ON duration of a DRX cycle because, "[o]nly when a PDCCH-WUS is decoded, the UE performs wake-up of additional hardware and processing (e.g., by performing BWP switching, CSI-RS processing, etc.) to get

ready for potential DL/UL scheduling” in ON duration. Ex. 1008, *R1-1903016*, 1-2, FIG. 1. This is shown graphically below.

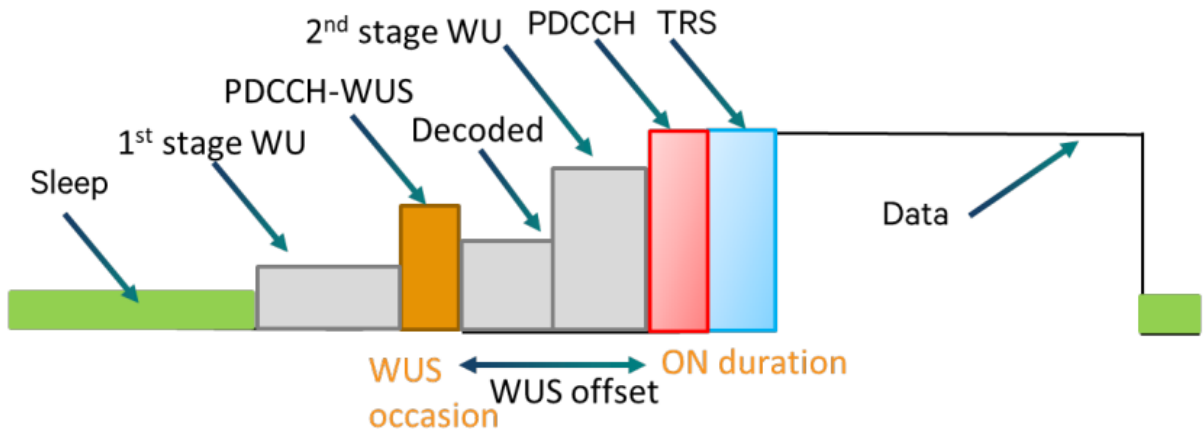


Figure 1: Two-stage wake-up timeline for PDCCH-based WUS

Ex. 1008, *R1-1903016*, 2, FIG. 1. When providing the PDCCH-WUS, “each UE can be configured with a specific BWP [bandwidth part], CORESET/search space, ... RNTI, etc., to monitor and distinguish its own PDCCH-WUS from others.”

Ex. 1008, *R1-1903016* goes on to provide additional results of studies showing power consumption savings resulting from PDCCH-WUS implementations.

98. *R1-1905031*, *R1-1904738*, *R1-1905384*, and *R1-1905466* further explain the PDCCH-WUS described in *R1-1903016*. For example, *R1-1905031* has the “objective” of “[s]pecify[ing] the PDCCH-based power saving signal/channel.” *R1-1905031*, 1. *R1-1905031* describes “two main use cases of PDCCH-based power saving signals” for different situations. Ex. 1007, *R1-1905031*, 1-2. The first use case relates to “wake-up signaling (WUS) during the inactive state (e.g.,

C-DRX off periods).” *R1-1905031*, 1-2. In this use case, the “UE enters the first stage for monitoring a wake-up PDCCH” only, but “does not expect to receive a same-slot scheduling grant for PDSCH” that occurs in ON duration PDCCH monitoring. Ex. 1007, *R1-1905031*, 2. Then, “when a wake-up PDCCH is decoded, the UE transitions to the second stage, by waking up additional hardware and processing (e.g., BWP/CC switching, CSI-RS processing, etc.), to get ready for DL/UL data scheduling” during the ON duration PDCCH monitoring” Ex. 1007, *R1-1905031*, 2. If no WUS PDCCH is received, the second-stage wake-up “can be skipped.” Ex. 1007, *R1-1905031*, 2. *R1-1905031* shows the same figure describing this PDCCH-WUS operation as *R1-1903016*, shown below.

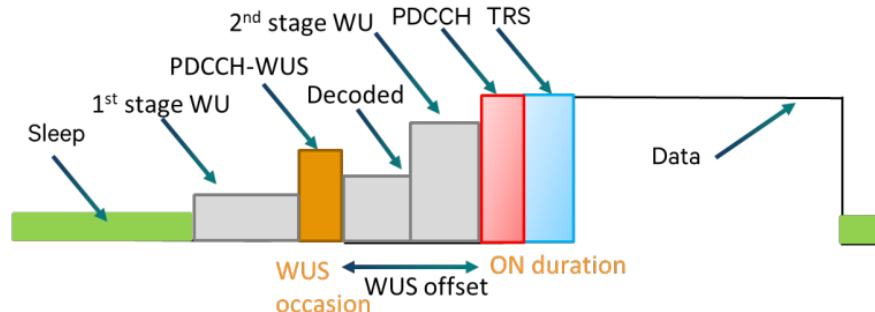


Figure 1: Two-stage wake-up timeline for PDCCH-based WUS (y-axis roughly proportional to power consumption)

Ex. 1007, *R1-1905031*, FIG. 1; compare Ex. 1008, *R1-1903016*, FIG. 1.

99. *R1-1905031* explains that the “detailed design of wake-up PDCCH may include a CORESET/Search space/BWP configuration for power-efficient WUS detection.” Ex. 1007, *R1-1905031*, 2. More specifically, a “power saving signal/channel can be used in the WUS (wake-up signaling).” *R1-1905031*, 3. In

this case, “[t]he primary function of the wake-up signal for C-DRX is to indicate whether the UE should wake-up and be prepared for transmission and reception in the upcoming C-DRX on-duration.” *R1-1905031*, 3. The WUS-PDCCH design also includes a “[w]ake-up CORESET,” which can be “a CORESET containing the wake-up PDCCH hav[ing] a configuration that can be distinct from CORESETs containing PDCCH scheduling transmissions” during ON duration monitoring. *R1-1905031*, 3.

100. *R1-1904738* provides additional but similar teachings, confirming the POSITA’s understanding of WUS-PDCCH. Like *R1-1903016* and *R1-1905031*, *R1-1904738* describes a “PDCCH-based power saving signal/channel.” *R1-1904738*, 1. *R1-1904738* describes two options, similar to those described in *R1-1905031*, in which option 1 explains that a “power saving signal in NR can be used to indicate UE whether to monitor PDCCH in a DRX on duration or not.” *R1-1904738*, 2; *see also* *R1-1904738*, 1. For example, “if [the] UE successfully detects power saving signal, [the] UE ... monitors PDCCH when drx-onDurationTimer is running as R15 DRX operation,” but “[i]f [the] UE cannot detect power saving signal, UE will not monitor PDCCH in this DRX cycle.” *R1-1904738*, 2. This is shown in FIG. 1 below.

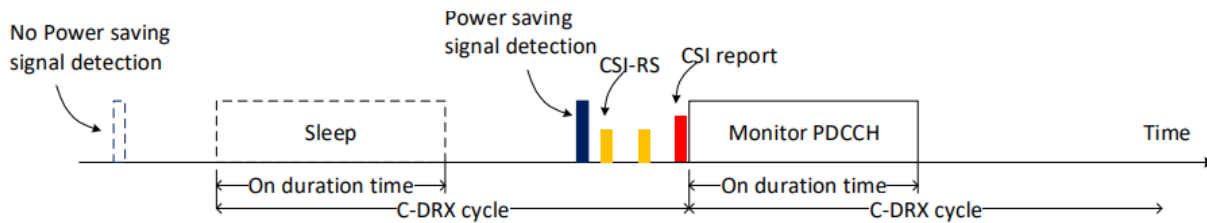


Figure 1. Procedure of CSI measurement before DRX ON triggered by power saving signal

R1-1904738, FIG. 1.

101. R1-1905384 addresses additional aspects of the “PDCCH-based power saving signal/channel,” including “search space” and “CORESET” configurations. R1-1905384, 1, 3, 7. R1-1905384 explains that some of the “[m]ain components in PDCCH monitoring comprise *control resource set (CORESET) configuration* for determining time and frequency resources for CCEs, *search space set configuration* for determining how and when UE monitors PDCCH, DCI format (part of search space set configuration) for determining signalled information and *RNTI for addressing the information to the certain UE(s)*.” R1-1905384, 3 (emphases added). The “set of PDCCH candidates for a UE to monitor is defined in terms of PDCCH search space sets” for the wake-up signal monitoring and “define[] how and where to search PDCCH candidates.” R1-1905384, 7. “Each search space set is associated with one CORESET.” R1-1905384, 7. Although several options are possible, one option includes “[a] power saving channel specific search space set could be associated to power saving

specific CORESET for power saving (CORESET-PS) for monitoring power save DCI format,” although other CORESETs are also possible. *R1-1905384*, 7.

102. Last, *R1-1905466* confirms that “the PDCCH based power saving signal needs to indicate ‘wake-up’ based on which the UE can decide to decode/not decode subsequent PDCCH monitoring occasion(s),” which can be performed “using a regular PDCCH decoder.” *R1-1905466*, 1-2. As with the previous documents, *R1-1905466* refers to a “DCI size/format for PDCCH-based wakeup signal (WUS)” that is “monitored separately (e.g. X slots before DRX On duration) from scheduling PDCCH monitoring.” *R1-1905466*, 3. This PDCCH-WUS “can largely reuse the coreset and search space configurations used for configuring PDCCH monitoring for the UE.” *R1-1905466*, 3. As before, “if a WUS is detected in a WUS monitoring occasion, the UE should wake-up for the ON duration(s) associated with the WUS monitoring occasion.” *R1-1905466*, 3.

103. *R1-1905466* also addresses situations where the “UE miss[es] the WUS.” *R1-1905466*, 3. Because “missing the WUS” “can increase latency significantly,” then “as a fall-back[, the] UE should monitor some search spaces/PDCCH On durations even when WUS is not detected.” *R1-1905466*, 3-4.

104. Thus, these basic textbooks and 3GPP documents show that a POSITA was well acquainted with the following features of DRX operations before April 30, 2019, the earliest claimed priority date of the ’911 patent:

- The network (base station) providing configuration information to configure the UE to monitor a scheduling PDCCH search space during ON duration for scheduling information, such as the CORESET/search space for receiving a PDCCH containing a DCI.
- The network (base station) providing configuration information to configure the UE to monitor a WUS PDCCH search space to receive wake-up information, such as the CORESET/search space for WUS monitoring.
- The UE monitoring the scheduling PDCCH CORESET/search space during ON duration for the period of the onDurationTimer to determine scheduling information for a downlink or uplink transmission.
- When the WUS is not detected, the UE may still monitor the PDCCH ON duration search space for scheduling information, for example, to prevent latency caused by “missing,” e.g., not detecting, the WUS.

VII. THE '911 PATENT

A. Alleged Invention of the '911 Patent

105. As I discuss in Section VI.A above, the '911 patent acknowledges that much of its teachings were known WUS-DRX operations for prior art 4G/LTE and

5G/NR systems. I repeat some of that discussion below, followed by a description of what the '911 patent describes as its contribution to the art.

106. The '911 patent “generally relates to wireless communications, and more particularly, to a method of physical downlink control channel (PDCCH) monitoring and a related device.” Ex. 1001, 1:16-21. The '911 patent acknowledges that, for prior-art 4G (LTE) and 5G (NR) devices, “[o]ne efficient UE power saving mechanism is to trigger the UE for network access from a power efficient mode” described as a “Discontinuous Reception (DRX) cycle.” Ex. 1001, 1:35-49. The '911 patent also acknowledges that this prior art DRX user equipment, a “power saving signal/channel/procedure is used” in which the “power saving signal/channel” is used to “trigger[] the UE to achieve reduction in PDCCH monitoring is related to using the power saving signal/channel to trigger UE to skip PDCCH monitoring” Ex. 1001, 2:1-18. Similarly, the '911 patent acknowledges that a “on-duration” timer (e.g., “drx-onDurationTimer”) refers to the “duration that the UE waits after waking up, to receive PDCCHs” and an “inactivity-timer” refers to the “duration that the UE waits to successfully decode a PDCCH, from the last successful decoding of a PDCCH” during “on-duration.” Ex. 1001, 2:29-41, 2:61-65. The DRX “active-time” describes the “total duration that the UE monitors PDCCH” and “includes the ‘on-duration’ of the DRX cycle,” and “the time [the] UE is performing continuous reception while the inactivity

timer has not expired, and the time when the UE is performing continuous reception while waiting for a retransmission opportunity.” Ex. 1001, 2:46-51.

107. The '911 patent also acknowledges that the prior art 4G (LTE) and 5G (NR) DRX operation also included monitoring “a WUS [wake-up signaling] on a WUS occasion.” Ex. 1001, 3:12-14. “If the UE receives the WUS signal on the WUS occasion, the UE may spend a time to decode the WUS signal, and then wake up to monitor the PDCCH on the upcoming (or next) on-duration time of the DRX cycle.” Ex. 1001, 3:14-17. However, “if the UE does not receive the WUS signal on the WUS occasion, the UE could switch to the sleep state, namely not wake up to monitor the PDDCH [sic] for a period (until the next WUS occasion or on-duration time).” Ex. 1001, 3:13-22. I copy my previous annotated FIG. 2 below.

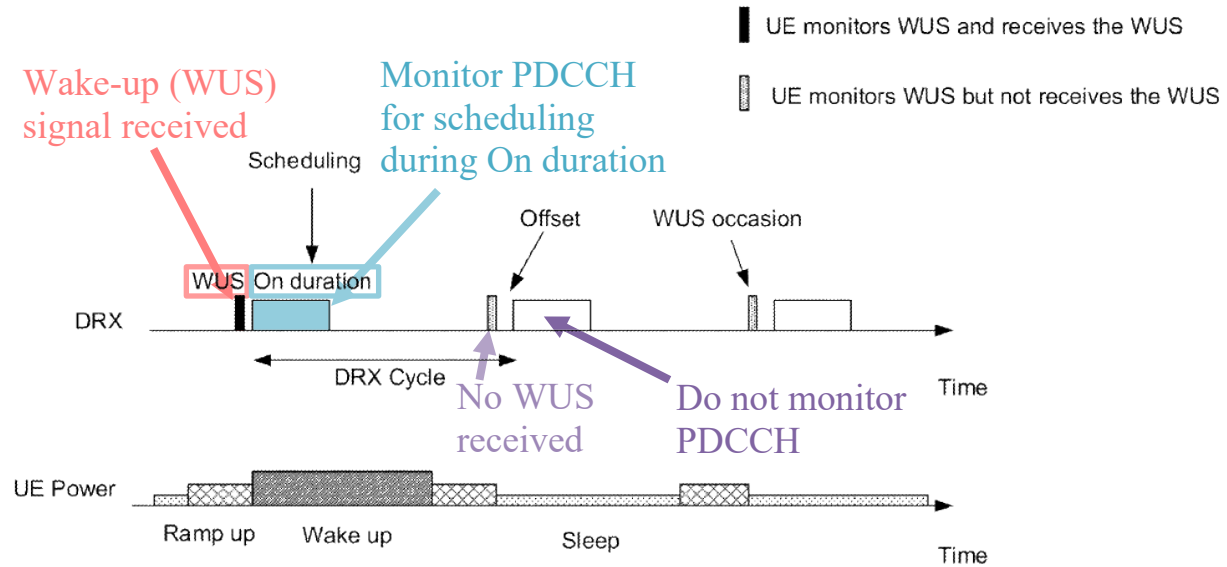


**FIG. 2
(RELATED ART)**

Ex. 1001, FIG. 2 (annotated).

108. The '911 patent also explains that “[t]he WUS occasion may be indicated by a control resource set (CORESET) or search space configuration” that “may be a specific CORESET or search space for the purpose of WUS monitoring (e.g., time and/or frequency resource for monitoring the WUS).” Ex. 1001, 3:23-30. My annotated version of prior art FIG. 3, shown below, shows example “CORESET[s] (or search space[s])” for the WUS monitoring occasion and PDCCH scheduling monitoring occasion. Ex. 1001, 3:31-34, FIG. 3.

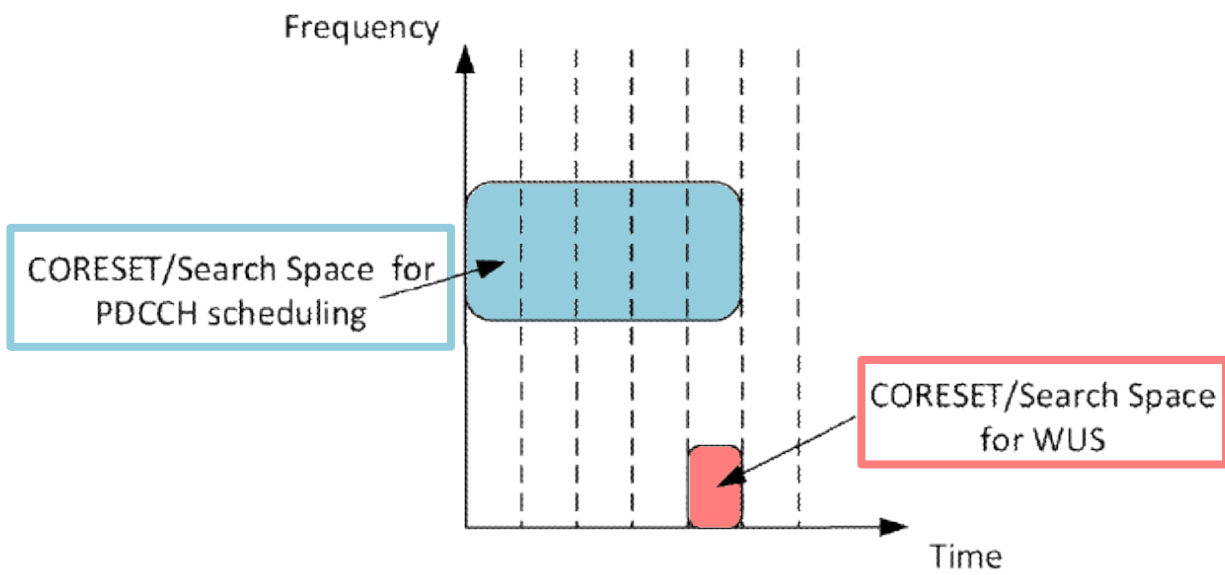


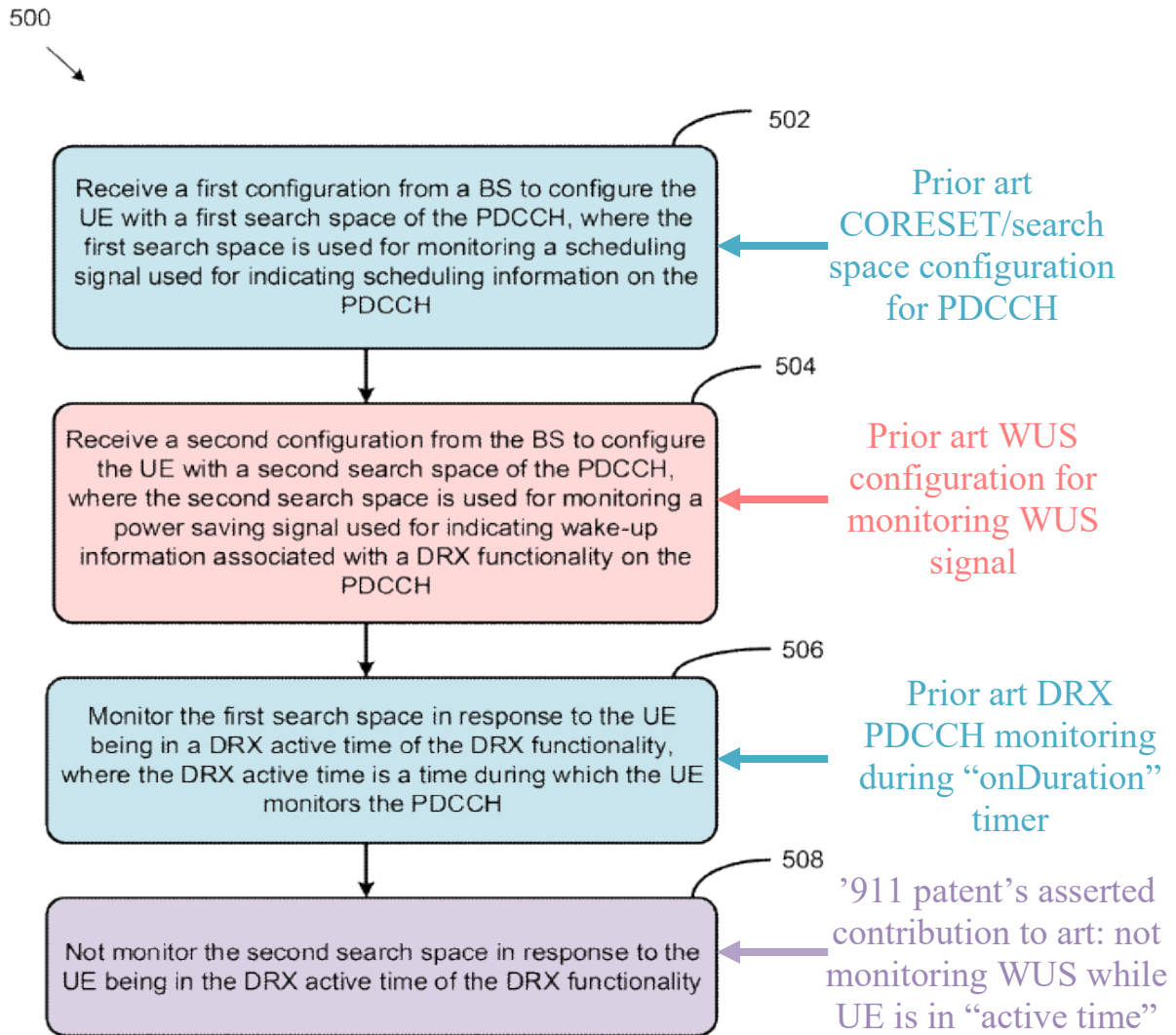
**FIG. 3
(RELATED ART)**

Ex. 1001, FIG. 3.

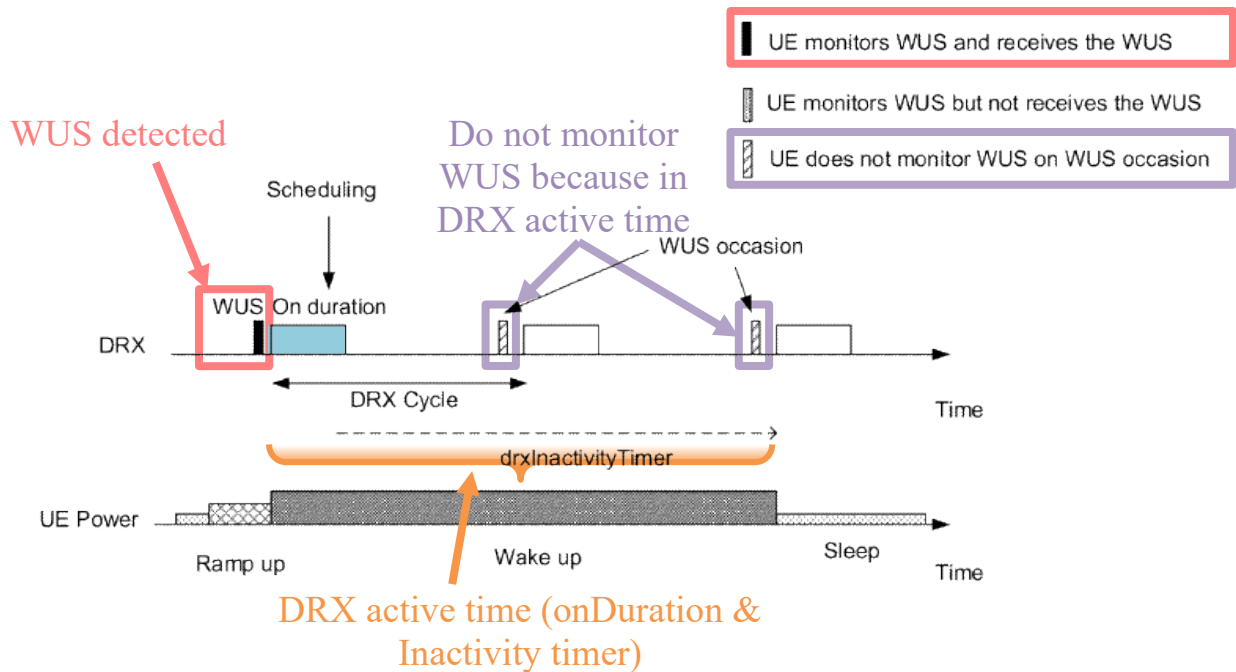
109. After acknowledging the prior art WUS-DRX functionality, the '911 patent professes to identify a problem in this prior art where, "if the active time of the UE overlaps with the on duration of the next DRX cycle (e.g., if an amount of time of the DRX inactivity timer is longer than the DRX cycle), ... the UE may need to monitor the PDCCH for scheduling as well as the WUS occasion simultaneously, which increases power consumption of the UE," which it claims to show in FIG. 4. Ex. 1001, 3:39-46, FIG. 4. The '911 patent claims to solve this

issue and “achieve[] UE power saving by not monitoring the search space for scheduling the power saving signal (e.g., WUS) during the DRX active time.”

Ex. 1001, 7:6-8, FIG. 5. In other words, the asserted advancement of the '911 patent over the prior art is to not monitor the WUS if the UE is in active time. I have annotated FIG. 5 and FIG. 6 below.

**FIG. 5**

Ex. 1001, FIG. 5.

**FIG. 6**

Ex. 1001, FIG. 6.

110. Claim 1 of the '911 patent recites:

[1Preamble] A method for a user equipment (UE) monitoring a physical downlink control channel (PDCCH), the method comprising:

[1a] receiving a first configuration from a base station to configure the UE with a first search space of the PDCCH, wherein the first search space is used for monitoring a scheduling signal used for indicating scheduling information;

[1b] receiving a second configuration from the base station to configure the UE with a second search space of the PDCCH, wherein the second search space is used for

monitoring a power saving signal used for indicating wake-up information associated with a Discontinuous Reception (DRX) functionality;

[1c] in response to not receiving the power saving signal while monitoring the second search space, starting a DRX on-duration timer of the DRX functionality;

[1d] monitoring the first search space in response to the UE being in a DRX active time of the DRX functionality, wherein the DRX active time is a time during which the UE monitors the PDCCH; and

[1e] not monitoring the second search space in response to the UE being in the DRX active time of the DRX functionality.

Ex. 1001, 13:41-64.

111. In claim 1, elements [1Preamble], [1a], [1b], and [1d] recite merely acknowledged conventional DRX wake-up signaling operations, as explained above. *See* Ex. 1001, 1:25-3:46, FIGS. 2, 3; *see supra* § VI. Element [1c] was added to claim 1 by amendment to achieve allowance because it was indicated as allowable subject matter during prosecution. Ex. 1002, 111, 147-154; *see generally* Ex. 1001. Element [1e] corresponds to the '911 patent's alleged contribution to the art, as I explain above.

B. Prosecution History

112. The application that matured into the '911 patent was filed on April 27, 2020, as U.S. Patent Application No. 16/859,945 and claims priority to U.S. Provisional Application No. 62/840,451, filed April 30, 2019. Ex. 1001, cover; Ex. 1002, 3, 56.

113. During prosecution, the examiner rejected original claims 1-4, 7, 9-14, 17, 19, and 20 under 35 U.S.C. § 103 as obvious based on U.S. Patent Application Publication No. 2020/0229092 (“Wu”) in view of U.S. Patent Application Publication No. 2019/0297577 (“Lin”), and additional prior art. Ex. 1002, 99, 101-110. The Examiner indicated that original claims 5, 6, 8, 15, 16, and 18 “are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.” Ex. 1002, 111.

114. In response, the applicant “amend[ed] independent claims 1 and 11 (without prejudice or disclaimer) to incorporate the allowable subject matter of claims 5 and 15, respectively” Ex. 1002, 153. This amendment added the language of element [1c] to the independent claims: “in response to not receiving the power saving signal while monitoring the second search space, starting a DRX on-duration timer of the DRX functionality” Ex. 1002, 148, 150.

115. The examiner then allowed the claims and certain post-allowance amendments to correct “formal matters.” Ex. 1002, 158-165.

VIII. CLAIM CONSTRUCTION

116. I have been instructed that the “intrinsic record” includes the patent itself, including the claims, description, and figures (Ex. 1001), and the patent’s prosecution history—i.e., the record of proceedings at the U.S. Patent and Trademark Office (“Patent Office”) concerning the patent (Ex. 1002). I understand that, like the claims and written description, the prosecution history provides evidence to a person of ordinary skill in the art of how the inventor intended his patent to be understood, and how the Patent Office understood the patent. I understand that the inventor is permitted to apply a special definition to the terms or to limit the scope of claim terms in his patent claims, which may differ from the term’s plain and ordinary meaning. That special definition or limitation on scope may be provided in the patent’s written description, the patent’s prosecution history, or both.

117. I understand that claim interpretation may also be informed by “extrinsic evidence” (that is, evidence outside of the patent record itself). I have been informed that extrinsic evidence may include dictionaries, technical treatises, and other materials evidencing the meaning of a claim term and the understanding held by a POSITA in the relevant time period.

118. I have been asked for purposes of this declaration to apply the plain and ordinary meaning of the claim terms as they would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of the '911 patent.

119. I understand that no claim term's construction is in dispute at this time. Based on my review of these materials and my personal knowledge and experience, I have considered each term of the '911 patent as it would have been understood by a person of ordinary skill in the art at the earliest claimed priority date of April 30, 2019.

IX. LEVEL OF ORDINARY SKILL IN THE ART

120. In rendering the opinions set forth in this declaration, I have been asked to consider the '911 patent's claims and the prior art through the eyes of a person of ordinary skill in the art (which I may also refer to as "one skilled in the art," "skilled artisan," "POSITA," or similar variation). I have considered factors such as the educational level and years of experience of those working in the pertinent art, the types of problems encountered in the art, the teachings of the prior art, patents and publications of other persons or companies, and the sophistication of the technology.

121. Taking the factors described in the Legal Standards – Level of Ordinary Skill section into consideration, it is my opinion that a person of ordinary

skill in the art (“POSITA”) at least a master’s degree in electrical engineering or a similar field and at least two years of experience working with wireless mobile telecommunications systems. In my opinion, additional relevant work experience can compensate for less education, and *vice versa*.

X. THE PRIOR ART

122. In forming my opinions, I found the following prior art relevant when considering whether the claims of the ’911 patent would have been obvious to a person of ordinary skill in the art.

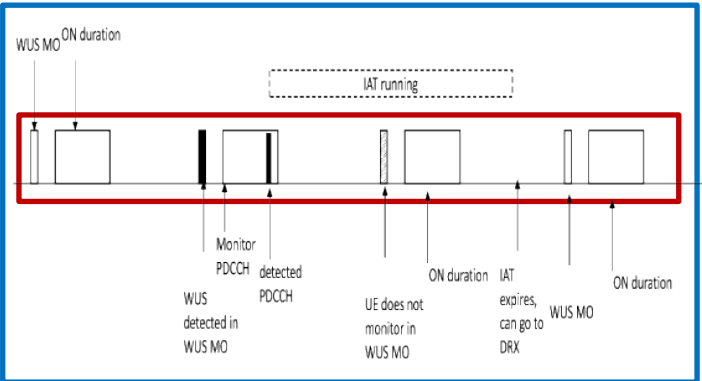
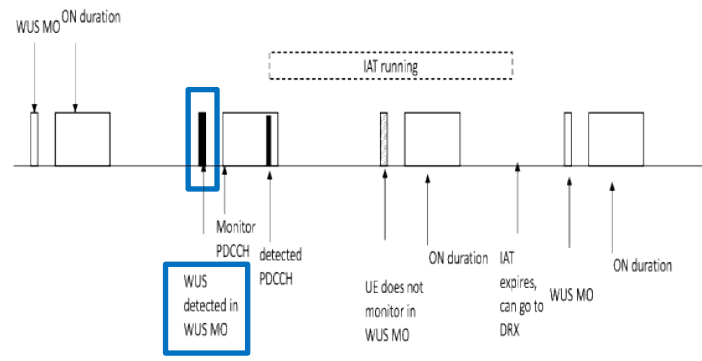
Ex. 1005	International Patent Application Publication No. WO 2020/0130930 to Nimbalker et al. (“ <i>Nimbalker</i> ”)
Ex. 1007	3GPP TSG-RAN WG1 #96bis R1-1905031, “PDCCH-based power saving channel design” (2019) (“ <i>R1-1905031</i> ”)
Ex. 1008	3GPP TSG-RAN WG1 #96 R1-1903016, “Potential Techniques for UE Power Saving” (2019) (“ <i>R1-1903016</i> ”)
Ex. 1009	International Patent Application Publication No. WO 2019/135654 to Anil et al. (“ <i>Anil</i> ”)

A. *Nimbalker*

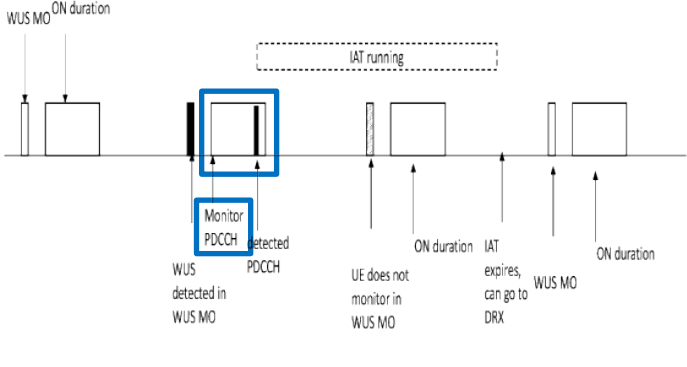
123. International Patent Application Publication No. WO 2020/130930 (“*Nimbalker*”; Ex. 1005) was filed December 23, 2019, and published June 25, 2020. *Nimbalker* claims priority to U.S. Provisional Application No. 62/784,114 (“*Nimbalker Provisional*”; Ex. 1006), filed December 21, 2018. The *Nimbalker Provisional* contains substantially the same relevant disclosures as *Nimbalker*. Throughout this declaration, I cite to both *Nimbalker* and the *Nimbalker Provisional* to show the correspondence. I have been instructed that this makes *Nimbalker* prior art to the ’911 patent.

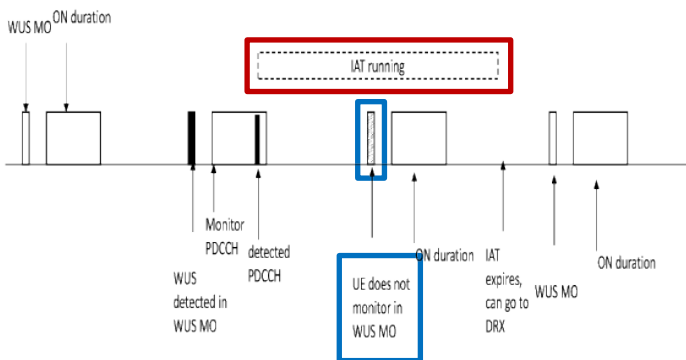
124. I was asked to compare *Nimbalker*’s claim 1 to the disclosures of the *Nimbalker Provisional* to determine whether the limitations of *Nimbalker*’s claim 1 are supported by the *Nimbalker Provisional*. It is my opinion that they are. In the chart below, I compare *Nimbalker* claim 1 to the prior disclosures in the *Nimbalker Provisional*’s disclosures filed December 21, 2018.

<i>Nimbalker</i> Claim 1	<i>Nimbalker Provisional</i> Support
1. A method performed by a wireless device (510) configured with Discontinuous Reception,	“1. A method performed by a wireless device, the method comprising:” <i>Nimbalker Provisional</i> , claim 1.

<i>Nimbalker Claim 1</i>	<i>Nimbalker Provisional Support</i>
DRX, the method comprising:	“According to a first set of embodiments, a UE can be configured with DRX and WUS resources.” <i>Nimbalker Provisional 20.</i>  Figure 2 <i>Nimbalker Provisional, 21, FIG. 2.</i>
monitoring (1602) for a first wakeup signal, WUS, during a first WUS monitoring occasion;	“monitoring for a wakeup signal during a wakeup signal monitoring occasion;” <i>Nimbalker Provisional, claim 1.</i>  Figure 2

<i>Nimbalker Claim 1</i>	<i>Nimbalker Provisional Support</i>
	<i>Nimbalker Provisional</i> , 21, FIG. 2.
in response to the wireless device detecting the first WUS during the first WUS monitoring occasion:	“if the wireless device detects a wakeup signal during the wakeup signal monitoring occasion:” <i>Nimbalker Provisional</i>, claim 1. Figure 2 <i>Nimbalker Provisional</i>, 21, FIG. 2.
monitoring (1604) a downlink control channel during a downlink control channel monitoring occasion associated with the detected first WUS; and	“monitoring a downlink channel during a downlink channel monitoring occasion associated with the detected wakeup signal;” <i>Nimbalker Provisional</i>, claim 1.

<i>Nimbalker Claim 1</i>	<i>Nimbalker Provisional Support</i>
	 Figure 2 <i>Nimbalker Provisional</i>, 21, FIG. 2.
abstaining (1604) from monitoring for a second WUS in a second WUS monitoring occasion based on a condition.”	“abstaining from monitoring for other wakeup signals while monitoring the downlink channel; and” <i>Nimbalker Provisional</i>, claim 1. “The UE may determine whether to attempt to detect WUS in a monitoring occasion based on a condition. Figure 2 illustrates a particular example, which will be described in further detail below.” <i>Nimbalker Provisional</i>, 20. “Figure 2: Example showing WUS operation including an example where UE does not monitor WUS in a

<i>Nimbalker Claim 1</i>	<i>Nimbalker Provisional Support</i>
	WUS occasion based on a condition (IAT running).” <i>Nimbalker Provisional</i>, 21.  Figure 2 <i>Nimbalker Provisional</i>, FIG. 2.

125. Based on my understanding of analogous art, it is my opinion that *Nimbalker* is analogous art to the '911 patent because it is directed to the same field of endeavor—wireless communications, including physical downlink control channel (“PDCCH”) monitoring. *Nimbalker*, 2, 8-9, FIGS. 2-3; *Nimbalker Provisional*, 17-18, 20, FIGS. 2-3; Ex. 1001, 1:18-21, 3:50-4:23. *Nimbalker* is also directed to the same problem as the '911 patent, for example, wake-up signals for discontinuous reception (DRX). *Nimbalker*, 2, 8-9, FIGS. 2-3; *Nimbalker Provisional*, 17-18, 20, FIGS. 2-3; Ex. 1001, Abstract, 2:52-4:23.

B. R1-1905031

126. 3GPP TSG-RAN WG1 #96bis R1-1905031, titled “PDCCH-based power saving channel design” (“*R1-1905031*”; Ex. 1007). I understand that *R1-1905031* was made publicly available not later than April 3, 2019, on 3GPP’s ftp server where it was accessible and known to be found by POSITAs. Ex. 1026, Rodermund Declaration, ¶¶21, 69-77. I also understand that *R1-1905031* was also made available and discussed at the 3GPP TSG-RAN WG1 #96bis meeting April 8-12, 2019, where it was publicly available to and discussed by POSITAs. Ex. 1026, Rodermund Declaration ¶¶69-77. I have been instructed that this makes *R1-1905031* prior art to the ’911 patent.

127. Based on my understanding of analogous art, it is my opinion that *R1-1905031* is analogous art to the ’911 patent because it is directed to the same field of endeavor—wireless communications, including physical downlink control channel (“PDCCH”) monitoring. *R1-1905031*, 1-10; Ex. 1001, 1:18-21, 3:50-4:23. *R1-1905031* is also directed to the same problem as the ’911 patent, for example, wake-up signals for discontinuous reception (DRX). *R1-1905031*, 1-10; Ex. 1001, Abstract, 2:52-4:23.

C. R1-1903016

128. 3GPP TSG-RAN WG1 #96 R1-1903016, titled “Potential Techniques for UE Power Saving” (“*R1-1903016*”; Ex. 1008). I understand that *R1-1903016*

was made publicly available not later than February 16, 2019, on 3GPP's ftp server where it was accessible and known to be found by POSITAs. Ex. 1026, Rodermund Declaration ¶¶20, 60-68. I also understand that *R1-1903016* was also made available and discussed at the 3GPP TSG-RAN WG1 #96 meeting February 25 through March 1, 2019, where it was publicly available to and discussed by POSITAs. Ex. 1026, Rodermund Declaration ¶¶60-68. I have been instructed that this makes *R1-1903016* prior art to the '911 patent.

129. Based on my understanding of analogous art, it is my opinion that *R1-1903016* is analogous art to the '911 patent because it is directed to the same field of endeavor—wireless communications, including physical downlink control channel (“PDCCH”) monitoring. *R1-1903016*, 1-4; Ex. 1001, 1:18-21, 3:50-4:23. *R1-1903016* is also directed to the same problem as the '911 patent, for example, wake-up signals for discontinuous reception (DRX). *R1-1903016*, 1-4; Ex. 1001, Abstract, 2:52-4:23.

D. *Anil*

130. International Patent Application Publication No. WO 2019/135654 (“*Anil*”; Ex. 1009) was filed January 7, 2019; published July 11, 2019. *Anil* claims priority to U.S. Provisional Application 62/613,977, filed January 5, 2018. I have been instructed that this makes *Anil* prior art to the '911 patent.

131. Based on my understanding of analogous art, it is my opinion that

Anil is analogous art to the '911 patent because it is directed to the same field of endeavor—wireless communications, including physical downlink control channel (“PDCCH”) monitoring. *Anil*, [222]-[262]; Ex. 1001, 1:18-21, 3:50-4:23. *Anil* is also reasonably pertinent to one of the particular problems being solved by the '911 patent, for example, beam failure recovery during discontinuous reception (DRX). *Anil*, [222]-[262]; Ex. 1001, 9:21-38.

XI. GROUNDS OF UNPATENTABILITY

132. Based on my review of the materials set forth above, including my application of the knowledge of a person of ordinary skill in the art, it is my opinion that claims 1-18 of the '911 patent would have been anticipated and/or obvious to one of ordinary skill in the art.

133. In particular, it is my opinion that claims 1-18 of the '911 patent would have been anticipated and/or obvious to a person of ordinary skill in the art based on the Grounds and respective combinations shown below:

Ground	Challenged Claims	Basis	Prior Art
1/2	1-3, 5, 6, 10-12, 14, 15	Anticipation / Obviousness	<i>Nimbalker</i>
3	2, 4, 11, 13	Obviousness	<i>Nimbalker</i> and <i>R1-1905031</i>
4	2, 4, 11, 13	Obviousness	<i>Nimbalker</i> and <i>R1-1903016</i>
5	7-9, 16-18	Obviousness	<i>Nimbalker</i> and <i>Anil</i>

XII. THE CHALLENGED CLAIMS ARE UNPATENTABLE OVER THE PRIOR ART

134. In my opinion claims 1-18 would have been anticipated by the prior art or rendered obvious to one skilled in the art based on the prior art at the earliest priority date of the '911 patent.

A. Grounds 1 and 2: Claims 1-3, 5, 6, 10-12, 14, and 15 Are Anticipated or Rendered Obvious by *Nimbalker*

135. *Nimbalker* anticipates or renders obvious claims 1-3, 5, 6, 10-12, 14, and 15.

1. Independent Claim 1

136. Claim 1 describes basic discontinuous reception (“DRX”) with wake-up signal operations in elements [1a], [1b], and [1d]. Elements [1c] and [1e] add additional limitations for when the wake-up signal is misdetected (described in [1c]) and when the wake-up signal monitoring period overlaps with the active time that the UE is monitoring the PDCCH (e.g., an ON duration period or inactivity timer period; described in [1e]). A POSITA would have understood that *Nimbalker* discloses each element of claim 1 or, alternatively, renders obvious claim 1.

a. **[1Preamble]: “A method for a user equipment (UE) monitoring a physical downlink control channel (PDCCH), the method comprising:”**

137. A POSITA would have recognized that *Nimbalker* discloses a method for a user equipment (UE) monitoring a physical downlink control channel (PDCCH).

138. For example, *Nimbalker* discloses that, in wireless communication systems, “significant power can be spent on monitoring the Physical Downlink Control Channel (PDCCH) in Long-term Evolution (LTE) based on a discontinuous reception (DRX) setting.” *Nimbalker*, 2; *Nimbalker Provisional*, 17-18. *Nimbalker* explains that a “similar problem may also exist in NR if similar DRX settings with traffic modelling are utilized.” *Nimbalker*, 2; *Nimbalker Provisional*, 18. In such cases, “the user equipment (UE) may need to perform blind detection in its configured control resource sets (CORESETs) to identify whether there is a PDCCH sent to it.” *Nimbalker*, 2; *Nimbalker Provisional*, 18. To reduce the power consumption, *Nimbalker* teaches “[t]echniques that can reduce unnecessary PDCCH monitoring or allow the UE to go to sleep or wake-up only when required can be beneficial and reduce power consumption.” *Nimbalker*, 2; *Nimbalker Provisional*, 18.

139. In doing so, *Nimbalker* discloses monitoring PDCCH for a wake-up signal (“WUS”) and for scheduling and data transmissions during a DRX “ON

Nimbalker Provisional, 19, 20, 26, 27, FIGS. 2-3.

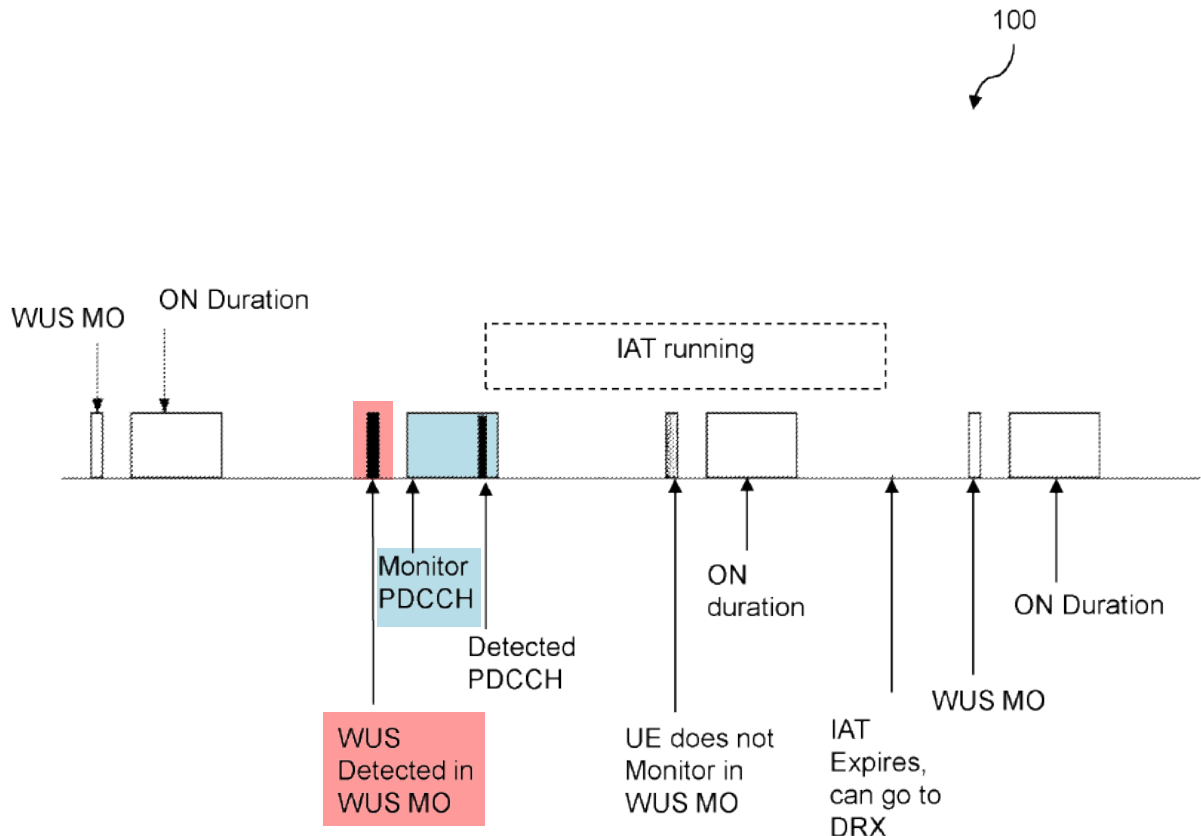


FIGURE 2

b. [1a]: “receiving a first configuration from a base station to configure the UE with a first search space of the PDCCH, wherein the first search space is used for monitoring a scheduling signal used for indicating scheduling information;”

140. A POSITA would have recognized that *Nimbalker* discloses receiving a first configuration from a base station to configure the UE with a first search

space of the PDCCH, wherein the first search space is used for monitoring a scheduling signal used for indicating scheduling information.

141. For example, *Nimbalker* discloses that a “regular PDCCH monitoring CORESET may have multiple search spaces that include search spaces configured for higher aggregation levels” (received first configuration from a base station to configure the UE with a first search space of the PDCCH). *Nimbalker*, 19; *Nimbalker Provisional*, 26. This first search space for the “PDCCH monitoring occasion” may be “preconfigured by the network or a network node,” for example, “an evolved NodeB, a gNB, or any other base station” and sent to the UE (configuration received by the UE from the base station). *Nimbalker*, 10-11; *Nimbalker Provisional*, 20. In another example, the “PDCCH monitoring occasion” search space may “be dynamically configured using information from the WUS” sent from the base station to the UE. *Nimbalker*, 10-11; *Nimbalker Provisional*, 20. Furthermore, a CORESET configuration for monitoring PDCCH containing a scheduling signal (e.g., a DCI) disclosed in *Nimbalker*, was a conventional part of DRX monitoring cycles. *See* Ex. 1014, *R1-1905384*, 3, FIG. 3 (“Main components in PDCCH monitoring comprise control resource set (CORESET) configuration for determining time and frequency resources for CCEs, search space set configuration for determining how and when UE monitors PDCCH, DCI format (part of search space set configuration) for determining

signalled information and RNTI for addressing the information to the certain UE(s), as illustrated in Figure 1 (arrow shows the association direction).”); Ex. 1024, *Sauter*, 23 (the base station transmits information on PCFICH for the UE to use to “compute[] the search space in which it [UE] has to look for assignment messages”); *Sesia LTE*, 35; *see supra* §§ VI.C.1-VI.C.2; *see also* Ex. 1012, *TS 38.331*, 248, 319, 322 (“SearchSpace” information element (“IE”) is contained in “PDCCH-Config” as part of an “RRCSetup” message received from base station, and “is used to configure UE specific PDCCH parameters such as control resource sets (CORSET), search spaces and additional parameters for acquiring the PDCCH” and “defines how/where to search for PDCCH candidates”⁶).⁷

142. *Nimbalker* also discloses the UE performing “scheduling PDCCH monitoring” to monitor for a scheduling signal used to indicate scheduling

⁶ The “PDCCH-Config” IE is contained in the “BWP-DownlinkDedicated” IE (*TS 38.331*, 173), which is contained in the “ServingCellConfig” IE (*TS 38.331*, 325), which is contained in the “CellGroupConfig” IE (*TS 38.331*, 178), which is contained in the “RRCSetup” message transmitted from the network (base station) to the UE (*TS 38.331*, 139).

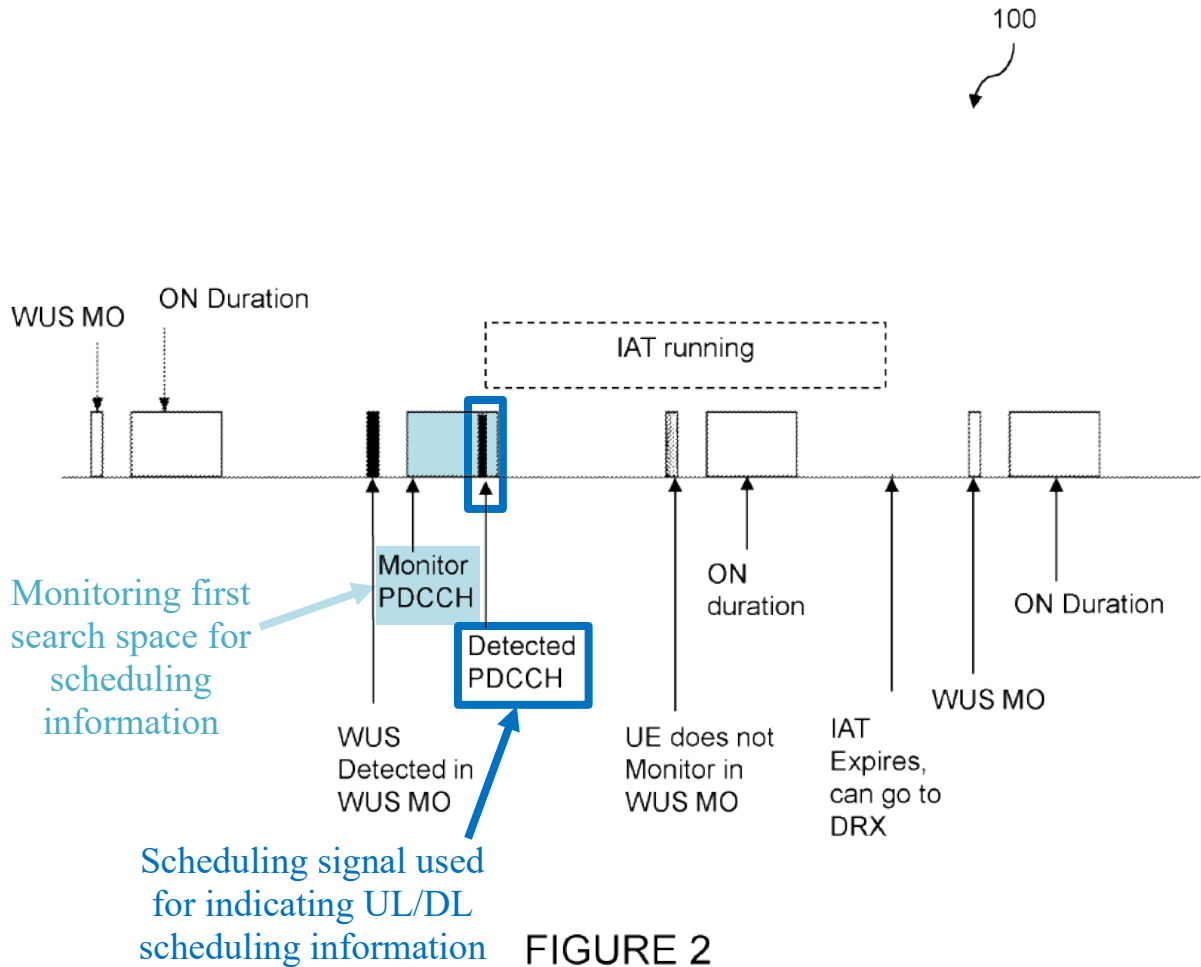
⁷ R1-1905384 also explains that “[e]ach search space set is associated with one CORESET.” *R1-1905384*, 7.

information during the DRX ON duration time when “a WUS-compatible PDCCH format” is “detect[ed].” *Nimbalker*, 20; *Nimbalker Provisional*, 27. *Nimbalker*’s first search space of the PDCCH is a “scheduling PDCCH occasion[.]” having a signal indicating scheduling information, such as, data transfer or that the UE can stop monitoring PDCCH. *Nimbalker*, 11; *Nimbalker Provisional*, 20. *Nimbalker* discloses that, while monitoring the PDCCH search space, “the UE may receive information in PDCCH Downlink Control Indicator or Downlink Control Information (DCI) (e.g.[,] in PDCCH scheduling UL/DL data for the UE)” (scheduling signal used for indicating scheduling information). *Nimbalker*, 9; *Nimbalker Provisional*, 19. As I discuss above in Section VI.C (state of the art), a POSITA would have known that a DCI sent from the base station, and received by the UE, was used to configure the UE with the search space for monitoring for scheduling information indicating downlink or uplink transmissions. For example, a POSITA would have recognized that *Nimbalker*’s configuration describes configuration parameters, such as DRX configurations and CORESET/search space configurations. See *TS 38.331*, 250, 319-322 (describing CORESET and search space parameters).

143. Monitoring the PDCCH in ON duration for the scheduling signal containing scheduling information was the purpose of the awakened DRX cycle. *Nimbalker*, 9, 11; *Nimbalker Provisional*, 19, 20 see also Ex. 1016, *Sesia LTE*, 24

(“The UE checks for scheduling messages (indicated by its C-RNTI on the PDCCH) during the ‘On Duration’ period of either the long DRX cycle or the short DRX cycle depending on the currently active cycle. When a scheduling message is received during an ‘On Duration’, the UE starts a ‘DRX Inactivity Timer’ and monitors the PDCCH in every subframe while the DRX Inactivity Timer is running.”); Ex. 1018, *Agarwal*, [0056] (“A DRX cycle consists of an ‘on duration’ when the UE 115 may monitor for control information (e.g., on PDCCH)
A UE 115 may receive scheduling messages on PDCCH during the on duration.
While monitoring PDCCH for a scheduling message, the UE 115 may initiate a ‘DRX Inactivity Timer’.” (emphasis added)).

144. *Nimbalker* FIG. 2 shows monitoring the first search space (monitor PDCCH) for the scheduling information (detected PDCCH with “Downlink Control Indicator or Downlink Control Information (DCI) (e.g.,] in PDCCH scheduling UL/DL data for the UE)”). *Nimbalker*, 9; *Nimbalker Provisional*, 19.



Nimbalker, FIG. 2; *Nimbalker Provisional*, FIG. 2.

- c. [1b]: “receiving a second configuration from the base station to configure the UE with a second search space of the PDCCH, wherein the second search space is used for monitoring a power saving signal used for indicating wake-up information associated with a Discontinuous Reception (DRX) functionality;”

145. A POSITA would have recognized that *Nimbalker* discloses receiving a second configuration from the base station to configure the UE with a second search space of the PDCCH, wherein the second search space is used for

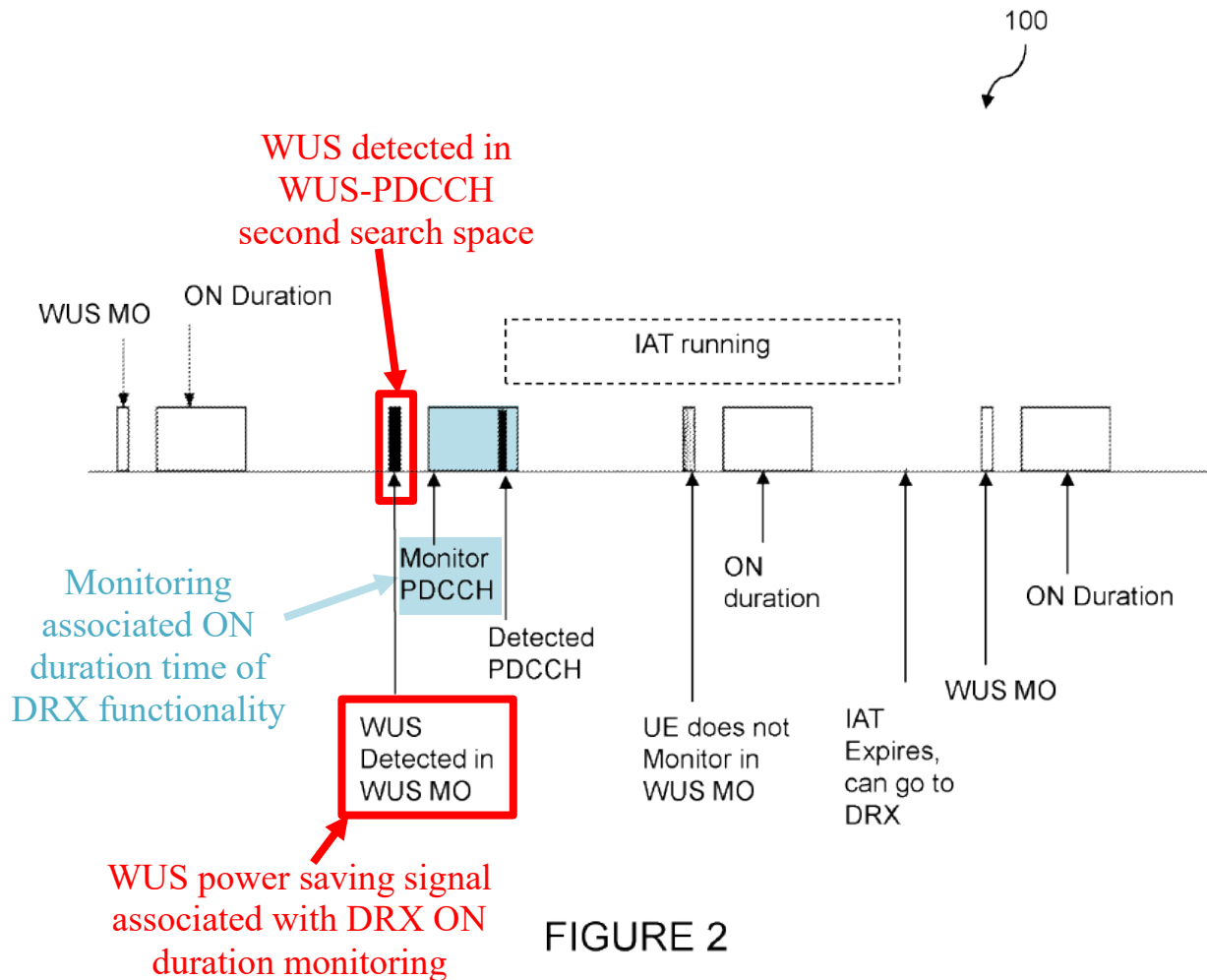
monitoring a power saving signal used for indicating wake-up information associated with a Discontinuous Reception (DRX) functionality.

146. For example, *Nimbalker* discloses that the “network node” may “use[] a PDCCH structure to transmit [the wake-up signal] WUS.” *Nimbalker*, 13, *Nimbalker Provisional*, 22. In such cases, the base station may send, and “the UE may be configured” with, “WUS resources” that are a second configuration to configure the UE with a “WUS-PDCCH search space” (second search space of the PDCCH). *Nimbalker*, 14, 20; *Nimbalker Provisional*, 23, 27. The “network” (e.g., base station) may “configure dedicated WUS CORESETs, whereby the search spaces in these CORESETs are configured for lower aggregation levels.” *Nimbalker*, 19; *Nimbalker Provisional*, 26. These WUS CORESET search spaces are in “WUS-compatible PDCCH format” and include “the relevant REs [resource elements] in the WUS-PDCCH search space” for WUS monitoring.” *Nimbalker*, 20; *Nimbalker Provisional*, 27. As I explain above in Section VI.C, different search spaces may be used for different DCI formats and/or different functions of the PDCCH, which was also known and used in 4G for configuring DRX cycles and information, and in 3GPP TDocs for configuring search spaces for WUS-PDCCH monitoring. *See, e.g., R1-1905031*, 5 (describing “[w]ake-up DCI design” send from the base station that includes configuration information for the “wake-up PDCCH” for the UE); *R1-1905384*, 3 (describing DCI for “control

resource set (CORESET) configuration for determining time and frequency resources for CCEs, search space set configuration for determining how and when [the] UE monitors PDCCH, DCI format (part of search space set configuration) for determining signalled information and RNTI for addressing the information to the certain UE(s)"); *RI-1905384*, 7 (describing "PDCCH search space sets" for wake-up signals and that "[e]ach search space set is associated with one CORESET"; describing "CORESET for monitoring power saving channel").

147. The UE uses the WUS-PDCCH search space to monitor a "wakeup signal" ("WUS"). *Nimbalker*, 8, 10; *Nimbalker Provisional*, 19, 20. A "'wake up signal' [WUS] is used to refer to any suitable signal, such as a power saving signal or signal for saving power." *Nimbalker*, 8; *Nimbalker Provisional*, 19. The WUS indicates wake-up information associated with a DRX functionality, for example, "the UE may monitor (i.e., attempt to detect) a WUS [power saving signal] in a WUS monitoring occasion" comprising the WUS-PDCCH CORESET search space (second search space) that indicates that the UE should wake up and monitor for scheduling PDCCH information. *Nimbalker*, 10, 14, 19, 20; *Nimbalker Provisional*, 20, 23, 26, 27. "[T]he WUS monitoring occasion may be at the beginning of a DRX ON duration, or before a DRX ON duration." *Nimbalker*, 10; *Nimbalker Provisional*, 20. "[I]f the UE detects a WUS in a WUS monitoring occasion, the UE may monitor the PDCCH during the PDCCH monitoring

occasion(s) associated with the WUS monitoring occasion” for scheduling information. *Nimbalker*, 10; *Nimbalker Provisional*, 20. That is, the WUS indicates wake-up information associated with the DRX ON duration functionality to identify an ON duration cycle where the UE should wake up and monitor for PDCCH scheduling information. *Nimbalker*, 10; *Nimbalker Provisional*, 20.



Nimbalker, FIG. 2; *Nimbalker Provisional*, FIG. 2.

148. The UE receiving a CORESET configuration for a power saving channel (WUS), disclosed in *Nimbalker*, was a conventional part of PDCCH

monitoring for different functions that the PDCCH was used. For example, as explained in Section VI.C, CORESETS and search spaces were set up by 3GPP to perform different functions, including configuring the UE through DCI, such as to define search spaces for WUS monitoring. *See also* Ex. 1014, *R1-1905384*, §§ 2.2.3-2.2.5.⁸

- d. **[1c]: “in response to not receiving the power saving signal while monitoring the second search space, starting a DRX on-duration timer of the DRX functionality;”**

149. A POSITA would have recognized that *Nimbalker* discloses or renders obvious, in response to not receiving the power saving signal while monitoring the second search space, starting a DRX on-duration timer of the DRX functionality.

150. For example, *Nimbalker* discloses that “with the ‘successful/unsuccessful WUS detection’ criterion,” the UE may “determine whether to monitor/skip monitoring PDCCH in PDCCH monitoring occasion(s) corresponding to the WUS monitoring occasion.” *Nimbalker*, 8-9; *Nimbalker*

⁸ *R1-1905384* explains that a “[p]otential dedicated search space set for power saving DCI format could be associated to one of the configured CORESETs or another option would be to configure dedicated CORESET for monitoring power saving channel.” *R1-1905384*, 7.

Provisional, 18. To do so, the UE may make this determination in response to “unsuccessful WUS detection” (not receiving the power saving signal while monitoring the second search space) and may consider “another reliability condition (e.g., whether RSRP measured by the UE is above/below a certain threshold, or whether WUS-PDCCH decoder’s internal information suggests a presence of a compatibly encoded PDCCH).” *Nimbalker*, 8-9, 12; *Nimbalker Provisional*, 18, 21. The UE does this because a “missed detection of a WUS may lead to increased latency and packet losses of data traffic that the UE is scheduled to receive.” *Nimbalker*, 12; *Nimbalker Provisional*, 21.

151. If the “UE [does] not detect WUS in a WUS monitoring occasion before a DRX ON duration” (not receiving the power saving signal while monitoring the second search space), the UE may “monitor the PDCCH occasion during the ON duration [start a DRX on-duration timer of the DRX functionality] even if a WUS is not detected in the WUS monitoring occasion,” for example, “[i]f the RSRP is lower than the threshold.” *Nimbalker*, 15; *Nimbalker Provisional*, 23.

152. In another example, “if the UE does not detect a WUS in a WUS monitoring occasion” (not receiving the power saving signal while monitoring the second search space), then the UE may “determine whether to wake-up and monitor the PDCCH” and start an ON duration timer of the DRX functionality, for

example, in “circumstances where WUS detection is less reliable” or the RSRP is low. *Nimbalker*, 12, 15; *Nimbalker Provisional*, 21, 23.

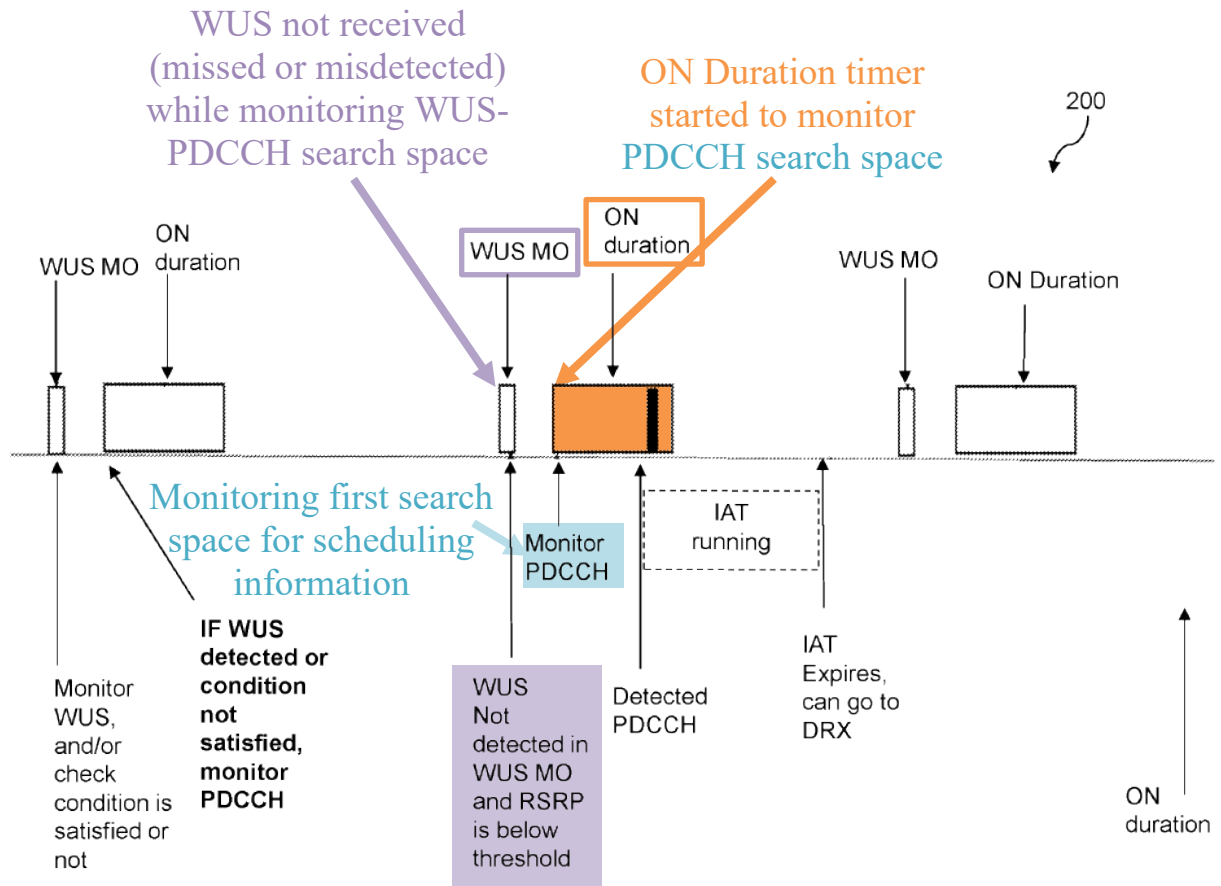


FIGURE 3

Nimbalker, FIG. 3; *Nimbalker Provisional*, FIG. 3.

153. A POSITA would have understood that *Nimbalker*’s disclosure of beginning an ON duration monitoring period discloses starting a “DRX on-duration timer” because that was the standard operation for tracking the ON duration time period. *Supra* § VI.C.2.

154. *Nimbalker* relates to a “[n]ew radio (NR) standard in 3GPP” and describes the previously known operation of PDCCH monitoring for LTE using DRX and wake-up signals to “reduce unnecessary PDCCH monitoring” and “allow the UE to ... wake-up only when required.” *Nimbalker*, 2; *Nimbalker Provisional*, 17-18. As was well known for LTE and NR, the length of an ON duration monitoring period of a DRX cycle was specified by the *drx-onDurationTimer* parameter identified in various 3GPP specifications and TDocs. *See* Ex. 1012, *TS 38.331*, 216-218 (identifying “*drx-onDurationTimer*” as a “*DRX-config*” parameter); Ex. 1025, *TS 36.331*, 470, 473 (identifying “onDurationTimer” as a “*DRX-Config*” parameter that specifies a “[t]imer for DRX in TS 36.321 [6]” having a “[v]alue in number of PDCCH sub-frames”); Ex. 1022, *TS 38.321*, 38 (“*drx-onDurationTimer*” specifies “the duration at the beginning of a DRX Cycle” as part of “the UE’s PDCCH monitoring activity” and is part of “Active Time”); Ex. 1011, *TS 36.321*, 9, 53, 123 (“*onDurationTimer*: Specifies the number of consecutive PDCCH-subframe(s) at the beginning of a DRX Cycle”; “the [DRX] Active Time includes the time while: *onDurationTimer* or *drx-InactivityTimer* ... is running”; “onDurationTimer” is when “[t]he MAC entity monitors PDCCH in PDCCH-subframes during the subframes [n, n+m-1].”); Ex. 1013, *RI-1904738*, 2 (“That is the power saving signal used before DRX cycle have two functions, one is to wake up UE in current DRX cycle to receive or transmit data, and another is

to trigger a CSI report before the beginning of *drx-onDurationTimer*” and “Power saving signal is transmitted before DRX cycle, if UE successfully detects power saving signal, UE measures and reports CSI before *drx-onDurationTimer* and monitors PDCCH when *drx-onDurationTimer* is running as R15 DRX operation.”); Ex. 1014, *R1-1905384*, 8 (“When DRX is configured, UE is required to monitor PDCCH only during *onDuration* of the DRX cycle. Network is able to control the UE PDCCH monitoring requirement using the parameters such as *OnDuration-timer*, *inactivity timer* and *DRX cycle length*.”); Anil, [226]-[227] (“When a DRX cycle is configured, the Active Time includes the time while: [*drx-onDurationTimer* or *drx-InactivityTimer* or *drx-RetransmissionTimerDL* or *drx-RetransmissionTimerUL* or *ra-ContentionResolutionTimer* is running”); Ex. 1017, *LTE in Bullets*, 11-12 (describing “*onDurationTimer*” for ON duration period of DRX PDCCH monitoring); *see also* Ex. 1001, 2:31-34 (acknowledging on-duration timer known in prior art).

155. Because *Nimbalker* relates to LTE and NR DRX for PDCCH monitoring, a POSITA would have recognized that the disclosure of starting a DRX ON duration period refers to starting the conventional *drx-onDurationTimer* specified in the configuration and described in 3GPP documents, such as TS 36.321, TS 36.331, TS 38.321, TS 38.331, R1-1905384, and R1-1904738. *See* Ex. 1012, *TS 38.331*, 216-218; Ex. 1025, *TS 36.331*, 470, 473; Ex. 1022, *TS*

38.321, 38; Ex. 1010, *TS 36.321*, 9, 53, 123; Ex. 1022, *TS 38.321*, 38; Ex. 1013, *R1-1904738*, 2; Ex. 1014, *R1-1905384*, 7; Ex. 1017, *LTE in Bullets*, 11-12; *see also* Ex. 1001, 2:31-34.

156. I have also been asked to consider the situation where *Nimbalker* is considered not to disclose starting an on-duration timer of the DRX functionality in response to not receiving the power saving signal while monitoring the second search space. In that case, it is my opinion that *Nimbalker* would have rendered this limitation obvious.

157. *Nimbalker* discloses monitoring the first PDCCH search space during an “ON duration” period, as explained above and below in element [1d].

Nimbalker FIGS. 2 and 3 show monitoring periods for the WUS monitoring, ON duration PDCCH monitoring, and inactivity timer monitoring along the time axis using boxes that denote each time period. *Nimbalker*, 15-16, FIGS. 2-3; *Nimbalker Provisional*, 24, FIGS. 2-3.

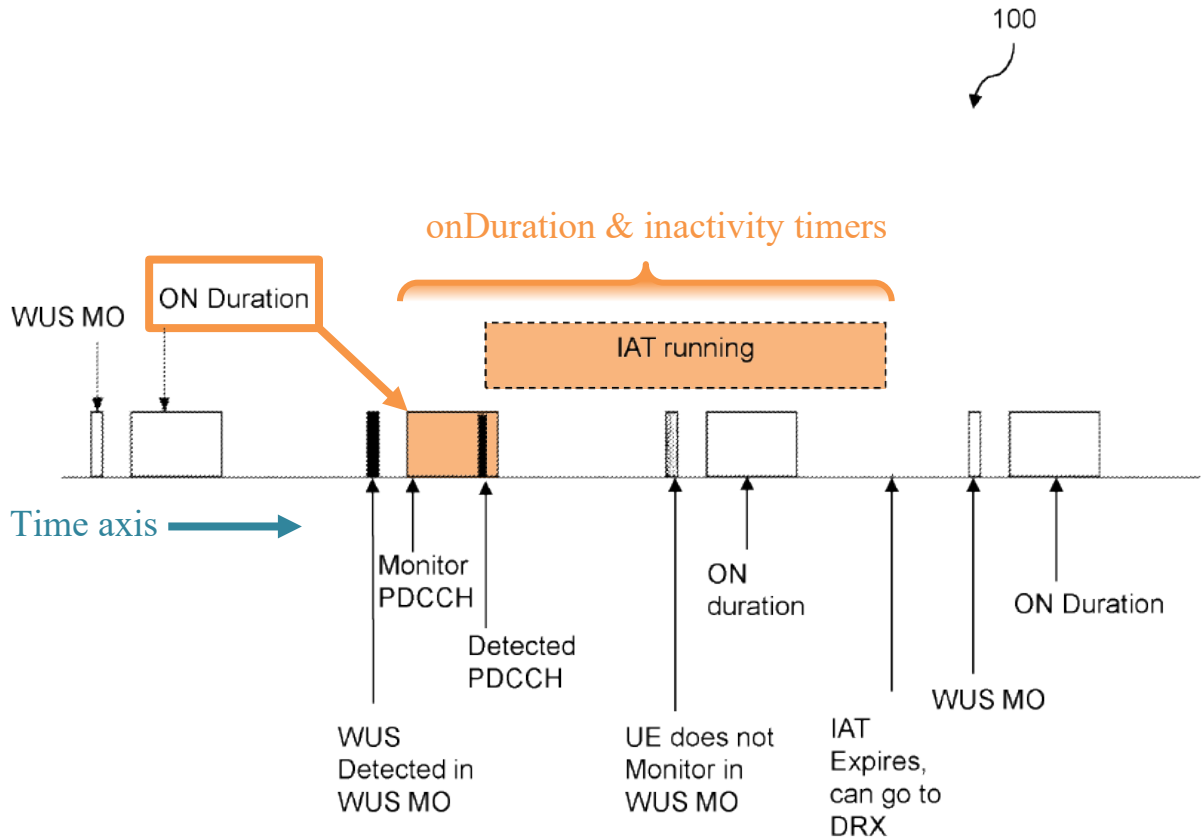


FIGURE 2

Nimbalker, FIG. 2; Nimbalker Provisional, FIG. 2.

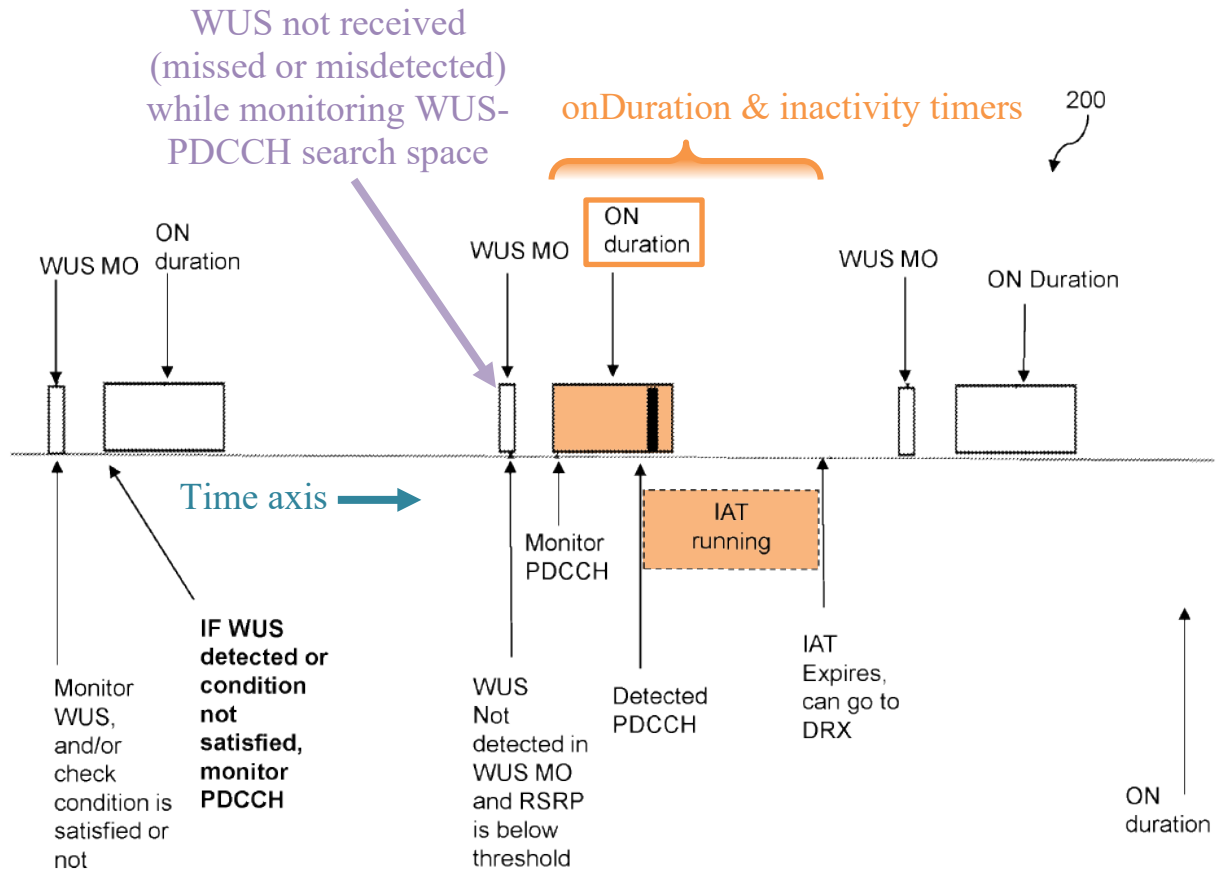


FIGURE 3

Nimbalker, FIG. 3; *Nimbalker Provisional*, FIG. 3.

158. *Nimbalker* explains that the inactivity timer is a “timer” specifying the period of time that the UE monitors PDCCH before returning to sleep. *Nimbalker*, 8, 10, FIGS. 2-3; *Nimbalker Provisional*, 18, 20, FIGS. 2-3. A POSITA would have found it obvious to start a timer for monitoring the “ON duration” period of the DRX functionality to reduce power consumption by ensuring that the UE stops monitoring the first search space of the PDCCH if no scheduling information is received during “ON duration,” which performs the same function as the inactivity

timer, but for the “ON duration” period. A POSITA would have found this obvious because it merely involves implementing 3GPP standards and recommendations, improves operation of the UE, and reduces power consumption.

i. Motivation to Use a DRX on-Duration Timer

159. A POSITA would have been motivated to start a DRX on-duration timer of the DRX functionality in response to not receiving the power saving signal while monitoring the second search space. *Nimbalker*, 12-15, FIGS. 2-3; *Nimbalker Provisional*, 21-24, FIGS. 2-3.

160. For example, a POSITA would have recognized, as explained above in Sections VI.C.2 and VI.C.3, that on-duration timers were the conventional practice when monitoring an ON duration period, such as the ON duration period in *Nimbalker* FIG. 3 following the missed detection or misdetection of the WUS. *See* Ex. 1012, *TS 38.331*, 216-218; Ex. 1025, *TS 36.331*, 470, 473; Ex. 1022, *TS 38.321*, 38; Ex. 1010, *TS 36.321*, 9, 53, 123; Ex. 1013, *R1-1904738*, 2; Ex. 1014, *R1-1905384*, 7; Ex. 1017, *LTE in Bullets*, 11-12; *see also* Ex. 1001, 2:31-34. A POSITA would have been motivated to use this conventional on-duration timer functionality during *Nimbalker*’s ON duration PDCCH monitoring following WUS misdetection to preserve UE battery life by limiting the amount of time the UE may monitor the PDCCH first search space if no scheduling messages are received because the UE will not have to monitor PDCCH for the entire DRX cycle. A

POSITA would have also been motivated to include this operation because it was specified in various 3GPP documents and was a well-known operation for DRX PDCCH monitoring to reduce power consumption, which is one of the objectives of *Nimbalker*. *See supra* §§ VI.C.1-VI.C.3. As I explain above in Sections VI.B-VI.C.3, 3GPP technical specifications and TDocs generally set forth the configurations and operations of UEs and, as such, a POSITA would have looked to both of those documents for both understanding the meaning of the prior art and also when looking for motivation and options for designing devices.

161. A POSITA would have recognized that this operation represents merely implementing a known prior-art drx-onDuration timer functionality being started by the UE for the ON duration monitoring time period in response to not receiving the WUS, which would have yielded the predictable result of timing *Nimbalker*'s ON duration period following non-received WUS (e.g., missed or misdetected). *See supra* §§ VI.C.2-VI.C.3. At a minimum, a POSITA would have found it obvious to try starting an on Duration timer at the start of the ON duration PDCCH monitoring period in response to not receiving the wake-up signal (for example, when WUS detection is unreliable, missed, or misdetected) because it was a known technique that would have improved *Nimbalker*'s device in the same way as known in the prior art. *See supra* §§ VI.C.2-VI.C.3.

ii. Expectation of Success

162. A POSITA would have reasonably expected to succeed in starting a DRX on-duration timer of the DRX functionality in response to not receiving the power saving signal while monitoring the second search space.

163. A POSITA would have recognized that starting a DRX on-duration timer of the DRX functionality for monitoring an ON duration time period, either in response to receiving a wake-up signal or in response to not detecting a wake-up signal, was well known and routine in the prior art. *See supra* §§ VI.C.2-VI.C.3; Ex. 1012, *TS 38.331*, 216-218; Ex. 1025, *TS 36.331*, 470, 473; Ex. 1022, *TS 38.321*, 38;; Ex. 1011, *TS 36.321*, 9, 53, 123; Ex. 1013, *R1-1904738*, 2; Ex. 1014, *R1-1905384*, 7; Ex. 1018, *LTE in Bullets*, 11-12; *see also* Ex. 1001, 2:31-34. A POSITA would have expected to succeed in implementing the functionality of starting an on-duration timer during the DRX ON duration period in response to not receiving a wake-up signal because such on-duration timer functionality was described in 3GPP documents. *See supra* §§ VI.C.2-VI.C.3; *see, e.g.*, Ex. 1012, *TS 38.331*, 216-218; Ex. 1025, *TS 36.331*, 470, 473; Ex. 1022, *TS 38.321*, 38; Ex. 1011, *TS 36.321*, 9, 53, 123; Ex. 1013, *R1-1904738*, 2; Ex. 1014, *R1-1905384*, 7; Ex. 1018, *LTE in Bullets*, 11-12.

164. Implementing this functionality in *Nimbalker*'s system to start an on-duration timer in response to not receiving the wake-up signal, such as for the

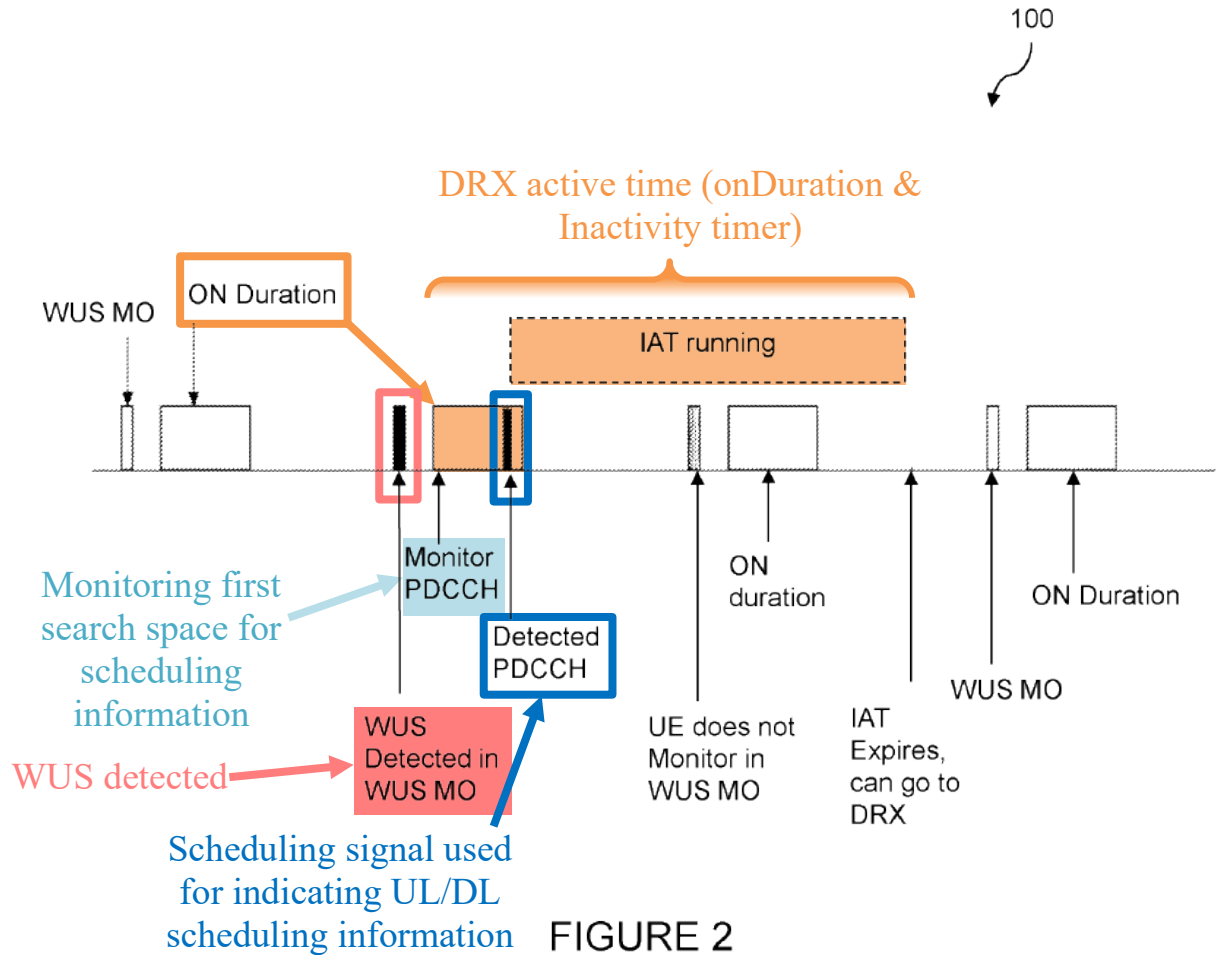
ON duration period in FIG. 3 after the WUS is not received because it is missed or misdetected, would have been merely the straightforward application of known, conventional techniques used according to their known functions to yield predictable results.

- e. **[1d]: “monitoring the first search space in response to the UE being in a DRX active time of the DRX functionality, wherein the DRX active time is a time during which the UE monitors the PDCCH; and”**

165. A POSITA would have recognized that *Nimbalker* discloses monitoring the first search space in response to the UE being in a DRX active time of the DRX functionality, wherein the DRX active time is a time during which the UE monitors the PDCCH.

166. *Nimbalker* discloses monitoring the first search space (e.g., PDCCH search space for UL/DL scheduling, *see* [1a]) in response to the UE being in a DRX active time in two ways: (1) when the WUS is detected to indicate the UE should monitor the PDCCH search space (e.g., *Nimbalker*, FIG. 2; *Nimbalker Provisional*, FIG. 2); and (2) when the WUS is not detected, but the UE determines it should monitor the PDCCH search space anyway (e.g., *Nimbalker*, FIG. 3; *Nimbalker Provisional*, FIG. 3). *Nimbalker*’s monitoring the first PDCCH search space in response to the UE being in DRX “active time” includes at least during the ON duration and/or inactivity timer periods. *See* Ex. 1001, 7:18-21.

167. *Nimbalker*, discussing FIG. 2, discloses that, “if the UE detects a WUS in a WUS monitoring occasion, the UE may monitor the PDCCH during the PDCCH monitoring occasion(s) associated with the WUS monitoring occasion,” for example, “within a DRX ON duration associated with the WUS monitoring occasion.” *Nimbalker*, 10, 14 (“[T]he UE may detect a WUS in a WUS monitoring occasion and then monitor the PDCCH during the corresponding ON duration.”); *Nimbalker Provisional*, 20, 23. Then, “[i]f the UE detects a PDCCH during the PDCCH monitoring occasion such as, for example, within a DRX ON duration associated with the WUS monitoring occasion, the UE may continue to monitor the PDCCH,” for example, “until [the] end of active time or until expiration of Inactivity timer (IAT).” *Nimbalker*, 10, 12, 14; *Nimbalker Provisional*, 20, 21, 23 (“Then, if the UE detects PDCCH, the UE may continue monitoring the PDCCH until end of active time,” such as until the end of an inactivity timer that starts when the PDCCH is detected). This continued active time monitoring includes the UE continuing to “decod[e] PDCCH candidates to detect a PDCCH intended for the UE” in the first PDCCH search space. *Nimbalker*, 10; *Nimbalker Provisional*, 20. Similar to FIG. 2, if the UE detects PDCCH during the ON duration while monitoring the first PDCCH search space, it may start an inactivity timer and continue monitoring the PDCCH as active time. *Nimbalker*, 10; *Nimbalker Provisional*, 20.



Nimbalker, FIG. 2; *Nimbalker Provisional*, FIG. 2.

168. Alternatively, as shown in *Nimbalker* FIG. 3, “if the UE does not detect a WUS in a WUS monitoring occasion” (not receiving the power saving signal while monitoring the second search space), then the UE may “determine whether to wake-up and monitor the PDCCH” of the first search space during ON duration, which is part of the active time. *Nimbalker*, 12, 15; *Nimbalker Provisional*, 21, 23. The first search space monitoring in active time (ON duration and/or inactivity timer) then proceeds as shown in FIG. 2.

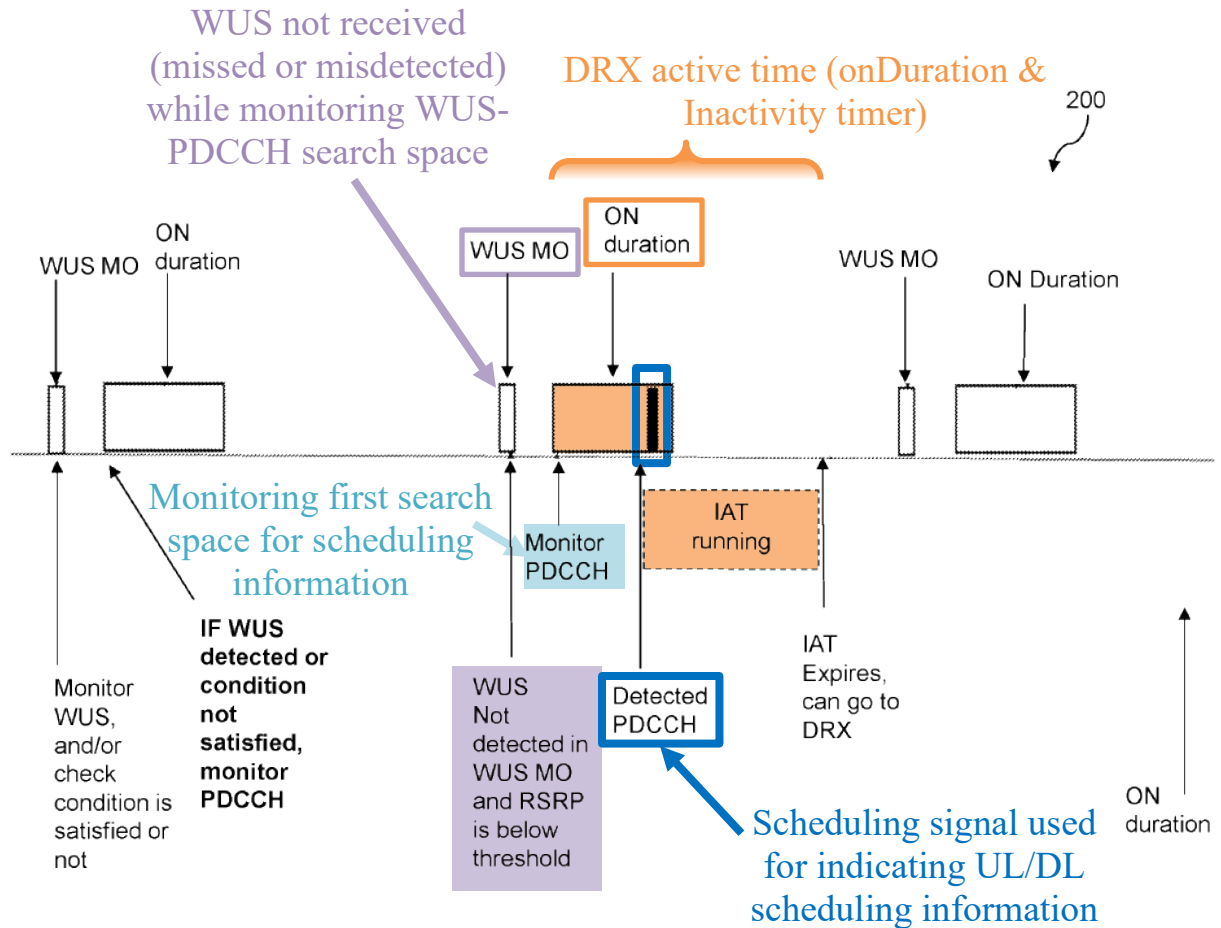


FIGURE 3

Nimbalker, FIG. 3; *Nimbalker Provisional*, FIG. 3.

- f. [1e]: “not monitoring the second search space in response to the UE being in the DRX active time of the DRX functionality.”

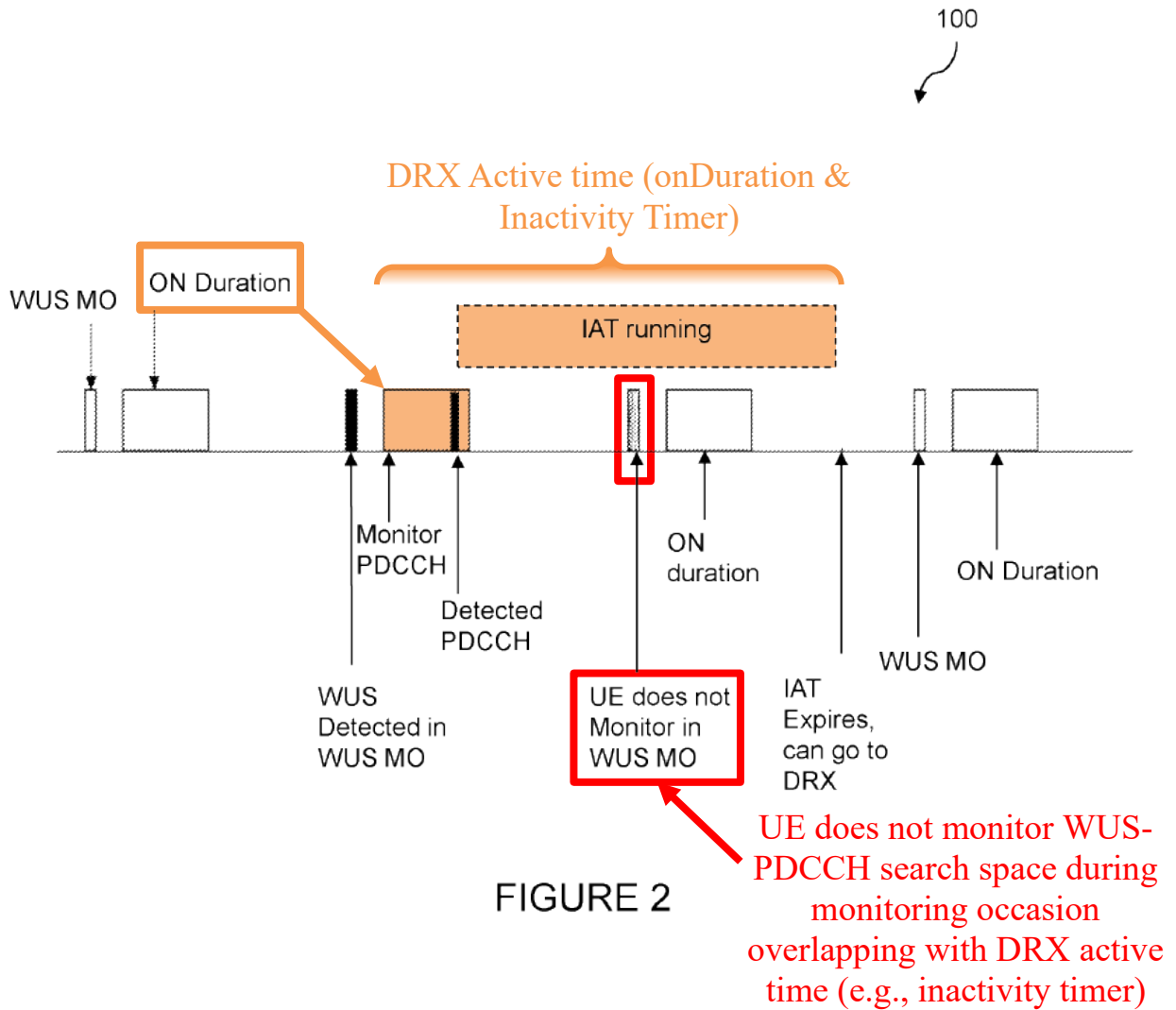
169. A POSITA would have recognized that *Nimbalker* discloses not monitoring the second search space in response to the UE being in the DRX active time of the DRX functionality.

170. For example, *Nimbalker* discloses that, as explained in element [1d], “if the UE detects PDCCH, the UE may continue monitoring the PDCCH until end

of active time.” *Nimbalker*, 14; *Nimbalker Provisional*, 23. The UE does not monitor the WUS-PDCCH second search space while it is monitoring the PDCCH during active time (ON duration and/or inactivity timer).

171. *Nimbalker* discloses that “the UE skip[s] monitoring of the WUS in a WUS occasion (or in one or more future WUS occasions) such as, for example, when the UE is in active time or when an inactivity timer is running.” *Nimbalker*, 8; *Nimbalker Provisional*, 18. Similarly, *Nimbalker* discloses that “the UE need not monitor for the WUS during WUS monitoring occasions that overlap the slots when the UE is monitoring the PDCCH (e.g., during ‘active time’).” *Nimbalker*, 11; *Nimbalker Provisional*, 20. *Nimbalker* further explains that, “if a WUS monitoring occasion overlaps with a time slot where the UE is monitoring PDCCH such as, for example, when the UE is in active time, the UE may skip WUS monitoring in that WUS monitoring occasion” *Nimbalker*, 9, 14 (“The UE may not monitor for a WUS in any WUS monitoring occasions that occur during active time.”); *Nimbalker Provisional*, 18, 23 (same).

172. This is shown in *Nimbalker* FIG. 2, where the third WUS monitoring occasion overlaps with the inactivity timer (IAT) of the DRX active time. As such, the UE does not monitor this WUS-PDCCH search space in response to the UE being in DRX active time of the DRX functionality. *Nimbalker*, 9, 11, 14, FIG. 2; *Nimbalker Provisional*, 18, 20, 23, FIG. 2.



Nimbalker, FIG. 2; *Nimbalker Provisional*, FIG. 2.

173. *Nimbalker* thus anticipates or renders obvious claim 1.

2. Claim 2

- a. **“The method of claim 1, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.”**

174. A POSITA would have recognized that *Nimbalker* discloses wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.

175. For example, *Nimbalker* discloses that “the WUS and PDCCH frequency resources may be different,” for example, “the WUS resources might be configured in the same frequency location (or BWP) where the SSB resides [the second search space includ[ing] ... a second frequency resource for the UE to monitor the power saving signal], whereas the PDCCH might be configured in another frequency location [the first search space includ[ing] ... a first frequency resource for the UE to monitor the scheduling signal].” *Nimbalker*, 16; *Nimbalker Provisional*, 24. A POSITA would have understood that different “frequency resources (or BWP [bandwidth part])” refer to the frequencies of the respective CORESETs of the WUS-PDCCH second search space (*see supra* § XII.A.1.c

(element [1b])) and the PDCCH scheduling first search space (*see supra* § XII.A.1.b (element [1a])). When these CORESET resources reside on different frequency resources or BWPs, they identify a respective first and second frequency resource that also have corresponding time resources within the respective search spaces or CORESETs, which each describe a time-frequency pair (e.g., resource elements). *See supra* §§ VI.C (state of the art), XII.A.1.b-XII.A.1.c (elements [1a], [1b]). For example, a POSITA reading *Nimbalker* would have recognized that the CORESETs “comprise control resource set[s] (CORESET) configuration[s] for determining time and frequency resources for CCEs” and “search space set configuration for determining how and when [the] UE monitors PDCCH” because *Nimbalker* relates to LTE and 5G devices and operations. *R1-1905384*, 3; *see supra* § VI.C.

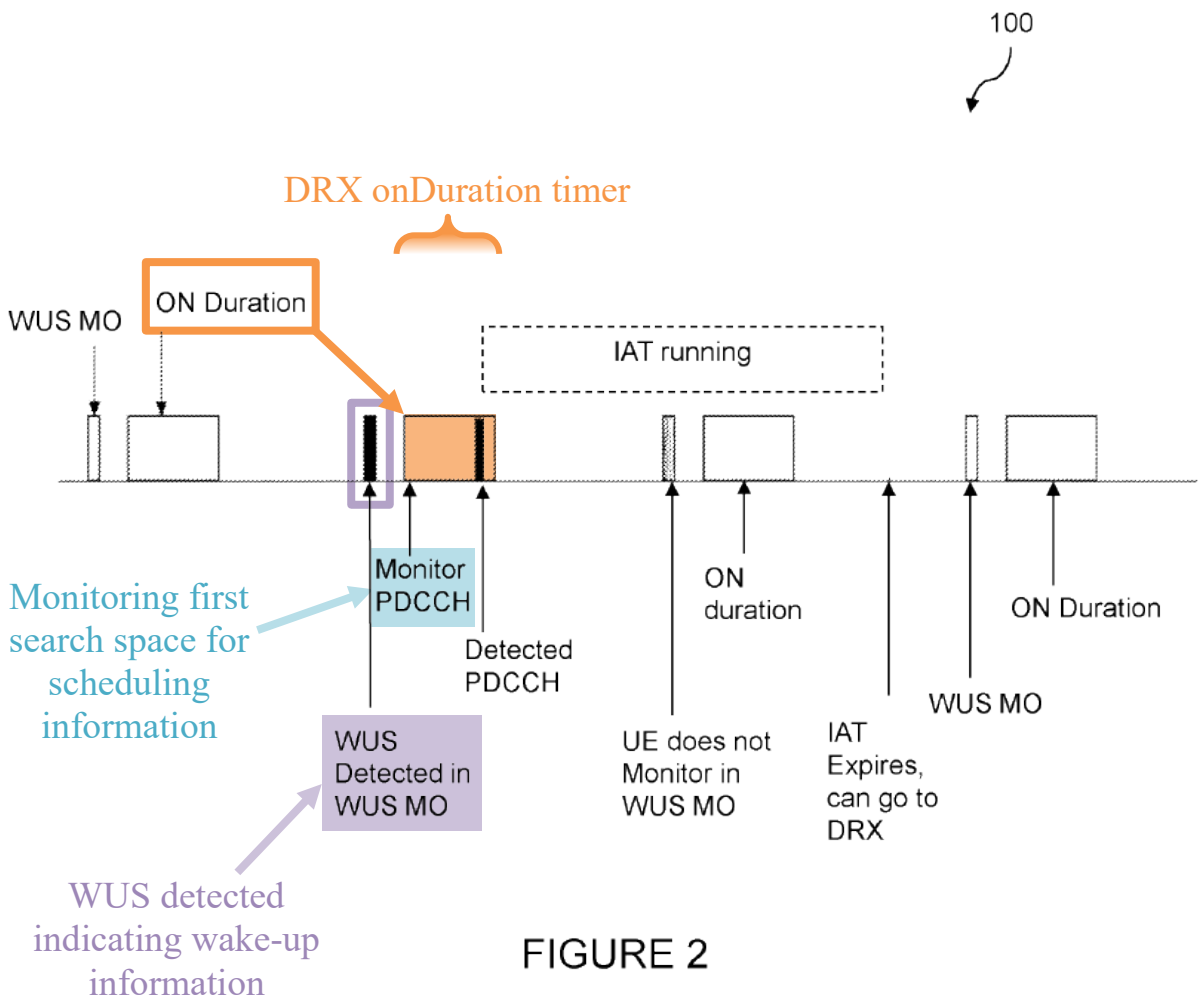
3. Claim 3

- a. **“The method of claim 1, further comprising:
determining whether to start a DRX on-duration
timer of the DRX functionality according to the wake-
up information.”**

176. A POSITA would have recognized that *Nimbalker* discloses or renders obvious the method further comprising determining whether to start a DRX on-duration timer of the DRX functionality according to the wake-up information.

177. As explained in element [1d], *Nimbalker* discloses the UE determining whether to monitor a PDCCH during a DRX ON duration monitoring

period of the DRX functionality according to the WUS information, which is shown in FIG. 2. As explained in element [1b], *Nimbalker*'s received WUS provides wake-up information, such as the corresponding ON duration period to monitor for scheduling PDCCH. *Nimbalker*, 10, 14, 19, 20; *Nimbalker Provisional*, 20, 23, 26, 27. As explained in element [1c], a POSITA would have understood that starting ON duration monitoring according to wake-up information in a WUS corresponds to starting the conventional onDuration timer, such as described in 3GPP documents and well known in the art.



Nimbalker, FIG. 2; *Nimbalker Provisional*, FIG. 2.

178. I have also been asked to consider the situation where *Nimbalker* is considered not to disclose starting a DRX on-duration timer of the DRX functionality according to the wake-up information. In that case, it is my opinion that a POSITA would have found this obvious based on *Nimbalker* for the reasons discussed here and in element [1c].

4. Claim 5

- a. **“The method of claim 1, wherein the power saving signal is not received in the second search space in response to when at least one of [i] the UE does not monitor the second search space and [ii] the UE unsuccessfully decodes the power saving signal.”**

179. A POSITA reading the language of claim 5 would have understood that it recites two alternatives because it recites “the power saving signal is not received ... in response to when at least one of ...” the recited options being performed. Although the claim uses the word “and,” in context, the POSITA would have understood that these recitations are alternative options recited in claim 5.⁹

⁹ Claim 5’s first recitation refers to “not receiv[ing]” the power saving signal when “the UE *does not monitor* the second search space” (emphasis added) whereas the second recitation refers to “the UE unsuccessfully decod[ing] the power saving

For example, because claim 5 recites “not monitoring” and also “unsuccessfully decod[ing],” a POSITA would have recognized these are separate, distinct options because attempting to decode the WUS involves monitoring the WUS PDCCH search space, whereas “not monitoring” does not. The ’911 patent also describes these separately in its specification. For example, “[i]n one embodiment, the UE may stay in DRX active if the UE decodes the WUS unsuccessfully.” Ex. 1001, 10:61-62. In other embodiments, the ’911 patent recites “not monitoring” the second search space to not receive the WUS. *See, e.g.*, Ex. 1001, 7:6-8, 9:4-15. Thus, in claim 5, the word “and” is simply used to delineate the two alternatives. It is my understanding that when alternatives are recited in a claim, then satisfying either option is considered to disclose the requirements of the claim, here claim 5.

180. A POSITA would have recognized that *Nimbalker* discloses the power saving signal is not received in the second search space in response to when at least one the UE unsuccessfully decodes the power saving signal.¹⁰

signal,” which requires monitoring and receiving the power saving signal WUS, but it is not successfully decoded. These are mutually exclusive.

¹⁰ Claim 1 recites “not receiving the power saving signal *while monitoring the second search space*,” but claim 5, option [i], recites “the power saving signal is not received ... when ... the UE *does not monitor the second search space*.” A

181. As explained in element [1c], *Nimbalker* discloses that “with the ‘successful/unsuccessful WUS detection’ criterion,” the UE may “determine whether to monitor/skip monitoring PDCCH in PDCCH monitoring occasion(s) corresponding to the WUS monitoring occasion.” *Nimbalker*, 8-9; *Nimbalker Provisional*, 18. When the UE performs “unsuccessful WUS detection” (the power saving signal is not received), such as when unsuccessfully decoding the WUS, the UE may consider “another reliability condition,” such as “whether [the] WUS-PDCCH decoder’s internal information suggests a presence of a compatibly encoded PDCCH.” *Nimbalker*, 8-9, 12, 19, 47, 49 (“a transmitted WUS is not successfully decoded by the UE”; “the wireless device received the wake up signal but was unable to successfully decode it”; and “the wireless device was unable to detect or decode a wakeup signal sent by the network node”); *Nimbalker Provisional*, 18, 26, 53, 55.

182. Indeed, with respect to the alternatives in claim 5, a POSITA would have recognized that the two most common reasons a WUS would not be received either because the UE is not monitoring the search space (alternative [i]) or

POSITA would have recognized that the second search space cannot both be monitored and not monitored at the same time. Therefore, my analysis focuses on the alternative option for claim 5.

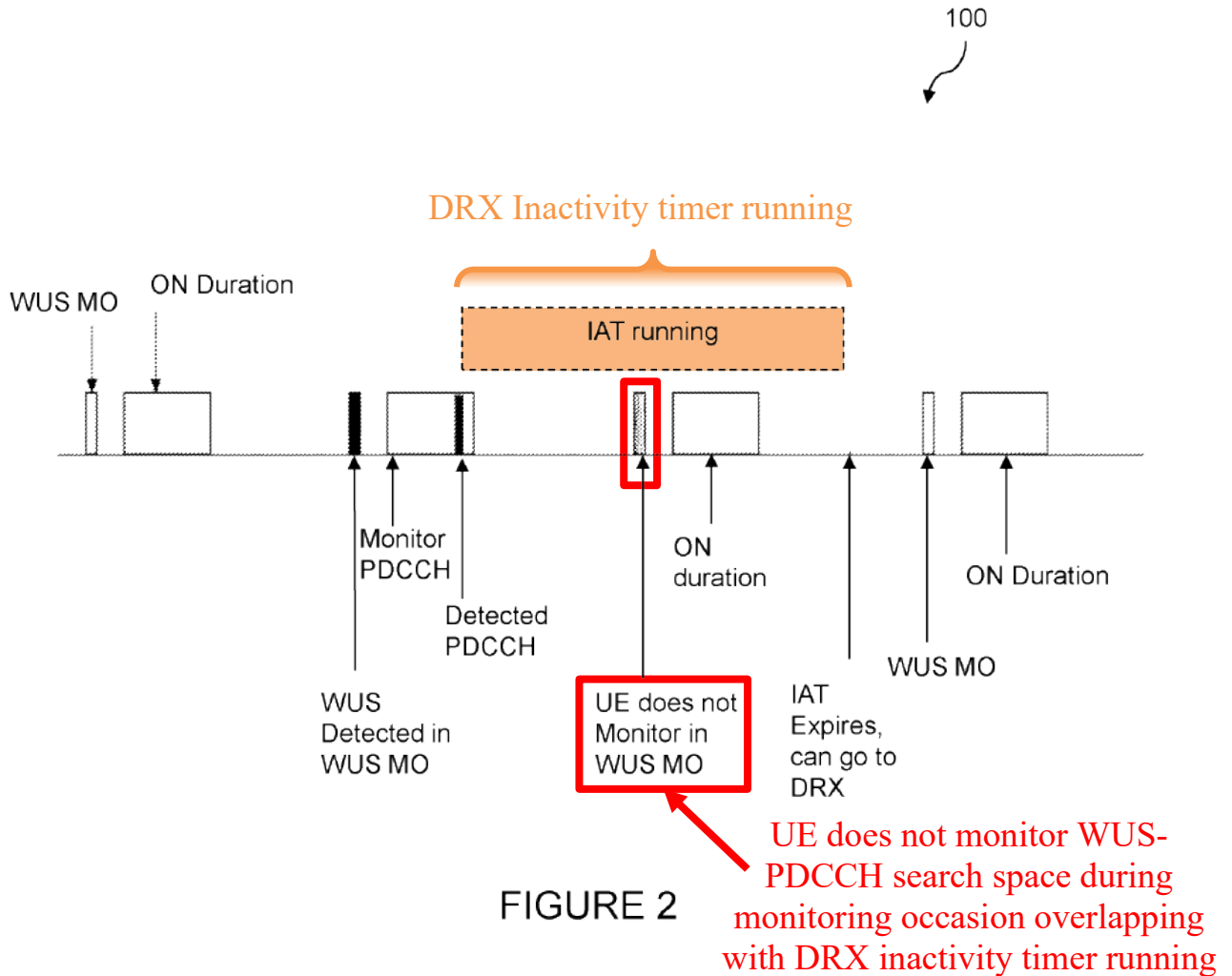
because the UE was monitoring the search space but misdetected or missed the WUS because it was not decoded correctly (alternative [ii]).

5. Claim 6

- a. “The method of claim 1, wherein the not monitoring the second search space comprises: not monitoring the second search space while a DRX inactivity timer of the DRX functionality is running.”**

183. A POSITA would have recognized that *Nimbalker* discloses wherein the not monitoring the second search space comprises not monitoring the second search space while a DRX inactivity timer of the DRX functionality is running.

184. As explained in element [1e], *Nimbalker* discloses that the UE does not monitor the WUS second search space while a DRX inactivity timer (IAT) is running during the DRX active time. As one example, *Nimbalker* discloses that “the UE skip[s] monitoring of the WUS in a WUS occasion [not monitoring the second search space] ... such as, for example, when the UE is in active time or when an inactivity timer is running.” *Nimbalker*, 8; *Nimbalker Provisional*, 18. This is shown in FIG. 2.



Nimbalker, FIG. 2; *Nimbalker Provisional*, FIG. 2.

6. Independent Claim 10

- a. [10Preamble]: “A user equipment (UE) monitoring a physical downlink (DL) control channel (PDCCH) in a wireless communication system, the UE comprising:”

185. A POSITA would have recognized that *Nimbalker* discloses a user equipment (UE) monitoring a physical downlink (DL) control channel (PDCCH) in a wireless communication system for the reasons discussed for [1Preamble].

- b. **[10a]: “a processor, for executing computer-executable instructions; and a non-transitory machine-readable medium, coupled to the processor, for storing the computer-executable instructions, wherein the computer-executable instructions instruct the processor to:”**

186. A POSITA would have recognized that *Nimbalker* discloses a processor, for executing computer-executable instructions, and a non-transitory machine-readable medium, coupled to the processor, for storing the computer-executable instructions, wherein the computer-executable instructions instruct the processor to perform the steps of [10b]-[10f].

187. For example, *Nimbalker* discloses that its described operations may be “implemented via processing circuitry, which may include one or more microprocessor[s] or microcontrollers” and that the “processing circuitry may be configured to execute program code stored in memory.” *Nimbalker*, 46-47; *Nimbalker Provisional*, 52. As one example, “processing circuitry 601 may be configured to process computer instructions and data” and may be “operatively coupled” to memory and storage media. *Nimbalker*, 34, FIG. 9; *Nimbalker Provisional*, 37-38, FIG. QQ2.

188. *Nimbalker*’s memory is a non-transitory computer-readable medium, for example, a “[s]torage medium 621 may allow UE 600 to access computer-executable instructions, application programs[,] or the like, stored on transitory or non-transitory memory media, to off-load data, or to upload data.” *Nimbalker*, 36;

Nimbalker Provisional, 39. *Nimbalker* also explains that the “[p]rogram code stored in memory includes program instructions for executing one or more telecommunications and/or data communications protocols as well as instructions for carrying out one or more of the techniques described herein.” *Nimbalker*, 47; *Nimbalker Provisional*, 52-53. FIG. 9 shows a UE comprising the memory 601 and storage media 621 being coupled to the processor 601 via a bus 602. *Nimbalker*, 34, 36; *Nimbalker Provisional*, 37-38, 40.

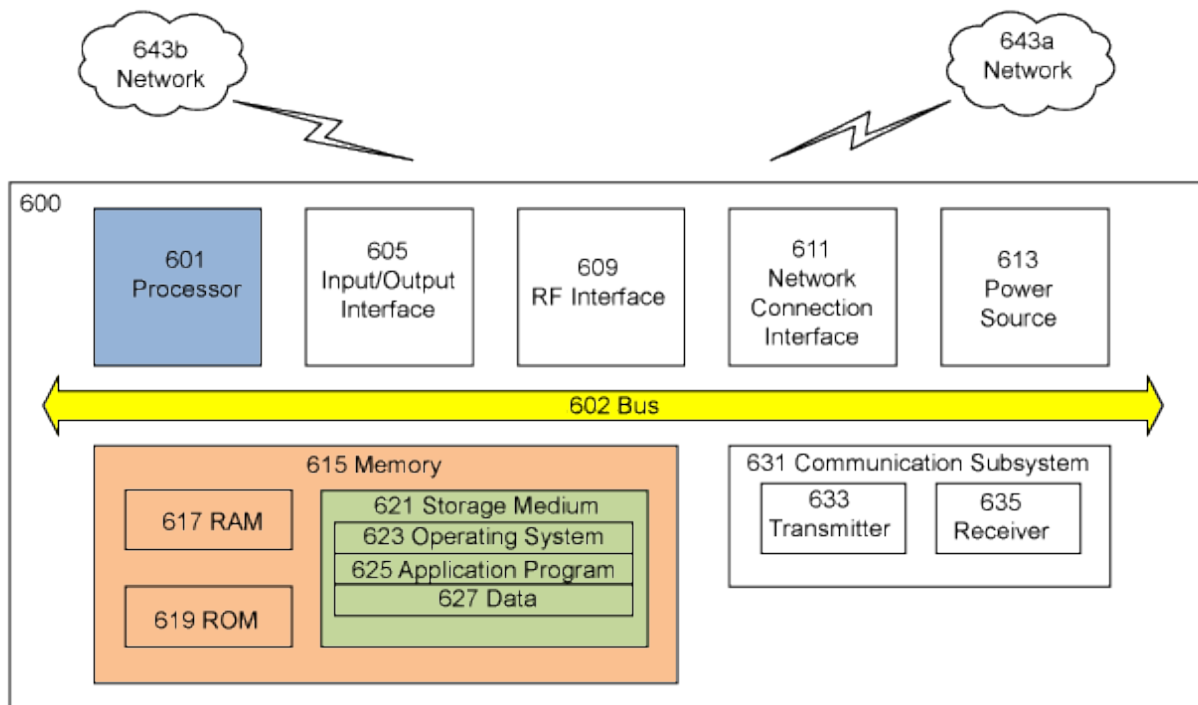


FIGURE 9

Nimbalker, FIG. 9; *Nimbalker Provisional*, FIG. QQ2.

- c. **[10b]: “receive a first configuration from a base station to configure the UE with a first search space of the PDCCH, wherein the first search space is used for monitoring a scheduling signal used for indicating scheduling information;”**

189. Element [10b] recites substantively the same limitations as element [1a], which *Nimbalker* discloses for at least the reasons I discuss for element [1a].

- d. **[10c]: “receive a second configuration from the base station to configure the UE with a second search space of the PDCCH, wherein the second search space is used for monitoring a power saving signal used for indicating wake-up information associated with a Discontinuous Reception (DRX) functionality;”**

190. Element [10c] recites substantively the same limitations as element [1b], which *Nimbalker* discloses for at least the reasons I discuss for element [1b].

- e. **[10d]: “in response to not receiving the power saving signal while monitoring the second search space, start a DRX on-duration timer of the DRX functionality;”**

191. Element [10d] recites substantively the same limitations as element [1c], which *Nimbalker* discloses or renders obvious for at least the reasons I discuss for element [1c].

- f. **[10e]: “monitor the first search space in response to the UE being in a DRX active time of the DRX functionality, wherein the DRX active time is a time during which the UE monitors the PDCCH; and”**

192. Element [10e] recites substantively the same limitations as element [1d], which *Nimbalker* discloses for at least the reasons I discuss for element [1d].

- g. [10f]: “not monitoring the second search space in response to the UE being in the DRX active time of the DRX functionality.”**

193. Element [10f] recites substantively the same limitations as element [1e], which *Nimbalker* discloses for at least the reasons I discuss for element [1e].

7. Claim 11

- a. “The UE of claim 10, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.”**

194. Claim 11 recites substantively the same additional limitations as claim 2, which *Nimbalker* discloses for at least the reasons I discuss for claim 2.

8. Claim 12

- a. “The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:
determine whether to start a DRX on-duration timer of the DRX functionality according to the wake-up information.”**

195. Claim 12 recites substantively the same additional limitations as claim 3, which *Nimbalker* discloses or renders obvious for at least the reasons I discuss for claim 3.

9. Claim 14

- a. **“The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:
not receive the power saving signal in the second search space in response to when at least one of [i] the UE does not monitor the second search space and [ii] the UE unsuccessfully decodes the power saving signal.”**

196. Claim 14 recites substantively the same additional limitations as claim 5, which *Nimbalker* discloses for at least the reasons I discuss for claim 5.

10. Claim 15

- a. **“The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:
not monitor the second search space while a DRX inactivity timer of the DRX functionality is running.”**

197. Claim 15 recites substantively the same additional limitations as claim 6, which *Nimbalker* discloses for at least the reasons I discuss for claim 6.

B. Ground 3: Claims 2, 4, 11, and 13 Are Rendered Obvious by *Nimbalker* in View of *R1-1905031*

198. I have also been asked to consider the situation where *Nimbalker* alone does not disclose or render obvious claims 2 and 11. In such case, it is my opinion that the combination of *Nimbalker* and *R1-1905031* would have rendered these claims obvious. The combination of *Nimbalker* and *R1-1905031* also would have rendered obvious claims 4 and 13.

1. Claim 2

- a. “The method of claim 1, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.”**

199. In my opinion, a POSITA would have found that the combination of *Nimbalker* and *R1-1905031* renders obvious wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.

200. As explained in Grounds 1/2, claim 2, *Nimbalker* discloses that the WUS-PDCCH and PDCCH “frequency resources may be different,” which results in different CORESET search spaces, including on different BWPs. *Nimbalker*, 16; *Nimbalker Provisional*, 24. For example, “the WUS resources might be configured in the same frequency location (or BWP) where the SSB resides” (second search space including a second frequency resource for the UE to monitor the power saving signal), “whereas the PDCCH might be configured in another frequency location” (first search space including a first frequency resource for the UE to monitor the scheduling signal). *Nimbalker*, 16; *Nimbalker Provisional*, 24.

201. *R1-1905031* explains that “[i]t is advantageous for a CORESET containing the wake-up PDCCH [second search space] to have a configuration that can be distinct from CORESETs containing PDCCH scheduling transmissions [first search space].” Ex. 1007, *R1-1905031*, 3. A POSITA would have recognized that “distinct” CORESET configurations have their own time resources and frequency resources. *See supra* § VI.C.1. This is especially true when they are on different bandwidth parts that reside on different frequency bands of the carrier. *See R1-1905031*, 2, 7 (describing “wake-up PDCCH” CORESET/search space being on different bandwidth part from PDCCH “for DL/UL data scheduling” and noting “BWP switching DCI”).

202. A POSITA would have found it obvious to have the first search space include a first time and first frequency resource for the UE to monitor the scheduling signal, and the second search space include a second time and second frequency resource for the UE to monitor the power saving signal, such that they are “distinct” CORESETs, as disclosed in *R1-1905031*. *R1-1905031*, 2-3. A POSITA would have recognized that distinct CORESETs would have allowed the “wake-up PDCCH [to] include a CORESET/Search space/BWP configuration [second search space] for power-efficient WUS detection,” while the scheduling PDCCH (first search space) would be chosen to provide efficient “DL/UL data scheduling” and data transfer. *R1-1905031*, 2.

i. Motivation to Combine

203. A POSITA would have been motivated to have the first search space include a first time and first frequency resource for the UE to monitor the scheduling signal, and the second search space include a second time and second frequency resource for the UE to monitor the power saving signal, such as taught by *R1-1905031*.

204. A POSITA would have recognized, as explained in Sections VI.C, XII.A.1.b, XII.A.1.c, XII.A.2, *Nimbalker*'s WUS-PDCCH CORESET/search space (second search space) and PDCCH for scheduling CORESET/search space (first search space) include time and frequency resources because they are specified in resource elements (REs). A POSITA would have been motivated to provide for different time and frequency resources for each of these search spaces based on *R1-1905031*'s teaching that it is "advantageous" for these CORESETs to "be distinct," for example, being provided on different bandwidth parts. *R1-1905031*, 2-3. A POSITA would have also been motivated to provide for different time and frequency resources because this "advantageous" practice is described in 3GPP documents, such as *R1-1905031*, that provide for useful configurations in LTE and 5G (NR), like *Nimbalker*'s disclosed devices. *Nimbalker*, 2, 21-22; *Nimbalker Provisional*, 17, 29-30; *see supra* §§ VI.C.1; XII.A.2 (ground 1, claim 2).

205. A POSITA would have recognized that this operation represents merely implementing known prior art to provide the first and second search spaces on different time and frequency resources so that they do not collide with each other, which would have yielded the predictable result of allowing *Nimbalker's* UE to receive and monitor each of the search spaces and allow system resources to be allocated for more efficient use. *See supra* §§ VI.C.1-VI.C.3; XII.A.1.b-XII.A.1.c (elements [1a], [1b]), XII.A.2 (ground 1, claim 2). At a minimum, a POSITA would have found it obvious to try providing the first and second search spaces on different time and frequency resources because it was a known technique that would have improved *Nimbalker's* device in the same way as known in the prior art. *See supra* §§ VI.C.1-VI.C.3; XII.A.1.b-XII.A.1.c (elements [1a], [1b]), XII.A.2 (ground 1, claim 2).

ii. Expectation of Success

206. A POSITA would have reasonably expected to succeed in providing the first and second search spaces on different time and frequency resources.

207. A POSITA would have recognized that using different time and frequency resources for different CORESETs/search spaces was well known and routine in the prior art, including being referred to in different 3GPP documents. *See supra* §§ VI.C.1-VI.C.3; XII.A.1.b-XII.A.1.c (elements [1a], [1b]), XII.A.2 (ground 1, claim 2). A POSITA would have expected to succeed in implementing

this functionality at least because the allocation of different times and frequencies for CORESETs/search spaces was described in 3GPP documents and also known for configuring the UE to monitor different resource elements of the PDCCH. *See supra* §§ VI.C.1-VI.C.3; XII.A.1.b-XII.A.1.c (elements [1a], [1b]), XII.A.2 (ground 1, claim 2).

208. Implementing this functionality in *Nimbalker*'s system to assign different time and frequency resources (CORESETs/search spaces) to the first search space for PDCCH scheduling and second search space for WUS monitoring would have been merely the straightforward application of known, conventional techniques used according to their known functions to yield predictable results.

2. Claim 4

- a. **“The method of claim 1, wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.”**

209. In my opinion, a POSITA would have found that the combination of *Nimbalker* and *R1-1905031* renders obvious wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.

210. *Nimbalker* discloses that “the WUS and PDCCH frequency resources may be different,” such that “the WUS resources might be configured in the same frequency location (or BWP)” and “the PDCCH might be configured in another frequency location [or BWP].” *Nimbalker*, 16; *Nimbalker Provisional*, 24.

211. *R1-1905031* explains that, “[i]n addition to including the wake-up CORESET and search space configurations, a wake-up BWP allows configuration[s] suitable for the wake-up PDCCH [BWP for power saving signal] ... that could be different from other, scheduling BWPs” for monitoring PDCCH during the ON duration for scheduling information. Ex. 1007, *R1-1905031*, 4. *R1-1905031* describes the “[w]ake-up DCI [d]esign” for the WUS-PDCCH search space as including a “BWP id ... so that the UE will have already switched to a BWP appropriate for the expected traffic by the time the C-DRX on-duration starts.” *R1-1905031*, 5. *R1-1905031* explains that this “can be achieved by means of a BWP indication in the wake-up DCI.” *R1-1905031*, 5 (“BWP indication in wake-up DCI can provide per-cell, not only per-UE, indication”); *see also* *R1-1905031*, 2 (“Only when a wake-up PDCCH is decoded, the UE transitions to the second stage, by waking up additional hardware and processing (e.g., **BWP/CC switching**, CSI-RS processing, etc.), to get ready for DL/UL data scheduling.” (emphasis added)), 3 (“Another benefit is the ability to associate the wake-up CORESET with beams (TCI states) that can be different from those used in the on-duration.”).

212. A POSITA would have found it obvious to have the power saving signal be used for indicating a bandwidth part switch of a cell to efficiently switch the UE between bandwidth parts of the cell so that the UE can more efficiently

monitor the WUS-PDCCH during wake-up signal monitoring and the scheduling PDCCH during ON duration.

i. Motivation to Combine

213. In my opinion, a POSITA would have been motivated to have the power saving signal be used for indicating a bandwidth part switch of a cell, such as taught by *R1-1905031*.

214. A POSITA would have recognized that *Nimbalker*'s WUS-PDCCH CORESET/search space (second search space) and PDCCH for scheduling CORESET/search space (first search space) may be more efficiently monitored on different frequency resources. *See Nimbalker*, 16; *Nimbalker Provisional*, 24. A POSITA would have been motivated to have the power saving signal indicate the bandwidth part that should be monitored, for example, in the WUS-PDCCH DCI, so that the UE monitors the correct BWP for the WUS search space or PDCCH scheduling search space. Ex. 1007, *R1-1905031*, 2-3 ("Another benefit is the ability to associate the wake-up CORESET with beams (TCI states) that can be different from those used in the on-duration."). A POSITA would have also been motivated to include this functionality in *Nimbalker*'s system so the base station can indicate to the UE which BWP should be monitored to allow the base station to more efficiently allocate resources based on the network usage and UE capabilities, for example, to provide for "a wake-up BWP allows configuration

suitable for the wake-up PDCCH [BWP for power saving signal]” that “could be different from other, scheduling BWPs.” *See* Ex. 1007, *R1-1905031*, 4. A POSITA also would have been motivated to provide these configurations to facilitate LTE and 5G (NR) operations, like *Nimbalker*’s devices. *Nimbalker*, 2, 21-22; *Nimbalker Provisional*, 17, 29-30; *see supra* § VI.C.

215. A POSITA would have recognized that this operation represents merely implementing known prior art to have the power saving signal be used for indicating a bandwidth part switch of a cell, which would have yielded the predictable result of allowing *Nimbalker*’s UE to monitor each of the search spaces at the appropriate time and allow system resources to be allocated for more efficient use. *See supra* §§ VI.C.1-VI.C.3; XII.A.1.b-XII.A.1.c (elements [1a], [1b]). At a minimum, a POSITA would have found it obvious to try having the power saving signal be used for indicating a bandwidth part switch of a cell because it was a known technique that would have improved *Nimbalker*’s device in the same way as known in the prior art and as was known from 3GPP documents.

ii. Expectation of Success

216. In my opinion, a POSITA would have reasonably expected to succeed in having the power saving signal be used for indicating a bandwidth part switch of a cell.

217. In my opinion, a POSITA would have recognized that having the power saving signal be used for indicating a bandwidth part switch of a cell was well known and routine in the prior art, including its reference in different 3GPP documents. *See supra* § VI.C; Ex. 1007, *R1-1905031*, 2-3; Ex. 1008, *R1-1903016*, 1, 4, 13. A POSITA would have expected to succeed in implementing this functionality in *Nimbalker*'s system at least because using the power saving signal for indicating a bandwidth part switch of a cell was described in 3GPP documents to more efficiently allow the UE to monitor the WUS search space and PDCCH scheduling search space. *See supra* § VI.C; Ex. 1007, *R1-1905031*, 2-3; Ex. 1008, *R1-1903016*, 1, 4, 13.

218. Implementing this functionality in *Nimbalker*'s system would have been merely the straightforward application of known, conventional techniques used according to their known functions to yield predictable results.

3. Claim 11

- a. **“The UE of claim 10, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.”**

219. Claim 11 recites substantively the same additional limitations as claim 2, which *Nimbalker* and *R1-1905031* render obvious for at least the reasons I discuss for claim 2.

4. Claim 13

- a. **“The UE of claim 10, wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.”**

220. Claim 13 recites substantively the same additional limitations as claim 4, which *Nimbalker* and *R1-1905031* render obvious for at least the reasons I discuss for claim 4.

C. Ground 4: Claims 2, 4, 11, and 13 Are Rendered Obvious by *Nimbalker* in View of *R1-1903016*

221. I have also been asked to consider the situation where *Nimbalker* alone does not disclose or render obvious claims 2 and 11. In such case, it is my opinion that the combination of *Nimbalker* and *R1-1903016* would have rendered these claims obvious. The combination of *Nimbalker* and *R1-1903016* also would have rendered obvious claims 4 and 13.

1. Claim 2

- a. “The method of claim 1, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.”**

222. In my opinion, a POSITA would have found that the combination of *Nimbalker* and *R1-1903016* renders obvious wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.

223. As explained in Grounds 1-3, claim 2, *Nimbalker* discloses that the WUS-PDCCH and PDCCH “frequency resources may be different,” which results in different CORESET search spaces, including on different BWPs. *Nimbalker*, 16; *Nimbalker Provisional*, 24.

224. *R1-1903016*, like *Nimbalker*, discloses the “[d]esign of new dedicated PDCCH-WUS,” which includes a “PDCCH structure, CORESET/search space, [and] BWP configuration specific for the WUS occasion” Ex. 1008, *R1-1903016*, 1-2. A POSITA would have understood that a “CORESET/search space, BWP configuration” that is “specific for the WUS occasion” describes

Nimbalker's WUS-PDCCH CORESET/search space (second search space) that is distinct from the PDCCH scheduling search space (first search space).

R1-1903016, 1-2. This is confirmed by *R1-1903016's* disclosure of the “PDCCH-WUS configuration” table providing for “CORESET” “[c]onfiguration[s].” *See* Ex. 1008, *R1-1903016*, 7.

i. Motivation to Combine and Expectation of Success

225. In my opinion, a POSITA would have found it obvious to have *Nimbalker's* first PDCCH scheduling search space include a first time and first frequency resource for the UE to monitor the scheduling signal, and the second WUS-PDCCH search space include a second time and second frequency resource for the UE to monitor the power saving signal, such that they are distinct CORESETs, as explained above for Grounds 1/2, claim 2, and Ground 3, claim 2. *See supra* §§ XII.A.2, XII.B.1.

226. In my opinion, a POSITA would have been motivated to have the first PDCCH search space include a first time and first frequency resource for the UE to monitor the scheduling signal to receive PDCCH scheduling UL/DL information, and the second WUS-PDCCH search space include a second time and second frequency resource for the UE to monitor the WUS power saving signal, such as taught by *R1-1903016*, and reasonably expected to succeed in doing so, for the

reasons discussed above for Grounds 1/2, claim 2, and Ground 3, claim 2. *See supra* §§ XII.A.2, XII.B.1.

2. Claim 4

- a. “The method of claim 1, wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.”**

227. In my opinion, a POSITA would have found that the combination of *Nimbalker* and *R1-1903016* renders obvious wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.

228. As explained in Ground 3, claim 4, *Nimbalker* discloses that “the WUS and PDCCH frequency resources may be different,” such that each has a different “frequency location” (or BWP). *Nimbalker*, 16; *Nimbalker Provisional*, 24.

229. *R1-1903016* discloses that, “when a PDCCH-WUS is decoded, the UE performs wake-up of additional hardware and processing (e.g., by performing BWP switching, ...) to get ready for potential DL/UL scheduling.” Ex. 1008, *R1-1903016*, 1. For the PDCCH-WUS, *R1-1903016* explains that “[o]ne advantage of PDCCH-WUS” is that “the wake-up [PDCCH-WUS] DCI can contain a BWP ID for the UE to switch to, providing additional flexibility to the scheduler to select a desired BWP and enabling an earlier BWP switch compared to waiting until the ON duration to signal the new BWP.” Ex. 1008, *R1-1903016*, 4.

230. A POSITA would have found it obvious to have *Nimbalker*'s WUS-PDCCH power saving signal be used for indicating a bandwidth part switch of a cell to efficiently switch the UE between bandwidth parts of the cell so that the UE can more efficiently monitor the WUS-PDCCH during wake-up signal monitoring and the scheduling PDCCH during ON duration, as taught by *Nimbalker* and *R1-1903016*.

i. Motivation to Combine

231. In my opinion, a POSITA would have been motivated to have the power saving signal be used for indicating a bandwidth part switch of a cell, such as taught by *R1-1903016*.

232. In my opinion, a POSITA would have recognized that *Nimbalker*'s WUS-PDCCH CORESET/search space (second search space) and PDCCH for scheduling CORESET/search space (first search space) may be more efficiently monitored on different BWPs (frequency resources). *See Nimbalker*, 16; *Nimbalker Provisional*, 24. A POSITA would have been motivated to have the power saving signal indicate the bandwidth part that should be monitored to “provid[e] additional flexibility to the scheduler to select a desired BWP and enabling an earlier BWP switch compared to waiting until the ON duration to signal the new BWP.” Ex. 1008, *R1-1903016*, 4. A POSITA would have also been motivated to include this functionality in *Nimbalker*'s system such that the base station can

indicate to the UE which BWP should be monitored to allow the base station to more efficiently allocate resources based on the network usage and each UE's capabilities. A POSITA also would have been motivated to provide for configurations that facilitate LTE and 5G (NR) operations, like *Nimbalker's* devices and methods. *Nimbalker*, 2, 21-22; *Nimbalker Provisional*, 17, 29-30; *see supra* §§ VI.C, XII.B.2.

233. A POSITA would have recognized that implementing this operation in *Nimbalker's* system represents merely implementing known prior art to have the power saving signal be used for indicating a bandwidth part switch of a cell (e.g., via *R1-1903016's* "BWP ID" in the wake-up [PDCCH-WUS] DCI), which would have yielded the predictable result of allowing *Nimbalker's* UE to switch between monitoring each of the search spaces at the appropriate time and allow system resources to be allocated for more efficient use. *See supra* §§ VI.C, XII.B.2. At a minimum, a POSITA would have found it obvious to try having *Nimbalker's* power saving signal be used for indicating a bandwidth part switch of a cell because it was a known technique that would have improved *Nimbalker's* device in the same way as known in the prior art and as was known from 3GPP documents. *See supra* §§ VI.C, XII.B.2.

ii. Expectation of Success

234. A POSITA would have reasonably expected to succeed in having the power saving signal be used for indicating a bandwidth part switch of a cell.

235. A POSITA would have recognized that having *Nimbalker's* power saving signal be used for indicating a bandwidth part switch of a cell was well known and routine in the prior art, including its reference in different 3GPP documents. *See supra* §§ VI.C, XII.B.2; Ex. 1008, *R1-1903016*, 1, 4, 13; Ex. 1007, *R1-1905031*, 2-3. A POSITA would have expected to succeed in implementing this functionality at least because using the power saving signal for indicating a bandwidth part switch of a cell was described in 3GPP documents to more efficiently allow the UE to monitor the WUS search space and the PDCCH scheduling search space. *See supra* §§ VI.C, XII.B.2; Ex. 1008, *R1-1903016*, 1, 4, 13; Ex. 1007, *R1-1905031*, 2-3.

236. Implementing this functionality in *Nimbalker's* system would have been merely the straightforward application of known, conventional techniques used according to their known functions to yield predictable results.

3. Claim 11

- a. “The UE of claim 10, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.”**

237. Claim 11 recites substantively the same additional limitations as claim 2, which *Nimbalker* and *RI-1903016* render obvious for at least the reasons I discuss for claim 2.

4. Claim 13

- a. “The UE of claim 10, wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.”**

238. Claim 13 recites substantively the same additional limitations as claim 4, which *Nimbalker* and *RI-1903016* render obvious for at least the reasons I discuss for claim 4.

D. Ground 5: Claims 7-9 and 16-18 Are Rendered Obvious by *Nimbalker* in View of *Anil*

239. In my opinion, the combination of *Nimbalker* and *Anil* renders obvious claims 7-9 and 16-18.

1. Claim 7

- a. “The method of claim 1, further comprising:
not monitoring the second search space in response to
the UE performing a random access procedure,
wherein the UE performs the random access
procedure in response to one of:
[i] a random access response window is running after
transmitting a first random access preamble; and
[ii] the UE has not received the scheduling signal on
the PDCCH indicating a new transmission addressed
to a Cell Radio Network Temporary Identifier
(C-RNTI) of the UE after successful reception of a
random access response corresponding to a second
random access preamble not selected by the UE
among contention-based random access preambles.”**

240. A POSITA reading the language of claim 7 would have understood that it recites two alternatives because it recites “perform[ing] ... in response to one of” the two subsequent options. Although the claim uses the word “and,” in context, the POSITA would have understood that these recitations are alternative options recited in claim 7. The specification of the ’911 patent describes these recitations as separate, alternative options. For example, the ’911 patent explains that “the UE may not monitor the WUS on the WUS occasion ((or [sic] ignore monitoring WUS on the WUS occasion)) [sic] when the UE performs a beam failure recovery procedure or a random access procedure for beam failure recovery.” Ex. 1001, 9:31-35. As another example, the ’911 patent explains that “the UE performing a random access procedure may mean a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been

received after successful reception of an RAR for the Random Access Preamble not selected by the MAC entity among the contention-based Random Access Preamble.” Ex. 1001, 9:39-44. This is recited without discussing a random access response window is running after transmitting a first random access preamble. The fact that claim 7 also recites actions being taken in response to “a first random access preamble” in [i] and “a second random access preamble” in [ii] indicates that these are different options because the UE would not need to send two random access preambles in beam failure recovery while waiting for responses described in the claim. Thus, in claim 7, the word “and” is simply used to delineate the two alternatives. It is my understanding that when alternatives are recited in a claim, then satisfying either option is considered to disclose the requirements of the claim, here claim 7.

241. In my opinion, a POSITA would have found that the combination of *Nimbalker* and *Anil* renders obvious not monitoring the second search space in response to the UE performing a random access procedure, wherein the UE performs the random access procedure in response to: [i] a random access response window is running after transmitting a first random access preamble.

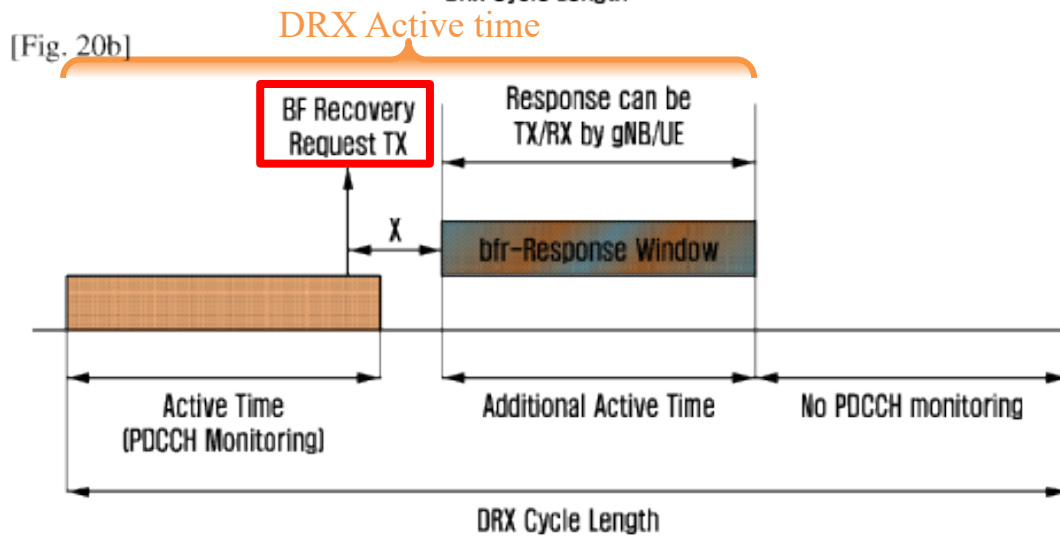
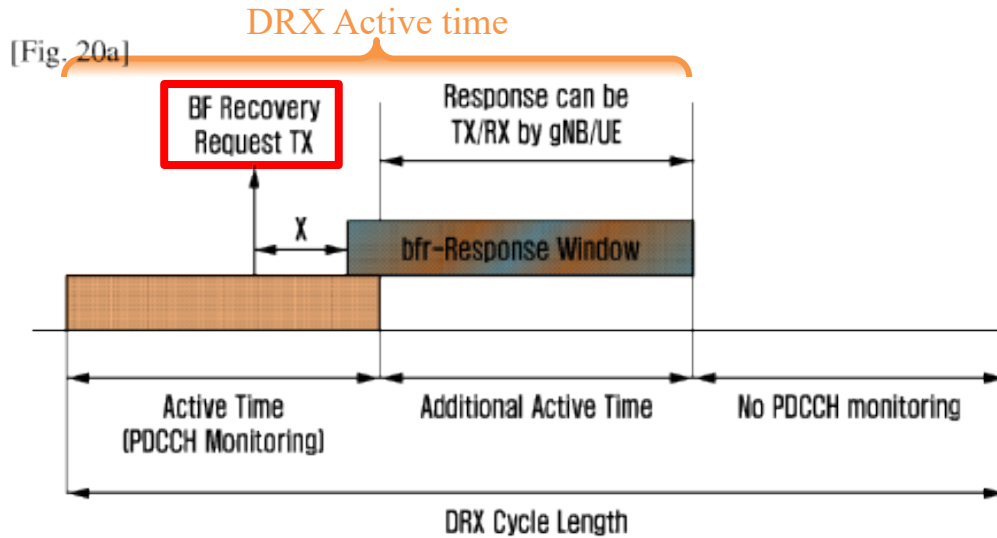
242. *Anil*, like *Nimbalker* and the ’911 patent, discloses DRX-related operations. *Anil* discloses performing a random access procedure of monitoring a

PDCCH in response to one of a random access bfr-ResponseWindow running after the UE transmits a first random access PRACH preamble. *Anil*, [89], [244]-[245].

243. For example, *Anil* discloses that “a UE ... transmits PRACH [Physical Random Access Channel] preamble [random access preamble] indicating [a] [b]eam failure recovery request during the active time” of a DRX cycle. *Anil*, [244]. After “transmit[ting] a PRACH preamble,” the “UE starts the bfr-ResponseWindow (i.e., ra-response Window configured in beam failure recovery configuration) and monitors the PDCCH of the serving cell for which beam failure recovery is initiated while bfr-ResponseWindow is running” *Anil*, [89]. *Anil* explains that, “[i]f DRX is configured and bfr-Response Window is running, [then] UE shall perform the operations ... defined for active time.” *Anil*, [245] (“active time also includes the time duration while bfr-Response Window (i.e., ra-response Window configured in beam failure recovery configuration) is running”). While the UE is in active time, “the UE shall monitor PDCCH at operation 2150” for scheduling information. *Anil*, [248]. *Anil*’s PDCCH monitoring in “active time” monitors a PDCCH for scheduling information during ON duration or the bfr-ResponseWindow timer.

244. As explained in element [1e], *Nimbalker* discloses that the UE does not monitor the WUS-PDCCH search space (WUS-PDCCH second search space) during “active time.” *See supra* § XII.A.1.f. The combination of *Anil* and

Nimbalker would result in the UE not monitoring the second search space in response to performing the random access procedure (*Anil*'s "monitor[ing] the PDCCH of the serving cell for which beam failure recovery is initiated") in response to when the random access response window is running ("while bfr-ResponseWindow is running") after transmitting the first random access preamble ("transmit[ting] PRACH preamble indicating [b]eam failure recovery request during the active time") because this search space is an "active time" where *Nimbalker* does not monitor WUS-PDCCH. *Anil*, [89], [244]-[245].



Anil, FIGS. 20a, 20b.

245. A POSITA would have found it obvious to not monitor the second (WUS-PDCCH) search space in response to the UE performing a random access procedure in response to when a random access response window is running after transmitting a first random access preamble, as recited in claim 7. For example, a POSITA would have found this obvious because *Anil* discloses the UE transmitting the PRACH preamble when there has been a beam failure and then monitoring a

PDCCH in “active time.” *Anil*, [89], [244]-[245]. *Nimbalker* teaches that, when the UE is in active time, it should not monitor the WUS-PDCCH. *See supra* § XII.A.1.f (element [1e]).

246. Furthermore, a POSITA would have found it obvious to not monitor the second search space for receiving the wake-up signal (WUS) because the UE is already “awake” and monitoring the PDCCH for the reception of a reply from the base station to UE in response to the RACH preamble that the UE sent to the base station. A POSITA would have found it obvious to have the UE not monitor for being told to wake up when the UE is already awake.

i. Motivation to Combine

247. In my opinion, a POSITA would have been motivated to implement the random access functionality by *Anil* in *Nimbalker*’s system to provide beam failure procedures, while not monitoring the WUS-PDCCH during the active time to reduce power consumption, as taught by *Nimbalker*.

248. In my opinion, a POSITA would have recognized that *Nimbalker*’s teaching that the UE should not monitor the WUS-PDCCH second search space would similarly reduce UE power consumption during the beam failure recovery period taught by *Anil*, where the UE “shall monitor PDCCH” as part of the “active time” when the “bfr-ResponseWindow” is running. *Anil*, [89], [244]-[245], FIGS. 20a, 20b. A POSITA would have been motivated to combine *Nimbalker* and

Anil to perform the operations of claim 7 to improve beam failure recovery, while reducing UE power consumption while performing beam failure recoveries by not monitoring the WUS-PDCCH search space when the UE is already monitoring the PDCCH for a response to a beam failure recovery request.

249. Whether to monitor the second search space in response to the UE performing a random access procedure would also have been recognized as one of two alternative options: either monitoring or not monitoring the second search space. Choosing to turn on or off monitoring the second search space in response to an event was well known in the art (e.g., in response to low signal strength, in response to the UE being in DRX active time, etc.) and taught by *Nimbalker*. A POSITA would have found it obvious to not monitor the second search space in response to the UE performing a random access procedure as merely one other condition that could be used to trigger turning off the WUS-PDCCH search space monitoring during an “active time.”

250. In my opinion, a POSITA would have recognized that the combination represents merely implementing known prior-art beam failure recovery with *Nimbalker*’s teaching to not monitor the WUS-PDCCH search space when the UE is in active time (e.g., while a bfr-ResponseWindow is running). A POSITA would have been motivated to incorporate beam failure recovery so that the UE can obtain a new connection with the base station if a prior signal is lost.

This would have yielded the predictable result of performing beam failure recovery, as taught by *Anil*, while reducing power consumption by not monitoring the WUS-PDCCH search space, as taught by *Nimbalker*, during the bfr-ResponseWindow. At a minimum, a POSITA would have found it obvious to try not monitoring WUS-PDCCH while the bfr-ResponseWindow is running when performing beam failure recovery because it was a known technique that would have improved *Nimbalker*'s device in the same way as known in the prior art.

ii. Expectation of Success

251. In my opinion, a POSITA would have reasonably expected to succeed in implementing *Anil*'s beam failure recovery process into *Nimbalker*'s system, which does not monitor the second search space during the active time, to allow the UE to perform recovery when a beam fails, while providing for better power consumption during beam failure recovery procedures. A POSITA would have recognized that not monitoring the WUS-PDCCH search space while *Anil*'s bfr-ResponseWindow is running represents merely turning off the WUS-PDCCH search space monitoring, which was a well known operation, as disclosed by *Nimbalker*. A POSITA would have expected to succeed in implementing this functionality in *Nimbalker*'s system because *Nimbalker* already discloses not monitoring the second (WUS-PDCCH) search space during DRX active time. See *supra* § XII.A.1.f (element [1e]). *Anil* merely teaches that the “active time” in

which *Nimbalker* does not monitor the second search space may also include while a bfr-ResponseWindow is running. *Anil*, [89], [244]-[245], FIGS. 20a, 20b.

252. Implementing this functionality in *Nimbalker*'s system would therefore have been merely the straightforward application of known, conventional techniques used according to their known functions to yield predictable results.

2. Claim 8

- a. **“The method of claim 1, further comprising:
not monitoring the second search space in response to
at least one of [i] the UE performing a beam failure
recovery procedure and [ii] the UE monitoring a third
search space on the PDCCH, wherein the third search
space is configured for the UE to monitor a beam
failure response from the base station.”**

253. A POSITA reading the language of claim 8 would have understood that it recites two alternatives because it recites “not monitoring ... in response to at least one of ...” the subsequent options. Although the claim uses the word “and,” in context, as discussed above, the POSITA would have understood that these recitations are alternative options recited in claim 8. The specification of the '911 patent describes these as separate, alternative options. For example, the '911 patent explains that “the UE may not monitor the WUS on the WUS occasion ... when the UE performs a beam failure recovery procedure,” without discussing monitoring a PDCCH search space for a beam failure response specifically. Ex. 1001, 9:31-38. Similarly, the '911 patent explains that, “[i]n one

implementation, the priority of monitoring the normal PDCCH may be higher than monitoring the WUS in one of the following scenarios,” including “[the] UE is performing a beam failure recovery procedure.” Ex. 1001, 10: 20-28. This description, similar to the language of [i], does not describe monitoring a beam failure response stated in [ii]. Likewise, to the extent the ’911 patent discusses [ii], it is “[i]n some implementations” where “the UE may need to monitor a specific CORESET/search space for beam failure recovery to find a candidate beam and/or to receive a beam indication (e.g., a transmission configuration indicator (TCI) state indication)” and “the UE may not be allowed to monitor the CORESET/search space for the WUS.” Ex. 1001, 9:21-30. Here again, this description is described separately from the ’911 patent’s more general description of [i]. Thus, in claim 8, the word “and” is simply used to delineate the two alternatives. It is my understanding that when alternatives are recited in a claim, then satisfying either option is considered to disclose the requirements of the claim, here claim 8.

254. In my opinion, a POSITA would have found that the combination of *Nimbalker* and *Anil* renders obvious not monitoring the second search space in response to the UE performing a beam failure recovery procedure under option [i]. *Nimbalker* and *Anil* also render obvious not monitoring the second search space in response to the UE monitoring a third search space on the PDCCH, wherein the

third search space is configured for the UE to monitor a beam failure response from the base station under option [ii].

255. As explained above for claim 7, the combination of *Nimbalker* and *Anil* renders obvious not monitoring the WUS-PDCCH search space (second search space) in response to the UE performing a beam failure recovery procedure, for example, when “monitor[ing] the PDCCH of the serving cell for which beam failure recovery is initiated while bfr-ResponseWindow is running.” *Anil*, [89]; *see supra* § XII.D.1 (claim 7); *see also Anil*, [244]-[245], FIGS. 20a, 20b.

256. This disclosure of *Anil*, in combination with *Nimbalker*, also renders obvious the alternative option in claim 8: not monitoring the second search space in response to the UE monitoring a third search space on the PDCCH, wherein the third search space is configured for the UE to monitor a beam failure response from the base station.

257. As explained for claim 7, while the “bfr-ResponseWindow is running,” the “UE shall perform the operations ... defined for active time.” *Anil*, [245]. This includes “monitor[ing] the PDCCH of [an] SpCell” (monitoring a third search space on the PDCCH) “for [a] response to [the] beam failure recovery request identified by the C-RNTI” (for the UE to monitor a beam failure response from the base station). *Anil*, [245], FIGS. 20a, 20b.

258. In my opinion, a POSITA would have found it obvious to not monitor the second search space in response to either alternative of claim 8 to reduce UE power consumption for the reasons explained in claim 7. *See supra* § XII.D.1. A POSITA would have been motivated to implement, based on the combination of *Nimbalker* and *Anil*, not monitoring the second search space in response to either alternative option in claim 8 to provide for beam failure recovery procedures while also reducing power consumption, and would have had a reasonable expectation of success in doing so, for the reasons explained in claim 7. *See supra* § XII.D.1.

3. Claim 9

a. “The method of claim 1, wherein the power saving signal is only received from a special cell (SpCell) of the base station.”

259. In my opinion, a POSITA would have found that the combination of *Nimbalker* and *Anil* renders obvious wherein the power saving signal is only received from a special cell (SpCell) of the base station.

260. The '911 patent does not explain what a “special cell (SpCell)” is. *See* Ex. 1001, 11:45-48, claims 9, 18.

261. *Anil* discloses that, “for Dual/Multi Connectivity operation[,] the term Special Cell (SpCell) refers to the Primary Cell (PCell) of the Master Cell Group (MCG) or the Primary Secondary Cell Group Cell (PSCell) of the Secondary Cell Group (SCG) depending on if the Media Access Control (MAC) entity is

associated to the MCG or the SCG, respectively. ... Otherwise[,] the term SpCell refers to the PCell.” *Anil*, [76]. This is consistent with 3GPP 38.321. *TS 38.321*, 10 (“**Special Cell**: For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG, otherwise the term Special Cell refers to the PCell.”). *Anil* also discloses that, “[a]fter reception of the Beam Failure Recovery Request from a UE, the SCell can share this information with SpCell” (e.g., primary cell) because the beam failure recovery may take place on the secondary cell (SCell). *Anil*, [83].

262. In my opinion, a POSITA would have found it obvious to have *Nimbalker*’s WUS-PDCCH power saving signal be only received from a special cell (SpCell) of the base station to provide for the wake-up signaling to occur with “PDCCH scheduling [for] UL/DL data” in transmissions from the primary cell (PCell), such as within a cell group disclosed by *Anil*. *Nimbalker*, 9; *Nimbalker Provisional*, 19.

i. Motivation to Combine

263. In my opinion, a POSITA would have been motivated to implement *Nimbalker*’s WUS-PDCCH power saving signal being only received from a special cell (SpCell) of the base station when the WUS-PDCCH is carried on the primary cell of the cell group.

264. In my opinion, a POSITA would have recognized that implementing *Nimbalker's* WUS-PDCCH such that the power saving signal is only received from a special cell (SpCell) of the base station would have enabled the UE to reduce power consumption on the primary cell (SpCell) in a multi-cell system, while reserving the secondary cell for other operations.

265. In my opinion, a POSITA would have been motivated to implement *Nimbalker's* WUS-PDCCH power saving signal to be only received from a special cell (SpCell) of the base station because, for example, it is one of a finite set of options (either implementing only on the SpCell (PCell), only on the SCell, or on both the SpCell and SCell). Since the WUS is transmitted via the PDCCH, and the PCell is used for transmitting the PDCCH, a POSITA would have found it obvious also transmit the WUS-PDCCH on the PCell, which is a "special cell." This would also provide for more capacity on the SCell other data transmissions. As such, a POSITA would have found it obvious, or at least obvious to try, in circumstances where using the WUS-PDCCH procedure on the SpCell might be beneficial to the UE, while not on another cell, which may use regular DRX or be reserved for maintenance operations.

266. In my opinion, a POSITA would have recognized that implementing this operation in *Nimbalker's* system represents merely implementing a known prior-art technique, which would have yielded the predictable result of only

receiving the WUS-PDCCH on the SpCell (e.g., PCell). At a minimum, a POSITA would have found it obvious to try because it was a known technique that would have improved *Nimbalker*'s device in the same way as known in the prior art.

ii. Expectation of Success

267. In my opinion, a POSITA would have reasonably expected to succeed in implementing *Nimbalker*'s WUS-PDCCH power saving signal being only received from a special cell (SpCell, e.g., PCell) of the base station when the WUS-PDCCH is carried on the primary cell signal.

268. In my opinion, a POSITA would have recognized that this merely represents performing the known operation (receiving the WUS-PDCCH power saving signal) from one cell, which was well known and routine in the prior art and represents merely monitoring the second search space for the SpCell. A POSITA would have expected to succeed in implementing this functionality in *Nimbalker*'s system because *Nimbalker* already discloses monitoring the second search space and implementing the operations of claim 8 would require merely performing *Nimbalker*'s disclosed operation only for the SpCell. This would have been merely the straightforward application of known, conventional techniques used according to their known functions to yield predictable results.

4. Claim 16

- a. “The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:**
not monitoring the second search space in response to the UE performing a random access procedure, wherein the UE performs the random access procedure in response to one of:
[i] a random access response window is running after transmitting a first random access preamble; and
[ii] the UE has not received the scheduling signal on the PDCCH indicating a new transmission addressed to a Cell Radio Network Temporary Identifier (C-RNTI) of the UE after successful reception of a random access response corresponding to a second random access preamble not selected by the UE among contention-based random access preambles.”

269. Claim 16 recites substantively the same additional limitations as claim 7, which *Nimbalker* and *Anil* render obvious for at least the reasons I discuss for claim 7.

5. Claim 17

- a. “The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:
not monitor the second search space in response to at least one of [i] the UE performing a beam failure recovery procedure and [ii] the UE monitoring a third search space of the PDCCH, wherein the third search space is configured for the UE to monitor a beam failure response from the base station.”**

270. Claim 17 recites substantively the same additional limitations as claim 8, which *Nimbalker* and *Anil* render obvious for at least the reasons I discuss for claim 8.

6. Claim 18

- a. “The UE of claim 10, wherein the power saving signal is only received from a special cell (SpCell) of the base station.”**

271. Claim 18 recites substantively the same additional limitations as claim 9, which *Nimbalker* and *Anil* render obvious for at least the reasons I discuss for claim 9.

XIII. CONCLUSION

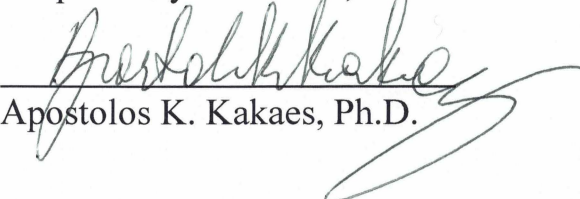
272. For the reasons set forth in Section XII, it is my opinion that one skilled in the art would have found claims 1-18 of the '911 patent anticipated and/or obvious.

273. In signing this declaration, I understand that the declaration will be filed as evidence in a contested case before the Patent Trial and Appeal Board of the United States Patent and Trademark Office. I acknowledge that I may be subject to cross-examination in this case and that cross-examination will take place within the United States. If cross-examination is required of me, I will appear for cross-examination within the United States during the time allotted for cross-examination.

274. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Date: July 1, 2025

Respectfully submitted,


Apostolos K. Kakaes, Ph.D.

Claims Listing

1. **[1Preamble]**¹¹ A method for a user equipment (UE) monitoring a physical downlink control channel (PDCCH), the method comprising:
[1a] receiving a first configuration from a base station to configure the UE with a first search space of the PDCCH, wherein the first search space is used for monitoring a scheduling signal used for indicating scheduling information;
[1b] receiving a second configuration from the base station to configure the UE with a second search space of the PDCCH, wherein the second search space is used for monitoring a power saving signal used for indicating wake-up information associated with a Discontinuous Reception (DRX) functionality;
[1c] in response to not receiving the power saving signal while monitoring the second search space, starting a DRX on-duration timer of the DRX functionality;

¹¹ I have added the bold brackets for ease of reference within the claims.

[1d] monitoring the first search space in response to the UE being in a DRX active time of the DRX functionality, wherein the DRX active time is a time during which the UE monitors the PDCCH; and

[1e] not monitoring the second search space in response to the UE being in the DRX active time of the DRX functionality.

2. The method of claim 1, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.
3. The method of claim 1, further comprising:
determining whether to start a DRX on-duration timer of the DRX functionality according to the wake-up information.
4. The method of claim 1, wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.

5. The method of claim 1, wherein the power saving signal is not received in the second search space in response to when at least one of **[i]** the UE does not monitor the second search space and **[ii]** the UE unsuccessfully decodes the power saving signal.
6. The method of claim 1, wherein the not monitoring the second search space comprises:

not monitoring the second search space while a DRX inactivity timer of the DRX functionality is running.
7. The method of claim 1, further comprising:

not monitoring the second search space in response to the UE performing a random access procedure, wherein the UE performs the random access procedure in response to one of:

[i] a random access response window is running after transmitting a first random access preamble; and **[ii]** the UE has not received the scheduling signal on the PDCCH indicating a new transmission addressed to a Cell Radio Network Temporary Identifier (C-RNTI) of the UE after successful reception of a random access response

corresponding to a second random access preamble not selected by the UE among contention-based random access preambles.

8. The method of claim 1, further comprising:
not monitoring the second search space in response to at least one of **[i]** the UE performing a beam failure recovery procedure and **[ii]** the UE monitoring a third search space on the PDCCH, wherein the third search space is configured for the UE to monitor a beam failure response from the base station.
9. The method of claim 1, wherein the power saving signal is only received from a special cell (SpCell) of the base station.
10. **[10Preamble]** A user equipment (UE) monitoring a physical downlink (DL) control channel (PDCCH) in a wireless communication system, the UE comprising:
[10a] a processor, for executing computer-executable instructions; and
a non-transitory machine-readable medium, coupled to the processor, for storing the computer-executable instructions, wherein the computer-executable instructions instruct the processor to:

[10b] receive a first configuration from a base station to configure the UE with a first search space of the PDCCH, wherein the first search space is used for monitoring a scheduling signal used for indicating scheduling information;

[10c] receive a second configuration from the base station to configure the UE with a second search space of the PDCCH, wherein the second search space is used for monitoring a power saving signal used for indicating wake-up information associated with a Discontinuous Reception (DRX) functionality;

[10d] in response to not receiving the power saving signal while monitoring the second search space, start a DRX on-duration timer of the DRX functionality;

[10e] monitor the first search space in response to the UE being in a DRX active time of the DRX functionality, wherein the DRX active time is a time during which the UE monitors the PDCCH; and

[10f] not monitoring the second search space in response to the UE being in the DRX active time of the DRX functionality.

11. The UE of claim 10, wherein the first search space includes at least one of a first time and a first frequency resource for the UE to monitor the scheduling

signal, and the second search space includes at least one of a second time and a second frequency resource for the UE to monitor the power saving signal.

12. The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:

determine whether to start a DRX on-duration timer of the DRX

functionality according to the wake-up information.
13. The UE of claim 10, wherein the power saving signal is further used for indicating a bandwidth part switch of a cell.
14. The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:

not receive the power saving signal in the second search space in response to

when at least one of [i] the UE does not monitor the second search

space and [ii] the UE unsuccessfully decodes the power saving signal.
15. The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:

not monitor the second search space while a DRX inactivity timer of the DRX functionality is running.

16. The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:

not monitoring the second search space in response to the UE performing a random access procedure, wherein the UE performs the random access procedure in response to one of:

[i] a random access response window is running after transmitting a first random access preamble; and [ii] the UE has not received the scheduling signal on the PDCCH indicating a new transmission addressed to a Cell Radio Network Temporary Identifier (C-RNTI) of the UE after successful reception of a random access response corresponding to a second random access preamble not selected by the UE among contention-based random access preambles.

17. The UE of claim 10, wherein the computer-executable instructions further instruct the processor to:

not monitor the second search space in response to at least one of [i] the UE performing a beam failure recovery procedure and [ii] the UE

monitoring a third search space of the PDCCH, wherein the third search space is configured for the UE to monitor a beam failure response from the base station.

18. The UE of claim 10, wherein the power saving signal is only received from a special cell (SpCell) of the base station.