

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ONEPLUS TECHNOLOGY (SHENZHEN) CO., LTD.
Petitioner,

v.

PANTECH CORPORATION,
Patent Owner.

IPR2025-00762
U.S. Patent No. 10,863,573

**DECLARATION OF DR. TITUS LO,
IN SUPPORT OF PETITION FOR
INTER PARTES REVIEW**

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EXHIBIT LIST

Exhibit	Reference
1001	U.S. Patent No. 10,863,573 (“’573 Patent” or “’573Pat.”)
1002	File History of the ’573 Patent (“’573FH”)
1003	Declaration of Dr. Titus Lo in Support of Petition
1004	Dr. Titus Lo Curriculum Vitae
1005	U.S. Patent Application Publication No. 2014/0301362 (“Koskinen”)
1006	U.S. Patent Application Publication No. 2009/0149189 (“Sammour”)
1007	U.S. Patent Application Publication No. 2016/0021581 (“Deenoo”)
1008	U.S. Patent Application Publication No. 2014/0301281 (Koskinen281)
1009	<i>Pantech Corp.et al. v. Oneplus Tech. (Shenzhen) Co., Ltd.</i> , 5:24-cv-00038-RWS-JBB (E.D. Tex.), Dkt. No. 1, Complaint
1010	<i>Pantech Corp.et al. v. Oneplus Tech. (Shenzhen) Co., Ltd.</i> , 5:24-cv-00038-RWS-JBB (E.D. Tex.), Dkt. No. 9, Waiver of Service
1011	3GPP TS 36.323 v.11.2.0 (2013-03) (Packet Data Convergence Protocol (PDCP) specification)
1012	3GPP TS 36.300 v.11.5.0 (2013-03) (E-UTRAN overall description)
1013	3GPP TS 36.322 v.11.0.0 (2012-09) (Radio Link Control (RLC) protocol specification)
1014	3GPP TS 36.331 v.11.3.0 (2013-03) (Radio Resource Control (RRC); Protocol specification)
1015	<i>Pantech Corp.et al. v. Oneplus Tech. (Shenzhen) Co., Ltd.</i> , 5:24-cv-00038-RWS-JBB (E.D. Tex.), Dkt. No. 47, First Amended Docket Control Order
1016	DocketNavigator stay statistics for Judge Schroeder in EDTX
1017	Tdoc R2-130324 (3GPP TSG RAN WG2 #81, St. Julian’s, Malta, 28th January – 1st February, 2013) Source: NTT DOCOMO, INC., Discussion on U-plane architecture for dual connectivity

Exhibit	Reference
1018	Tdoc R2-131327 (3GPP TSG-RAN WG2 #81bis, Chicago, USA, April 15-19, 2013) Source: InterDigital Communications, User Plane Architecture for Dual Connectivity
1019	Tdoc R2-131621 (3GPP TSG RAN WG2 Meeting #82, Fukuoka, Japan, 20 - 24 May 2013) Source: Nokia Siemens Networks (Rapporteur)
1020	https://www.3gpp.org/about-us/ , “About 3GPP – The 3 rd Generation Partnership Project (3GPP)”
1021	https://www.3gpp.org/about-us/introducing-3gpp , “Introducing 3GPP”
1022	https://web.archive.org/web/20130127165723/http://isearch.3gpp.org/isysadvsearch.html , “ http://isearch.3gpp.org/isysadvsearch.html ,” Document Search 3GPP)
1023	https://web.archive.org/web/20250000000000*/http://isearch.3gpp.org/isysadvsearch.html , (Document Search 3GPP page not archived after 10/4/2022)
1024	(“3GPP documents are public and can be accessed via the 3GPP web site”) available at https://web.archive.org/web/20070219081417/http://tools.ietf.org/html/rfc3314
1025	https://www.3gpp.org/about-us/3gpp-faqs , (“3GPP FAQ’s”)
1026	https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_81bis/Docs , (Directory listing screen capture for R2-131327)
1027	3GPP TS 36.104 v.11.4.0 (2013-03) (Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception)
1028	3GPP TS 36.101 v.11.4.0 (2013-03) (Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception)
1029	3GPP TS 36.300 v.12.6.0 (2015-06) (Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description)

Exhibit	Reference
1030	3GPP TS 36.323 v.12.4.0 (2015-06) (Evolved Universal Terrestrial Radio Access (E-UTRA); Packet Data Convergence Protocol (PDCP) specification)
1031	https://en.wikipedia.org/wiki/3GPP , (3GPP Wikipedia)
1032	https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/ev-do-rev-a-and-b-wireless-broadband-for-the-masses-whitepaper.pdf , (EV-DO Rev. A and B: Wireless Broadband for the Masses)
1033	https://www.etsi.org/technologies/mobile/3g , (3 rd Generation (UMTS))
1034	https://www.etsi.org/technologies/mobile/4g , (4 th Generation (LTE))
1035	https://www.qualcomm.com/news/onq/2017/08/understanding-3gpp-starting-basics , (Understanding 3GPP – starting with the basics)
1036	https://www.ericsson.com/en/about-us/history/company/timeline-placeholder/timeline-2010-4g-arrives , (2010: 4G arrives)
1037	3GPP TS 36.932 v.12.1.0 (2013-03): Technical Specification Group Radio Access Network; Scenarios and requirements for small cell enhancements for E-UTRA and E-UTRAN
1038	3GPP TS 23.401 v.11.5.0 (2013-03) (General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access)
1039	3GPP TS 36.322 v.8.2.0 (2008-05) (Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Link Control (RLC) protocol specification)
1040	3GPP TS 36.323 v.8.2.1 (2008-05) (Evolved Universal Terrestrial Radio Access (E-UTRA) Packet Data Convergence Protocol (PDCP) specification)

I, Titus Lo, do hereby declare as follows:

I. INTRODUCTION

1. My name is Titus Lo, and I have been retained by counsel for Petitioner OnePlus Technology (Shenzhen) Co., Ltd. (“Petitioner”) as a consultant to provide my opinion regarding certain prior art references and U.S. Patent No. 10,863,573 (the “’573 Patent”).

2. I make this declaration based upon my own personal knowledge and, if called upon to testify, would testify competently to the matters stated herein.

3. I have been asked to provide my expert opinion connection with the *Inter Partes* Review of the ’573 Patent to Jung *et al.* concerning whether it is unpatentable over certain prior art. This declaration is a statement of my opinions on issues relating to the patentability of claims 1-5 and 8-12 (the “Challenged Claims”) of the ’573 Patent. As I explain more fully below, it is my opinion that all of the Challenged Claims would have been obvious to a person of ordinary skill in the art (“POSITA”) at the time of the alleged invention.

4. I am being compensated for my work in this matter at my standard hourly rate. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this investigation. My compensation is not contingent on the outcome of this matter or the specifics of my testimony.

5. I have reviewed and considered the following documents in connection

with my analysis of the '573 Patent:

- EX1001: U.S. Patent No. 10,863,573 (“’573 Patent” or “’573Pat.”)
- EX1002: File History of the ’573 Patent (“’573FH”)
- EX1005: U.S. Patent Application Publication No. 2014/0301362 (“Koskinen”)
- EX1006: U.S. Patent Application Publication No. 2009/0149189 (“Sammour”)
- EX1007: U.S. Patent Application Publication No. 2016/0021581 (“Deenoo”)
- EX1008: U.S. Patent Application Publication No. 2014/0301281 (Koskinen281)
- EX1011: 3GPP TS 36.323 v.11.2.0 (2013-03) (Packet Data Convergence Protocol (PDCP) specification)
- EX1012: 3GPP TS 36.300 v.11.5.0 (2013-03) (E-UTRAN overall description)
- EX1013: 3GPP TS 36.322 v.11.0.0 (2012-09) (Radio Link Control (RLC) protocol specification)
- EX1014: 3GPP TS 36.331 v.11.3.0 (2013-03) (Radio Resource Control (RRC); Protocol specification)
- EX1017: Tdoc R2-130324 (3GPP TSG RAN WG2 #81, St. Julian’s,

Malta, 28th January – 1st February, 2013) Source: NTT DOCOMO, INC., Discussion on U-plane architecture for dual connectivity

- EX1018: Tdoc R2-131327 (3GPP TSG-RAN WG2 #81bis, Chicago, USA, April 15-19, 2013) Source: InterDigital Communications, User Plane Architecture for Dual Connectivity
- EX1019: Tdoc R2-131621 (3GPP TSG RAN WG2 Meeting #82, Fukuoka, Japan, 20 - 24 May 2013) Source: Nokia Siemens Networks (Rapporteur)
- EX1020: <https://www.3gpp.org/about-us/>, “About 3GPP – The 3rd Generation Partnership Project (3GPP)”
- EX1021: <https://www.3gpp.org/about-us/introducing-3gpp>, “Introducing 3GPP”
- EX1022: <https://web.archive.org/web/20130127165723/http://isearch.3gpp.org/isysadvsearch.html>, “<http://isearch.3gpp.org/isysadvsearch.html>,” Document Search 3GPP)
- EX1023: https://web.archive.org/web/20250000000000*/http://isearch.3gpp.org/isysadvsearch.html, (Document Search 3GPP page not archived after 10/4/2022)
- EX1024: (“3GPP documents are public and can be accessed via the 3GPP web site”) available at

<https://web.archive.org/web/20070219081417/http://tools.ietf.org/html/rfc3314>

- EX1025: <https://www.3gpp.org/about-us/3gpp-faqs>, (“3GPP FAQ’s”)
- EX1026: https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_81bis/Docs, (Directory listing screen capture for R2-131327)
- EX1027: 3GPP TS 36.104 v.11.4.0 (2013-03) (Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception)
- EX1028: 3GPP TS 36.101 v.11.4.0 (2013-03) (Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception)
- EX1029: 3GPP TS 36.300 v.12.6.0 (2015-06) (Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description)
- EX1030: 3GPP TS 36.323 v.12.4.0 (2015-06) (Evolved Universal Terrestrial Radio Access (E-UTRA); Packet Data Convergence Protocol (PDCP) specification)
- EX1031: <https://en.wikipedia.org/wiki/3GPP>, (3GPP Wikipedia).
- EX1032: <https://www.qualcomm.com/content/dam/qcomm-martech/dm-assets/documents/ev-do-rev-a-and-b-wireless-broadband->

for-the-masses-whitepaper.pdf, (EV-DO Rev. A and B: Wireless Broadband for the Masses)

- EX1033: <https://www.etsi.org/technologies/mobile/3g>, (3rd Generation (UMTS))
- EX1034: <https://www.etsi.org/technologies/mobile/4g>, (4th Generation (LTE))
- EX1035: <https://www.qualcomm.com/news/onq/2017/08/understanding-3gpp-starting-basics>, (Understanding 3GPP – starting with the basics)
- EX1036: <https://www.ericsson.com/en/about-us/history/company/timeline-placeholder/timeline-2010-4g-arrives>, (2010: 4G arrives)
- EX1037: 3GPP TS 36.932 v.12.1.0 (2013-03): Technical Specification Group Radio Access Network; Scenarios and requirements for small cell enhancements for E-UTRA and E-UTRAN
- EX1038: 3GPP TS 23.401 v.11.5.0 (2013-03) (General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access)
- EX1039: 3GPP TS 36.322 v.8.2.0 (2008-05) (Evolved Universal Terrestrial Radio Access (E-UTRA) Radio Link Control (RLC))

protocol specification)

- EX1040: 3GPP TS 36.323 v.8.2.1 (2008-05) (Evolved Universal Terrestrial Radio Access (E-UTRA) Packet Data Convergence Protocol (PDCP) specification)

6. In forming the opinions expressed below, I have considered:

- a) the documents listed above;
- b) the relevant legal standards as explained to me by the Petitioner's counsel, including the standard for obviousness, and any additional authoritative documents as cited in the body of this declaration;
- c) my own knowledge and experience based upon my work in the field of wireless communications as described below; and
- d) any other documents not listed above but cited below.

7. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Patent Owner. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

8. My analysis of the materials produced in this proceeding is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to revise,

supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

9. Unless otherwise noted, all emphasis in any quoted material has been added.

II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

10. I am an expert in the field of telecommunication systems. I have studied, researched, and practiced in this field for over thirty years. My complete qualifications and professional experience are described in my *Curriculum Vitae*, a copy of which can be found in Exhibit 1004. The following is a brief summary of my relevant qualifications and professional experience.

11. I earned my Bachelor of Applied Science degree in Electrical Engineering from the University of British Columbia in Vancouver, British Columbia, Canada in 1986. I earned my Master of Engineering degree in 1989 and Doctor of Philosophy (Ph.D.) degree in 1995, both in Electrical Engineering from McMaster University in Hamilton, Ontario, Canada. My Ph.D. dissertation, entitled “MLE and RBF for AOA estimation in a Multipath Environment”, is about the concept and principle for application of artificial intelligence to antenna signal processing.

12. From 1989 to 1997, I had worked full time, first as a research engineer and then as a senior research engineer/project manager, at Communications

Research Laboratory, McMaster University, where I had been involved in numerous research and development projects related to antenna beamforming technology applied to mobile communications, satellite communications, and spaceborne radar systems. It was during this period that, foreseeing the important role of beamforming technology in future wireless communications, I was able to establish my international leading position in this field. I co-authored a technical reference book, entitled *Digital Beamforming in Wireless Communications*, the first of its kind in the field, published in 1996 by Artech House. After more than twenty years later, it is now a well-known fact that antenna beamforming is one of the cornerstone technologies employed in the 5th generation (5G) wireless communications networks.

13. It was because of both the importance of antenna beamforming technology to its wireless business and my exceptional expertise in the field that AT&T Wireless Services had persuaded me to join its Strategic Technology Group (STG) in 1997. At AT&T, as part of system design and engineering, I led the research and development of advanced radio technologies in an orthogonal frequency division multiplexing (OFDM) system, including antenna array processing, signal acquisition, synchronization, channel estimation, space-time coding, and transmission diversity, all of which were the critical elements to AT&T's fixed wireless network – the world's first carrier-grade and commercially

deployed orthogonal frequency division multiple access (OFDMA) system.

14. From 2001, I embarked on my startup endeavor in pursuing the development of advanced technologies to telecommunications. I worked in a number of startups subsequently. In 2001, I joined NextComm, Inc., a Kirkland, WA based startup that designed and developed application-specific integrated circuits (ASICs) for wireless local area network (WLAN) devices, where I was responsible for system engineering, including the design, implementation, and test, of IEEE 802.11a (OFDM-based) and 802.11b (spread spectrum-based) standard (a.k.a. Wi-Fi) compliant chipsets. During the tenure in NextComm, I participated in and contributed to the IEEE 802.11 Standard Working Group in the development of 802.11g amendment. In 2003, I served as the vice president of engineering and operations at Waltical Solutions, Inc., Bellevue, WA, where I directed an engineering team in the design and development of broadband wireless communications technologies (including 801.16e/WiMax) and systems. In 2006, I served as the vice president at, Neocific, Inc., a 4G pioneer based at Bellevue, WA, where I managed and mentored a team of researchers and engineers in the research and development of 4th generation (4G) wireless technologies, including key radio functionalities such as synchronization, random access, inter-cell interference mitigation, power control, and control signaling. In 2011, I engaged in consulting services to my clients by providing analysis, evaluation, and due diligence

investigation of technical aspects of intellectual property portfolios related to various wireless technologies, including 4G/LTE and IEEE 802.11.

15. Throughout my professional career, I have been granted more than 180 US and foreign patents in the area of wireless communications. I have published more than 80 technical papers in peer-reviewed international journals (e.g., IEEE Transactions and IEE Proceedings) and conference proceedings (e.g., IEEE International Conferences and Spie's International Symposiums). All my works have been cited by more than 7000 researchers and practitioners in the field over the years.

16. Throughout my career as a wireless technology expert, I have been privileged to share my knowledge and expertise by presenting and lecturing at a wide variety of industry and professional venues, as well as engaging with diverse technical and industrial communities. My work has focused on advancing the understanding and application of LTE/4G wireless technology, enabling me to deliver impactful presentations and conduct specialized training sessions for a broad spectrum of audiences, including:

- Large and Small Corporations: Within the wireless industry, I have collaborated with organizations of varying sizes, offering tailored insights into current and future LTE capabilities and features to help them address challenges and drive innovation.
- The Broader Wireless Community: I have actively contributed to

professional gatherings such as IEEE workshops and forums, where I have shared knowledge on emerging trends in wireless communication systems.

- Academic Institutions: Through academic seminars, I have supported the advancement of wireless technology research and development by connecting theoretical concepts with practical applications.

17. In addition to these endeavors, I have taken on leadership roles in organizing numerous global and local summits, conferences, and workshops centered on 4G/5G technology. These events have served as vital platforms for facilitating collaboration among industry experts, researchers, policymakers, and stakeholders.

18. I was appointed as an affiliated professor in the Department of Electrical & Computer Engineering at the University of Washington, Seattle, WA from 2008 to 2012. I have also served or been serving various leadership positions in the Institute of Electrical and Electronics Engineers (IEEE). For example, I have been serving as an organization committee member for IEEE 5G World Forum since its inception in 2018. I have been a senior IEEE member since 1998 and have been inducted in to the IEEE Eta Kappa Nu Honor Society in 2019.

III. LEVEL OF ORDINARY SKILL IN THE ART

19. My analysis reflects the views of a person of ordinary skill in the art in the field of the '573 Patent as of May 10, 2013, which I understand is the alleged

time of invention.

20. I have been advised by the Petitioner's counsel and understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; and (4) the prior art solutions to those problems. I understand that a POSITA is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a POSITA would also have knowledge from the teachings of the prior art, including the art cited below.

21. Taking these factors into consideration, in my opinion, on or before May 10, 2013, a POSITA would have been someone knowledgeable and familiar with design or development of telecommunication and/or wireless communications systems that are pertinent to the '573 Patent. That person would have a bachelor's degree in electrical engineering, computer engineering, computer science, or a related field and at least two years of practical experience working in the field of video processing systems. Lack of work experience can be remedied by additional education, and vice versa.

22. As of May 10, 2013, I met, and in fact exceeded, the qualifications of a person of ordinary skill in the art.

23. For purposes of this Declaration, in general, and unless otherwise noted, my statements and opinions, such as those regarding my experience and the understanding of a POSITA generally (and specifically related to the references I consulted herein), reflect the knowledge that existed in the field as of the earliest proper priority date of the '573 Patent (i.e., May 10, 2013). Unless otherwise stated, when I provide my understanding and analysis below, it is consistent with the level of a POSITA prior to the earliest alleged priority date of the '573 Patent.

IV. RELEVANT LEGAL STANDARDS

24. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the '573 Patent, I am relying on certain basic legal principles that counsel have explained to me. These principles are discussed below.

25. I understand that for an invention claimed in a patent to be found patentable, it must be, among other things, new and not obvious in view of what was known before the invention was made.

26. I understand the information that is used to evaluate whether an invention is new and not obvious is generally referred to as “prior art” and generally includes patents and printed publications (e.g., books, journal publications, articles on websites, product manuals, etc.).

27. I understand that in this proceeding the Petitioner has the burden of proving that the claims of the '573 Patent are anticipated by or obvious in view of

the prior art by a preponderance of the evidence. I understand that “a preponderance of the evidence” is evidence sufficient to show that a fact is more likely true than it is not.

28. I understand that prior art to the ’573 Patent in this proceeding includes patents and printed publications in the relevant art that predate the proper priority date of the alleged invention recited in the ’573 Patent.

29. I understand that terms appearing in the patent claims are to be interpreted according to their “ordinary and customary meaning” in an IPR proceeding. In determining the ordinary and customary meaning, the words of a claim are first given their plain meaning as they would have been understood by a POSITA at the time of the alleged invention, in light of the specification and file history. I understand that treatises and dictionaries may be consulted, albeit under limited circumstances, to determine the meaning attributed by a POSITA at the time of the alleged invention. I have followed this approach in my analysis and have applied the ordinary and customary meaning of those terms throughout my analysis in this Declaration.

30. I understand that there are two ways in which prior art may render a patent claim unpatentable. First, the prior art can be shown to “anticipate” the claim. Second, the prior art can be shown to have made the claim “obvious” to a person of ordinary skill in the art. In this declaration I focus on “obviousness.” My

understanding of the legal standard for “obviousness” is set forth below.

31. I have been informed that a claimed invention is unpatentable as obvious if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. I have also been informed by counsel that the obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter.

32. Specifically, I understand that the obviousness question requires consideration of four factors (although not necessarily in the following order):

- The scope and content of the prior art;
- The differences between the prior art and the claims at issue;
- The knowledge of a person of ordinary skill in the pertinent art; and
- Whatever objective factors indicating obviousness or non- obviousness may be present in any particular case.

33. I have been informed by counsel that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of claimed subject matter. Some of these rationales include the following: (a) combining prior art elements according to known methods to yield

predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention. I also understand that, at least in IPR proceedings, admissions in the patent or in the prosecution file history of the patent (referred to as Applicant Admitted Prior Art or “AAPA”) can be used to establish background knowledge possessed by a POSITA, to furnish a motivation to combine, to assess whether a patent’s claims would have been obvious, and/or to supply a missing limitation.

34. I further understand that certain factors may support or rebut the obviousness of a claim. I understand that such secondary considerations include, among other things, commercial success of the patented invention, skepticism of those having ordinary skill in the art at the time of invention, unexpected results of the invention, any long-felt but unsolved need in the art that was satisfied by the alleged invention, the failure of others to make the alleged invention, praise of the alleged invention by those having ordinary skill in the art, and copying of the alleged

invention by others in the field. I understand that there must be a nexus—a connection—between any such secondary considerations and the alleged invention. I also understand that contemporaneous and independent invention by others is a secondary consideration tending to show obviousness.

35. I am not aware of any allegations by the named inventor of the '573 Patent or any assignee of the '573 Patent that any secondary considerations are relevant to the obviousness analysis of any Challenged Claim of the '573 Patent.

36. I understand that a petition must identify, for any terms with means-plus-function limitations, the specific portions of the specification that describe the structure, material, or acts corresponding to each claimed function. I also understand a rebuttable presumption exists that without use of the term, “means,” a claim term is not interpreted as means-plus-function, but that other nonce words like “component” have been found to satisfy the rebuttable presumption and invoke a means-plus-function claim construction of such a claim term.

37. I also understand that a petitioner seeking to demonstrate that the prior art discloses a means-plus-function limitation must prove that the corresponding structure—or an equivalent—was present in the prior art and performing the same claimed function.

38. I understand that the standard for determining whether the prior art discloses the corresponding structure or an equivalent is whether there are

insubstantial differences, which means that if the assertedly equivalent structure performs the claimed function in substantially the same way to achieve substantially the same result as the corresponding structure described in the specification, it is equivalent.

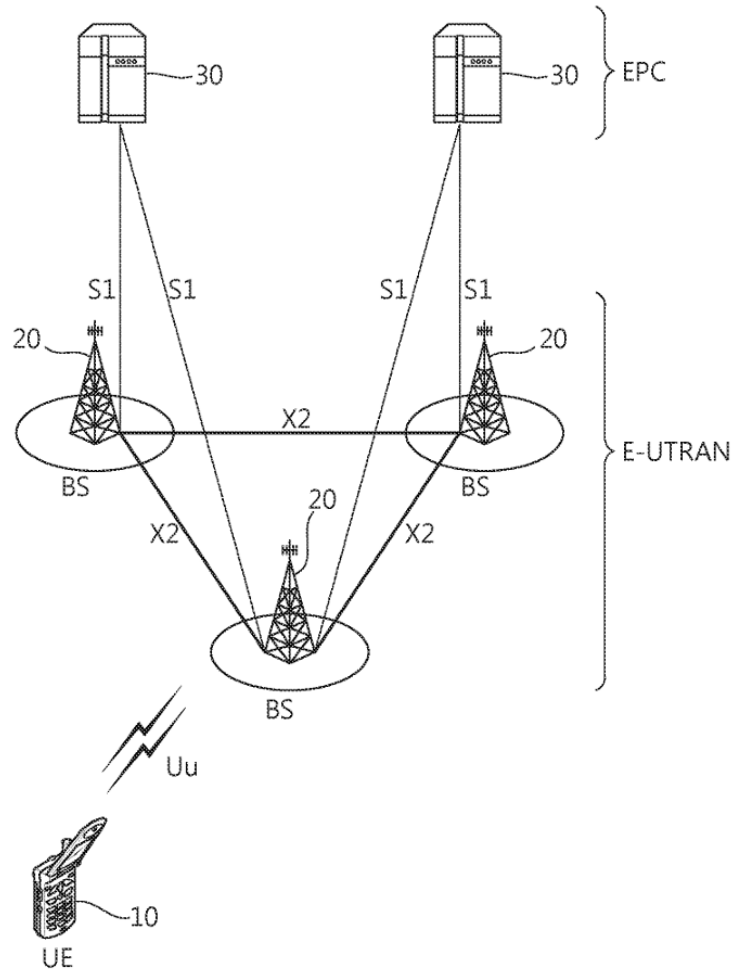
39. I understand that proving structural equivalence does not require a component-by-component analysis, but rather that it is sufficient to show structure, materials, or acts that perform the claimed function in substantially the same way to achieve substantially the same result because the claim limitation is the overall structure corresponding to the claimed function and not individual components.

40. I understand that for a claim to be valid, its scope must be definite, and that improperly introducing a term can lead to an unascertainable scope of a term, rendering it indefinite. I understand that any claim element first addressed in the claims by the antecedent basis, “a” may then be identified later in the claims by the antecedent basis, “the.” I understand that failing to follow this convention may lead to ambiguity in the identification of the particular claim element in question, leading to an indefinite scope of the claim’s term. For purposes of this proceeding, I identified and provided my best understanding of any such terms despite such ascertainable scope.

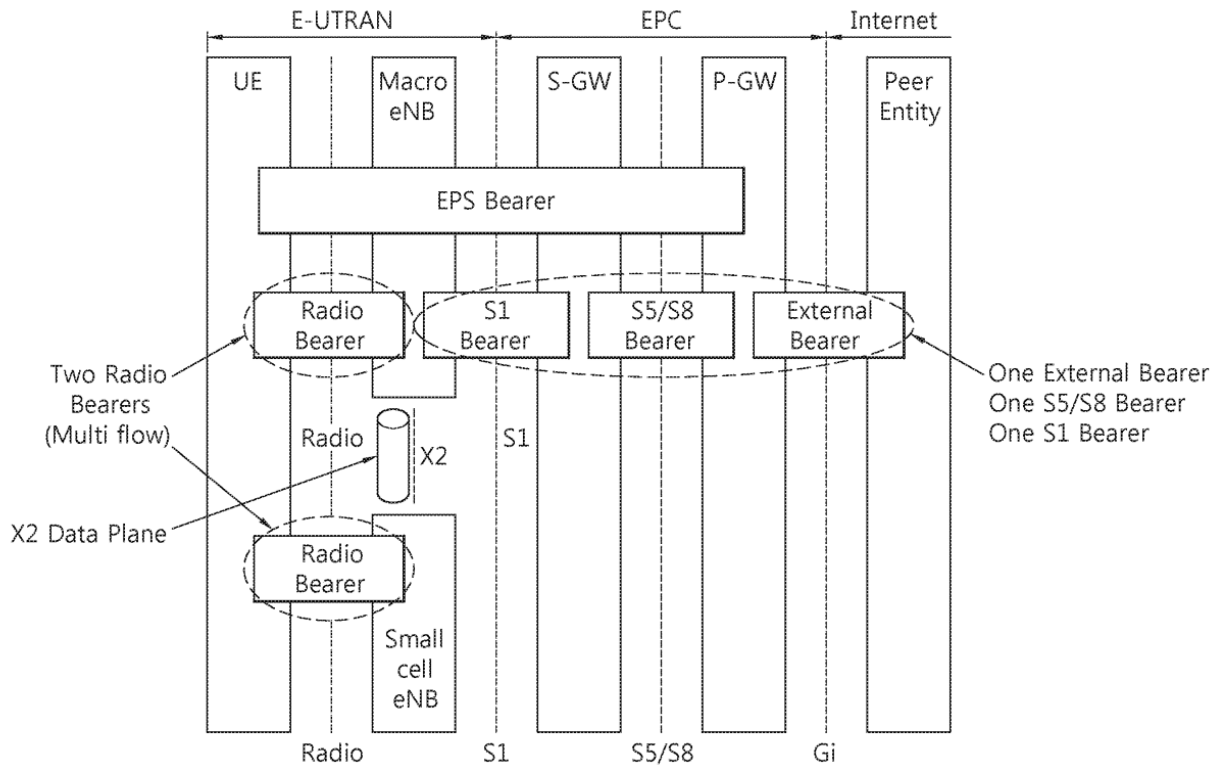
V. SUMMARY OF THE '573 PATENT

A. Specification

41. The '573 Patent is titled "Method and apparatus for sequential forwarding considering multi-flow in dual connectivity system." '573Pat., Title. The '573 Patent discloses a "user equipment receiving multi-flow data with respect to one evolved packet system (EPS) bearer through a macro base station (macro eNB) and a small base station (small eNB) in a wireless communication system supporting dual connectivity." *Id.*, Abstract. Thus, the "[u]ser Equipment (UE) can perform wireless communication through two or more base stations among base stations constituting at least one serving cell." *Id.*, 1:48-50. The '573 Patent discloses that "The macro base station manages data flow control, security, and header compression according to a packet data convergence protocol (PDCP) for data transmitted to the small base station through a radio bearer (RB)." *Id.*, 1:61-64. And although "the wireless communication system is a single flow structure in which a service is provided to the UE through one RB for one EPS bearer service..., in the case of the wireless communication system supporting the dual connectivity, the service of one EPS bearer can be provided to the UE through not one RB but two RBs established in the macro cell and the small cell, respectively. That is, the service can be provided to the UE through multi-flows." *Id.*, 1:65-2:6. I have reproduced Figures 1 and 8, below, that depicts such a system.



'573Pat., Fig. 1.



'573Pat., Fig. 8.

42. “[I]n the case of the UE in which the multi-flows are constituted,” a radio link control (RLC) layer in the UE is associated with each of the macro and small base stations. *Id.*, 2:21-27,11:66-12:29, Fig. 11. The RLC layer in the UE includes “the RLC entity for the small base station and the RLC entity for the macro base station...distinguished to receive the respective RLC SDUs” (service data units) over the multi-flows from the respective macro and small base stations “and acquire the PDCP SDU and deliver the acquired PDCP SDU to the upper layer.” ‘573 Pat.,2:22-26. For the multi-flows, RLC entities in the macro base station and the small base station corresponding to the RLC entities in the RLC layer of the UE are

also present. '573 Pat.,12:2-6. I have reproduced Fig. 11, below, depicting the RLC entities **1115-1** and **1115-2** in the UE and the corresponding RLC entities **1140** and **1170** in the macro base station **1130** and the small base station **1160**, respectively. Fig. 11 also depicts a PDCP entity **1120** at the UE and a corresponding PDCP entity **1135** for the macro base station **1130** and the small base station **1160**. The PDCP entity **1120** is above the RLC entities **1115-1** and **1115-2** at the UE. The PDCP entity **1135** at the macro base station **1130** is above the RLC entity **1140** at the macro base station **1130** and above the RLC entity **1170** at the small base station **1160**. '573 Pat.,11:66-12:6. As such, at the RLC entities **1115-1** and **1115-2** of the UE **1100**, in-sequence delivery may be guaranteed but may not guarantee receiving PDCP PDUs in-sequence at the PDCP entity **1120** of the UE **1100**. Additionally, there may be a transmission delay of 20 to 60 ms for the PDCP PDU(s) from the PDCP entity **1135** of the macro base station **1130** to the PDCP entity **1120** of the UE **1100**. There may also be a time delay between the transmission of the PDCP PDU(s) to the RLC entity **1140** of the macro base station **1160** and the transmission of the PDCP PDU(s) to the RLC entity **1170** of the small base station **1160**. Hence, although the PDCP PDU(s) transmitted by the PDCP entity **1135** of the macro base station **1130** are received by the PDCP entity **1120** of the UE **1100**, there will accordingly be a difference in the receiving time between transmission through the RLC entity **1140** of the macro base station **1130** and transmission through the RLC entity **1170** of the

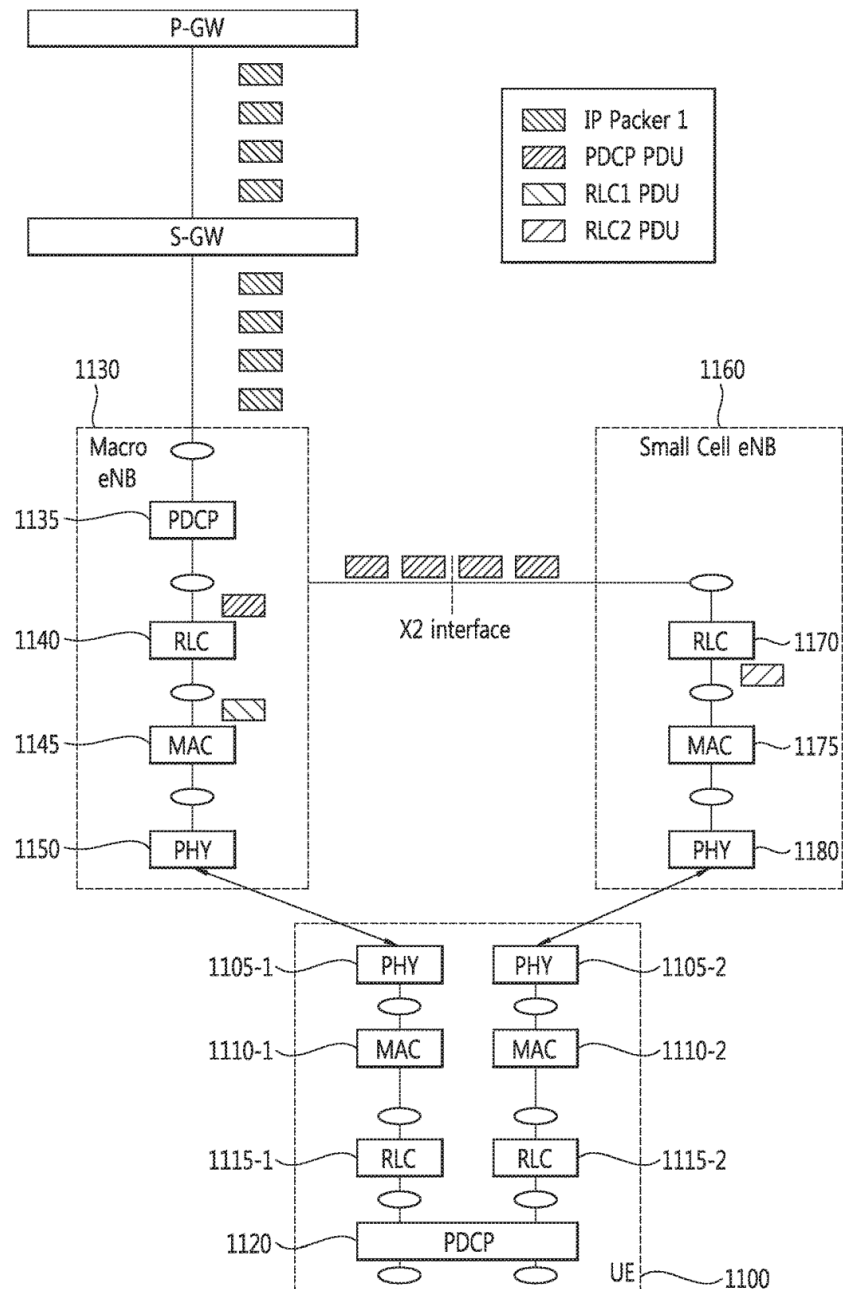
small base station **1160** and thus in-sequence delivery of the PDCP PDU(s) at the PDCP entity **1120** of the UE **1100** is difficult. ‘573 Pat., 12:6-29.

43. The ‘573 Patent acknowledges that because of this, the next layer up (packet data convergence protocol or “PDCP”) “cannot sequentially acquire the [data].” ‘573Pat., 1:61-64, 2:26-27, 12:30-63. In the example of FIG. 12 (reproduced below) where a PDCP PDU receives timing in the PDCP entity for the UE, a PDCP PDU is transmitted through a macro base station and a PDCP PDU is transmitted through a small base station to be sent to the UE’s PDCP entity. With respect to the service for one EPS bearer, the PDCP PDU to be transmitted through the macro base station and the PDCP PDU to be transmitted through the small base station may be determined by the macro base station. ‘573Pat., 12:30-38. [The macro base station, for the data transmitted through a radio bearer to a small base station, manages the “data flow control, security, and header compression “according to a packet data convergence protocol (PDCP).” ‘573Pat., 1:61-64.] In the example of FIG. 12, the PDCP PDUs with ‘odd’ sequence numbers (SNs) are transmitted through the macro base station and the PDCP PDUs with ‘even’ SNs are transmitted through the small base station. There may be a difference in time delay between when the PDCP PDU transmitted through the macro base station is received in the UE and when the PDCP PDU transmitted through the small base station is received in the UE. The PDCP PDU transmitted through the small base station may have a

transmission delay of ~20 to 60 ms. Hence, “there is a problem in sequentially transmitting the PDCP SDUs from the PDCP entity to the upper layer” because sequential transmission is not performed here as the PDCP entity of the UE does not sequentially receive the PDCP PDUs because of the difference in time between RLC SDUs (PDCP PDUs) received over two different RLC entities. In other words, a time delay results in the receiving of the PDCP PDU in the PDCP entity of the UE because the PDCP PDU transmitted from the common PDCP entity residing in the macro base station is transmitted through the macro base station’s RLC entity and is transmitted through the small base station’s RLC entity in a “multi-flow structure.” ‘573Pat.,12:39-63.

44. Thus, “in the case of the UE using the multi-flows, a new method for sequential delivery of the PDCP SDUs to the upper layer in the PDCP entity is required.” ‘573Pat., 2:27-30, 12:64-13:39. The received PDCP PDU is deciphered and header compressed by the PDCP entity of the UE, and then the PDCP SDU is transmitted to the upper layer by the PDCP entity. Here, if there is a PDCP SDU with a sequence number (SN) smaller than the current PDCP SDU’s sequence number, the PDCP SDUs are transmitted in order from “smaller SN to the larger SN” to the upper layer. Also, a discard timer may be operated at the transmission side of PDCP entity, where the discard timer is configured with a duration from the upper layer and started when a PDCP SDU is received from the upper layer. The PDCP

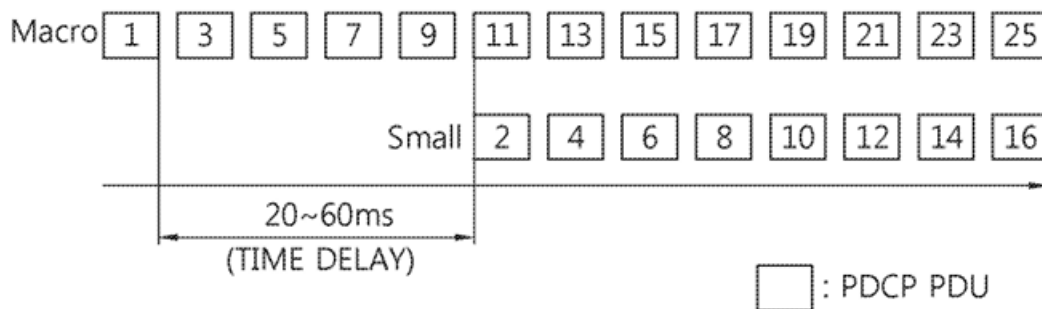
entity will discard this PDCP SDU upon expiry of the discard timer. Hence, even here, because of the expiry of the discard timer, a PDCP SDU with a particular sequence number can be missed. ‘573Pat.,12:64-13:11. Two cases are provided for where the PDCP PDUs are not received in-sequence when “multi-flows are supported in the dual connectivity situation.” The first case involves the discard timer in the base station that is driven for each PDCP SDU received in the uplink and processed by the base station’s PDCP entity. When the number of packets “input into the PDCP by driving the discard timer is larger than a predetermined reference,” the packets that are not processed before expiry of the discard timer may be discarded and these packets “may be newly processed based on a retransmission request performed in the upper layer.” ‘573Pat., 12:12-27. The second case involves a receiving delay for the transmission path of the PDCP PDUs where, because of the multi-flows, the macro base station’s PDCP entity separates and transmits the PDCP PDUs through the macro base station and through the small base station which may result in a time difference in the receiving of the PDCP PDUs at the PDCP entity of the UE “due to a delay caused due to different paths.” Therefore, for either the first or second case, “a method that may sequentially transmit the PDCP SDUs to the upper layer in the PDCP entity of the UE is required.” ‘573Pat., 12:28-39.



‘573 Pat., Fig. 11

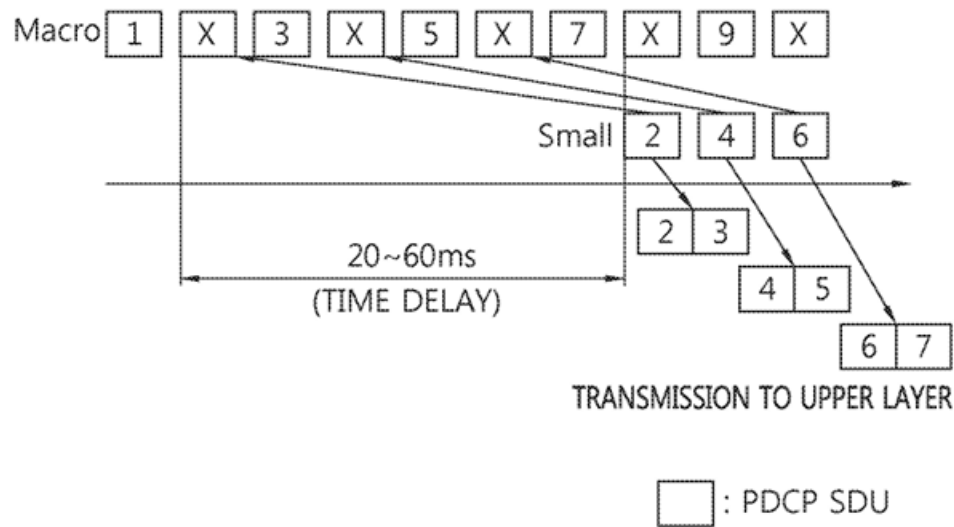
45. To overcome the issue of non-sequential delivery of PDCP data (PDCP packet data units (“PDU”)), the ‘573 Patent proposes to use “an in-sequence timer for the PDCP” to allow for delivering PDCP data (i.e., PDCP service data units

(“SDU”)) to upper levels. ’573Pat., 13:43-53. The “in-sequence timer” is started (i.e., “driven”) when a PDCP sequence number (“SN”) is missed. ’573Pat., 13:43-48. “[T]he duration of the in-sequence timer may be determined by considering the receiving delay of the transmission path of the PDCP PDU” or “an overall situation of the system.” ’573Pat., 13:48-53. I have reproduced Figure 12 below showing reception of the PDCP PDUs with a gap and time delay.



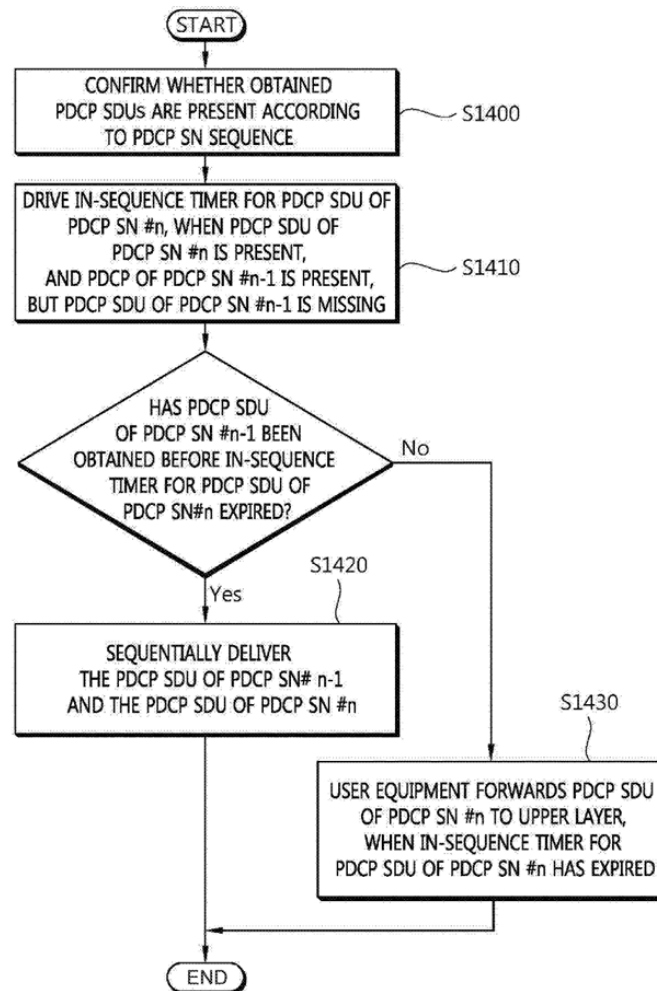
’573Pat., Fig. 12.

46. By using the “in-sequence timer” in the PDCP, the ’573 Patent purports to solve the problem of out-of-sequence PDCP PDUs by allowing the PDCP to wait for the missed PDUs before sending the corresponding SDUs to the upper level. *Id.*, 13:54-14:55. This is shown in Figure 13, reproduced below.



'573Pat., Fig. 13.

47. The '573 Patent discloses that the “timer duration may be established by considering a transmission delay time of the backhaul between the macro base station and the small base station.” '573Pat., 14:58-61. Furthermore, “The in-sequence timer may be transmitted from the macro base station to the UE through the RRC [“radio resource control”] message.” *Id.*, 14:62-63. In particular, the timer may be “included in a PDCP configuration which is an RRC information element [“IE”].” '573Pat., 14:63-66. The sequence of processing the PDCP PDUs using the in-sequence timer is shown below in Figure 14.



'573Pat., Fig. 14.

B. Prosecution History

48. I understand the '573 Patent issued from U.S. Patent Application No. 15/935,626 that was filed on March 26, 2018. The '573 Patent claims priority to a Korean application filed May 10, 2013. For purposes of this declaration, I treat May 10, 2013, as the priority date for the '573 Patent.

49. By my review, the Examiner rejected the pending claim because various prior art references independently taught receiving PDCP data in a user

equipment using dual connectivity. The Examiner twice noted, regarding prior art Ohta (U.S. Patent Application Publication No. 2012/0182971), that a “source base station” corresponded to the claimed “macro eNB” and a “target base station” corresponded to the claimed “small eNB.” ’573FH, 111, 141. This interpretation was not contested by Applicant when responding to the Examiner’s Ohta-based rejections. *Id.*, 40-43, 127-129.

50. Applicant amended the claims to recite the limitations that indicated “wherein the RRC message includes a PDCP-configuration information element (IE), and the PDCP-configuration IE includes a field indicating a value of the in-sequence timer.” *Id.*, 36. This resulted in the Notice of Allowance. *Id.*, 17-19. The ’573 Patent issued on December 8, 2020, with a terminal disclaimer to U.S. Patent No. 9,930,720. *Id.*, 140.

51. By my review, Koskinen, Deenoo, and Sammour were not cited in the ’573 file history.

VI. TECHNOLOGY BACKGROUND

A. Wireless Technology

52. Wireless technology enables information transmission over distances without physical connections, using electromagnetic waves such as radio waves, infrared, or microwaves to facilitate device communication. One of the most prevalent wireless technologies entail cellular radio systems which typically include

mobile devices (e.g., cell phones, cellular modems, smartphones, etc.), base stations, and core networks with connections to external networks.

53. Base stations typically provide wireless radio access through different air interface standards, enabling mobile stations served by the base stations to connect to external networks such as the public switched telephone network (PSTN), the internet, and other cellular provider networks. A mobile device is also identified by the term User Equipment (UE) primarily in the context of 3GPP (3rd Generation Partnership Project), and the term "mobile station" commonly used in the early days of cellular networks, particularly in the context of GSM (Global System for Mobile Communications) and other 2G/3G technologies. Another term for a mobile device, albeit less commonly used, is Wireless Transmit/Receive Unit (WTRU), which can apply to a wider range of wireless communication devices.

54. 2G mobile wireless technologies consisting of GSM and Code-Division Multiple Access (CDMA) provided voice and basic data services such as short message service (SMS) and (multimedia messaging service) MMS and limited web browsing in the late 1990s to the early 2000s.

55. With the increasing demand for mobile data services, 3G mobile networks such as Universal Mobile Telecommunication Systems (UMTS) including wideband-CDMA (W-CDMA) technology and CDMA-based Evolution Data Optimized (EVDO) networks were introduced in the early to mid 2000s that

supported higher data rate services (e.g., up to 2.4 Mbps for EVDO rev 0 and up to 2 Mbps for UMTS). EX1032; EX1033. Eventually, High-Speed Downlink Packet Access (HSDPA), High-Speed Uplink Packet Access (HSUPA), and High-Speed Packet Access (HSPA+) were integrated into UMTS networks to provide even higher data speeds to support the continuously growing number of smartphones and mobile data applications.

56. With the ever growing need to support even higher data speeds (e.g. 100 Mbps in downlink /50 Mbps in uplink) and more mobile data applications, the need for the next generation of wireless technologies (4G) became evident. EX1034. There were initially three 4G standards efforts. One was Ultra Mobile Broadband (UMB) started by 3GPP2 and another was WiMAX (IEEE 802.16e). However, these are now largely abandoned in favor of the third 4G standard called Long Term Evolution (LTE) led by 3GPP. EX1035. LTE is the most prevalent 4G mobile wireless technology in the world and was first commercially available in late 2009. EX1036.

57. Because LTE exemplifies wireless technology advancement, I have concentrated on LTE as an example throughout this Technology Background section.

58. LTE provides wireless high-speed data transmission in cellular networks. A cellular network that employs LTE technology is typically referred to as the Evolved Packet System (EPS).

B. Evolved Packet System (EPS)

59. EPS encompasses the entire system architecture, including both the Evolved Universal Terrestrial Radio Access Network (E-UTRAN or simply RAN), Evolved Packet Core (EPC), along with base stations (eNodeB or simply eNB) and mobile devices or User Equipment (UE). EPS is an end-to-end all-IP (Internet Protocol) network that supports data communication between UEs and external networks like the internet. EX1038; EX1038, § 4.71.

60. The RAN manages the air interface, providing radio access to the UEs and the connectivity to the EPS. eNBs are typically interconnected via the S1 interface to the RAN, but some eNBs are directly interconnected using the X2 interface if favorable physical conditions exist, such as suitable backhaul, site topology, low latency connection, and synchronization. The S1 interface supports functions including authentication, mobility management, and bearer management, while the X2 interface supports functions such as handover, load balancing, and interference coordination. EX1012, § 4; EX1012, § 4.6.1, p. 25.

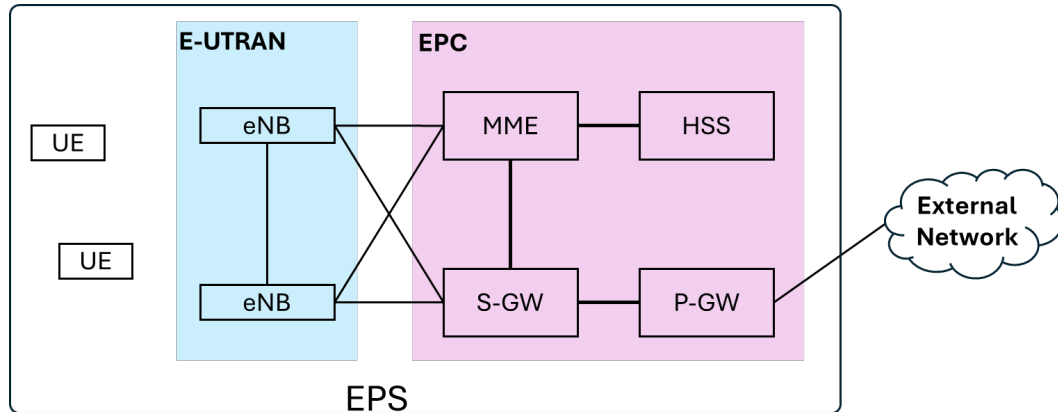


Fig. #1 (based on EX1038)

61. The EPC manages and controls the flow of data between the RAN and external packet data networks. The EPC consists of:

- Mobility Management Entity (MME)
- Serving Gateway (S-GW)
- Packet Data Network Gateway (P-GW)
- Home Subscriber Server (HSS)

C. Base Station [based on EX1027]

62. An eNB serves as the main communication point for one or more UEs, connecting them to the EPS and beyond. It typically consists of the following key components:

- An antenna system: Includes one or multiple antennas that transmit and

receive radio signals. These antennas are strategically positioned to cover designated areas and ensure optimal signal quality.

- A transceiver: Combines both transmitter and receiver functions, handling the conversion of radio signals to digital signals and vice versa.
- A baseband unit (BBU): Processes the baseband signal, managing encoding, decoding, and other digital signal processing tasks.
- A radio frequency (RF) power amplifier: Boosts the strength of outgoing signals to ensure they can travel long distances and reach UEs within the coverage area.
- A backhaul connection: Links the eNB to the EPC, facilitating data transfer and communication with other network components.

63. The eNB (base station) performs the following primary functions:

- Signal Transmission and Reception: Enables communication services like voice calls, text messaging, and data by transmitting and receiving radio signals.
- Network Connection: Connects UEs to the EPC and external networks such as the internet, for seamless communication.
- Handover Management: Manages transitions between cells to ensure continuous connectivity as UEs move.
- Resource Management: Coordinates with other base stations to manage resources, balance loads, and optimize network performance.

64. Base stations vary in coverage size, with traditional ones, known as macro base stations or macro cells, having a coverage radius of several miles. The terms “base station” and “cell” are often used interchangeably when referring to their functionality.

65. In contrast, small base stations, which include microcells, picocells, and femtocells, offer limited coverage, typically ranging from a few meters to a few hundred meters. Despite their smaller scale, small base stations contain the same key components as macro base stations and perform similar primary functions, albeit with reduced capability. They usually have their own backhaul connection to the core network and they may use different (usually higher) carrier frequencies.

66. Small base stations are used to enhance network performance in densely populated areas or where macro cell coverage is weak. For example, LTE Small Cell Enhancements are particularly useful in providing dual connectivity, where a user equipment (UE) connects to both a macro base station and a small base station simultaneously. This setup allows for even higher data speeds and improved network efficiency. In the context of dual connectivity, the macro base station is called the master eNB (MeNB), whereas the small base station the secondary eNB (SeNB). EX1027. In the context of small indoor cell enhancement, it is known as LTE hotspot indoor cell (LTE-Hi) technology. EX1037.

D. User Equipment (UE) [based on EX1028]

67. A UE is an electronic device that connects wirelessly to eNBs to access network services. It consists of several key components:

- Cellular Radio: Includes an antenna, transceiver, and circuitry for communication with base stations.
- Baseband Processor: Handles signal processing tasks like modulation, demodulation, encoding, decoding, multiplexing, and error correction to ensure reliable data transmission.
- Microprocessors: Execute the operating system and applications, managing communication protocols and software.
- Memory and Storage: Provide capacity for data storage and application execution.

68. The primary functions of a UE, with respect to the EPS, include:

- Signal Transmission and Reception: Enables voice calls, text messaging, and data by transmitting and receiving radio signals.
- Network Registration: Registers with the RAN by sending identification information to the base station for service authorization.
- Handover Management: Collaborates with base stations to manage transitions between cells, maintaining continuous connectivity.
- Data Processing: Processes received data to ensure correct

interpretation and presentation to the user. EX1028.

E. Radio Protocol

69. Effective communication between base stations and UEs requires a set of rules and standards known as radio protocols. These protocols govern aspects of data formatting, transmission timing, and error correction, ensuring device interoperability and standardized communication.

70. The LTE radio protocol architecture is divided into two main components: the user plane and the control plane, as shown in Fig. #2. EX1012; EX1012, §§ 4.3.1-4.3.2, pp. 22-23.

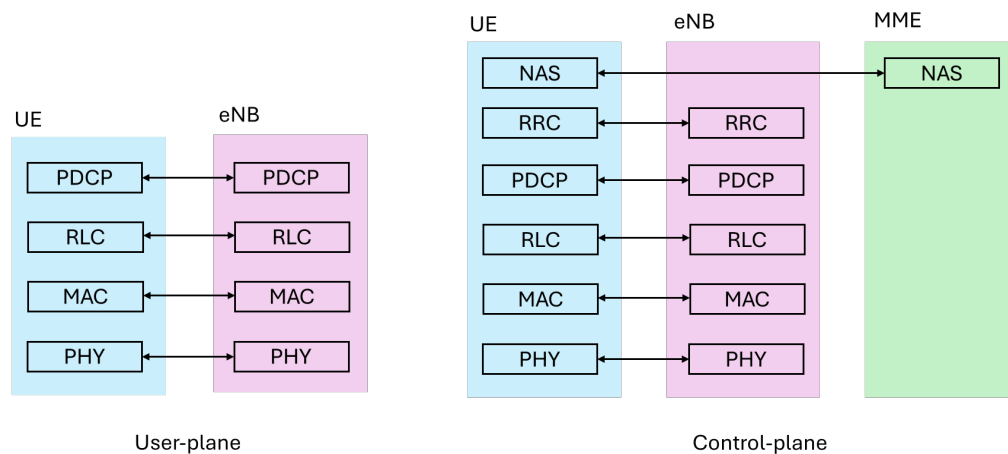


Fig. #2 based on EX1012, Figs 4.3.1-1 and 4.3.2.1, pp. 22-23.

71. The user plane is responsible for transmitting user data, such as voice, video, and internet traffic, between the UE and the RAN. Its protocol stack includes multiple layers (EX1012, § 4.3 pp. 22-23):

- PDCP (Packet Data Convergence Protocol): Ensures in-sequence

delivery of upper layer Protocol Data Units (PDUs), handles encryption/decryption (*i.e.*, ciphering/deciphering), header compression/decompression:(robust header compression) ROHC only, duplicate detection of lower layer Service Data Units (SDUs), retransmission of PDCP SDUs at handover, and reordering. It acts as an interface between the IP layer and lower layers, facilitating the convergence of data from different sources. EX1012, § 6.3, pp. 53-54.

- RLC (Radio Link Control): Ensures reliable data transfer over the radio link through segmentation, concatenation, reordering, duplicate detection, and retransmissions, operating in different modes, including Acknowledged Mode (AM), Unacknowledged Mode (UM), and Transparent Mode (TM). EX1012, § 6.2, pp. 52-53.

- MAC (Medium Access Control): Manages access to the radio channel, schedules data transmission and reception, multiplexes/demultiplexes MAC SDUs belonging to one or different logical channels into/from transport blocks (TB) delivered to/from the physical layer on transport channels, and performs error correction using Hybrid Automatic Repeat Request (HARQ). EX1012, § 6.1, pp. 50-52.

- PHY (Physical Layer): Defines the physical means (e.g., modulation/demodulation and coding/decoding) of transmitting/receiving data over the radio interface using techniques like OFDMA for downlink and SC-FDMA

(single carrier frequency division multiple access) for uplink. EX1012, § 5, pp. 39-49.

72. The control plane handles signaling and control messages necessary for network access, mobility management, and resource allocation. Its protocol stack also includes the PDCP, RLC, MAC, and PHY layers for supporting the control plane functions, with two additional protocols or layers on top of RLC:

- RRC (Radio Resource Control): Manages radio resource configuration, mobility, and connection setup. EX1012, § 7, pp. 56-57.
- NAS (Non-Access Stratum): Handles higher-level signaling between the UE and the core network for tasks like authentication and session management. For instance, PDCP also handles ciphering and integrity protection for the control plane. EX1012, § 6.3.1, p.54.

73. Both the user and control plane protocol stacks are implemented in eNBs and UEs. Each layer communicates with its peer layer on the counterpart device, ensuring reliable and efficient data delivery across the network.

F. Interface Between Layers

74. In transmission from the eNB, data flows from the PDCP layer down through each protocol layer, with each layer adding its own headers and control information. This process continues until the data reaches the physical layer, where it is transmitted over the medium. In reception by the UE, data flows in reverse,

starting at the physical layer and moving up through each layer, with each layer removing its corresponding headers and control information until the data reaches the PDCP layer, depending on if the data is being received or sent, respectively.

75. Each layer interacts with its adjacent layers using Service Data Units (SDUs) and Protocol Data Units (PDUs). When data is passed between layers, the sending layer refers to it as an SDU, while the receiving layer treats it as a PDU. Each layer processes the PDU according to its specific functionality and then sends the processed data unit as an SDU to the next adjacent layer. This process continues until the data reaches either the uppermost or lowest layer.

76. For example, in the case of a UE receiving data shown in Fig. #3:

- The PHY layer receives data and sends data as a SDU (aka. Transport block) to the MAC.
- The MAC layer receives this SDU from the PHY layer, which now becomes the PDU, removes the MAC header and padding from the PDU, and then passes the resulting data unit as a SDU to the RLC layer.
- The RLC layer receives this SDU from the MAC layer, which now becomes a PDU, processes the PDU by removing its RLC header, and then sends the resulting data unit as a SDU to the PDCP layer.
- Finally, the PDCP layer receives this SDU from the RLC layer, which now becomes a PDU, removes the headers from the PDU, and then passes the

processed data unit as a SDU to the network.

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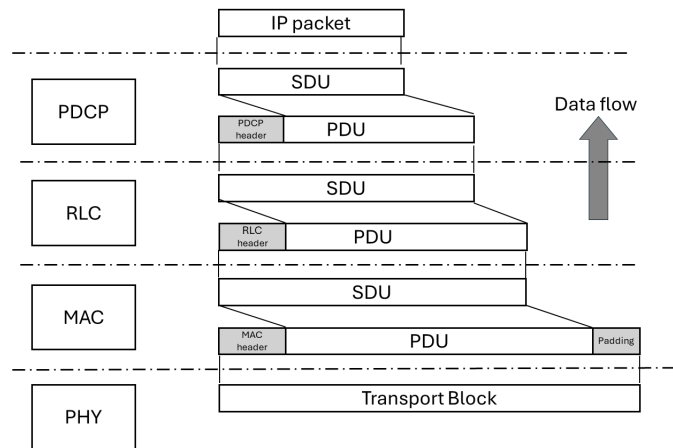


Fig. #3 based on EX1012, § 6, pp. 49-54.

77. This protocol layering approach ensures that data is transmitted and received efficiently while maintaining proper formatting and functionality at each stage of communication. It provides modularity and flexibility in implementation. Each layer can be modified or updated independently without affecting other layers. This means that new technologies can be introduced, or issues can be fixed in one layer without disrupting the entire system, making it easier to adapt to changing network requirements or technological advancements. It promotes compatibility by ensuring that changes in one layer do not affect others, allowing for backward compatibility.

G. Radio Bearer

78. A radio bearer (RB) is a logical or abstract communication channel that

carries a specific type of data between a UE and the RAN over a radio frequency (RF) signal. It is a virtual concept that specifies how data or signaling is treated as it travels across the network, including quality of service (QoS) characteristics like priority, latency, and throughput. An RB is not a physical entity, but rather a software-defined channel that's managed by the RAN. EX1038, § 4.7.2.2, p. 62.

79. There are two types of radio bearers:

- Signaling Radio Bearer (SRB): SRBs are used for transmitting control plane traffic, including RRC (Radio Resource Control) and NAS (Non-Access Stratum) messages. These messages are essential for network setup, configuration, and management. Several types of SRBs are defined in LTE for different types of control signaling. EX1012, § 7.1, p. 56.

- Data Radio Bearer (DRB): DRBs are used for transmitting user plane traffic, such as internet data, video streaming, and voice calls. They carry IP packets and are essential for providing services to users. DRBs can be classified into default bearers and dedicated bearers, each with different QoS characteristics tailored to specific applications. EX1012, § 13.1, pp. 98-99.

80. Radio bearers are configured using radio protocols, specifically through RRC (Radio Resource Control) messages. These messages establish and modify radio bearers, defining their QoS characteristics and parameters. The configuration of radio bearers involves layers such as RRC, PDCP, RLC, MAC, and PHY, each

contributing to the setup and management of bearers. For example, a PDCP bearer is a logical connection between two PDCP entities (e.g., at a UE and an eNB, respectively), which is configured by the PDCP configuration information element in a RRC message. EX1014.

H. RRC Protocol

81. The Radio Resource Control (RRC) protocol plays a crucial role in the control plane by managing radio resource configurations, mobility, and connection setup between User Equipment (UEs) and the radio access network. It handles signaling and control messages, including connection requests, configurations, measurements, and reports. RRC messages contain comprehensive configuration details organized into information elements (IEs) that facilitate independent management of different parameters. EX1012, § 7, pp. 56-59.

82. The modular design of wireless communication protocols allows for the separation of configuration information into distinct IEs for distinct purposes. This approach makes it easier to independently manage and update specific parameters at one layer without affecting other layers. For example, configuration parameters (a.k.a sub-elements) only related to the RLC entity itself, such as RLC sequence numbers and timer values, are defined in the RLC configuration IE (see Fig. #3). Similarly, configuration parameters only related to the PDCP entity itself, such as PDCP sequence numbers and a timer value, are defined in the PDCP configuration

IE (see Fig. #4).

RLC-Config field descriptions
maxRetxThreshold Parameter for RLC AM in TS 36.322 [7]. Value t1 corresponds to 1 retransmission, t2 to 2 retransmissions and so on.
pollByte Parameter for RLC AM in TS 36.322 [7]. Value kB25 corresponds to 25 kBytes, kB50 to 50 kBytes and so on. kBInfinity corresponds to an infinite amount of kBytes.
pollPDU Parameter for RLC AM in TS 36.322 [7]. Value p4 corresponds to 4 PDUs, p8 to 8 PDUs and so on. pInfinity corresponds to an infinite number of PDUs.
sn-FieldLength Indicates the UM RLC SN field size, see TS 36.322 [7], in bits. Value size5 means 5 bits, size10 means 10 bits.
t-PollRetransmit Timer for RLC AM in TS 36.322 [7], in milliseconds. Value ms5 means 5ms, ms10 means 10ms and so on.
t-Reordering Timer for reordering in TS 36.322 [7], in milliseconds. Value ms0 means 0ms, ms5 means 5ms and so on.
t-StatusProhibit Timer for status reporting in TS 36.322 [7], in milliseconds. Value ms0 means 0ms, ms5 means 5ms and so on.

Fig. #3 – “RLC-Config field descriptions” of EX1014, p. 220.

PDCCP-Config field descriptions
discardTimer Indicates the discard timer value specified in TS 36.323 [8]. Value in milliseconds. Value ms50 means 50 ms, ms100 means 100 ms and so on.
maxCID Indicates the value of the MAX_CID parameter as specified in TS 36.323 [8].
pdcp-SN-Size Indicates the PDCCP Sequence Number length in bits. For RLC UM: value <i>len7bits</i> means that the 7-bit PDCCP SN format is used and <i>len12bits</i> means that the 12-bit PDCCP SN format is used. For RLC AM: value <i>len15bits</i> means that the 15-bit PDCCP SN format is used, otherwise if the field is not included upon setup of the PDCCP entity 12-bit PDCCP SN format is used, as specified in TS 36.323 [8].
profiles The profiles used by both compressor and decompressor in both UE and E-UTRAN. The field indicates which of the ROHC profiles specified in TS 36.323 [8] are supported, i.e. value <i>true</i> indicates that the profile is supported. Profile 0x0000 shall always be supported when the use of ROHC is configured. If support of two ROHC profile identifiers with the same 8 LSB's is signalled, only the profile corresponding to the highest value shall be applied.
rn-IntegrityProtection Indicates that integrity protection or verification shall be applied for all subsequent packets received and sent by the RN on the DRB.
statusReportRequired Indicates whether or not the UE shall send a PDCCP Status Report upon re-establishment of the PDCCP entity as specified in TS 36.323 [8].

Fig. #4 – “PDCCP-Config field descriptions” of EX1014, p. 203

83. In contrast, RLC or PDCCP parameters concerned with the establishment or reconfiguration of a radio bearer are specified in the RRC Connection Setup or Reconfiguration messages. These messages are part of the broader RRC protocol functions, which include managing radio bearers and ensuring seamless connectivity

during mobility events like handovers. EX1014, Section 5.3.5, pp. 49-56. 81.82.

84. A parameter or sub-element can be represented by a field, which can contain a simple value, such as an integer or string, or a complex value, such as a list of simple values or a structure. EX1014, p. 203

I. Dual Connectivity and Multi-Flow

85. LTE Dual Connectivity is a feature that enables a UE to connect to a MeNB and a SeNB. This allows the UE to aggregate the resources from both base stations, improving overall throughput, mobility, and coverage. The dual connectivity capability is particularly useful in scenarios where a UE is at the edge of two cells or in areas with limited coverage.

86. In dual connectivity, the MeNB typically manages the control plane, handling tasks such as mobility management, radio resource control, and security, whereas both the MeNB and SeNB provide user plane resources, allowing the UE to receive and transmit data over both connections. The radio bearer configuration and management are handled through Radio Resource Control (RRC) messages exchanged between the UE and the MeNB, with the SeNB providing additional configuration and control information as needed.

87. From a radio bearer perspective, dual connectivity supports two main configurations: dual radio bearers, which are applicable to both uplink and downlink, and split bearers, which are only applicable to downlink. In dual radio bearers, two

separate radio bearers are established, one for each base station, allowing the UE to communicate with each base station independently. In split bearer, a single radio bearer is split between the MeNB and SeNB, allowing the UE to receive data simultaneously over both connections. In the context of split bearers, the feature that a UE simultaneously receives downlink data from multiple eNBs is called multi-flow, as illustrated in Fig. #5. The RLC functionality is split across two eNBs to improve efficiency and reliability, and such an arrangement is also known as the distributed RLC protocol. The radio bearer configuration is managed by the MeNB, which ensures that the UE receives the necessary configuration and control information to establish and maintain the dual connectivity. EX1029, § 4.9 pp. 45-46.

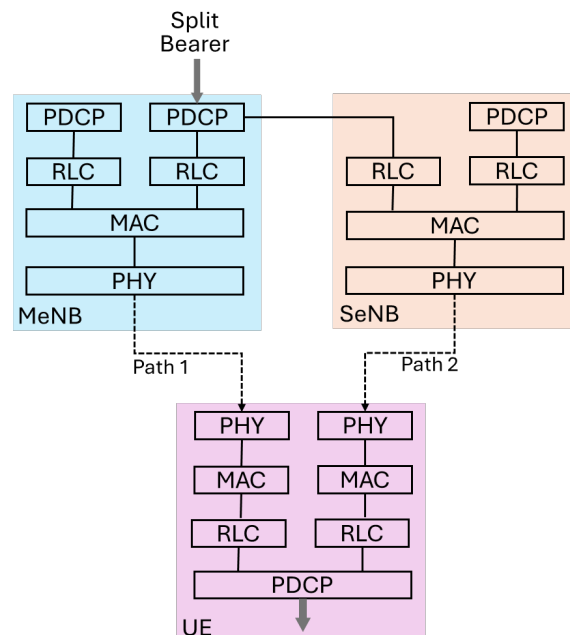


Fig. #5 based on EX1029, § 4.9.2 p. 45.

J. PDU Reordering

88. In transmission from the eNB, each PDU at the PDCP layer is also assigned a sequence number (SN) specific to the PDCP layer. Similarly, each PDU at the RLC layer is assigned an SN specific to that layer. The SN resides in the header of the PDU. These SNs play a crucial role in ensuring that data is delivered in the correct order to the next layer at the receiver by enabling PDU reordering.

89. There are various scenarios where data is received out of order. For example, when data packets are lost or corrupted, the receiver requests their retransmission. Since retransmitted data packets may arrive later than correctly received ones, data packets can become out of order. This situation is common in ARQ/HARQ processes.

90. Another scenario occurs during an intra-LTE handover (also known as X2-based handovers). When the UE hands over from one eNB (source) to another eNB (target), the RLC context (such as RLC configurations and RLC buffering) is lost. This means the target eNB lacks knowledge of the previous RLC sequence numbers. As a result, the UE may experience packet duplication or out-of-order delivery due to the transition between different serving eNBs.

91. Yet another scenario arises in multi-flow applications, where a UE receives data from both a MeNB and an SeNB simultaneously (Fig. #5). Such a setup increases overall data throughput by aggregating resources from both base stations

but can also create an out-of-sequence problem due to different time delays for the two transmission paths.

92. In these examples, PDU reordering is a critical mechanism for maintaining the integrity of data transmission by ensuring that packets are delivered in sequence. PDU reordering can be accomplished in either the RLC layer or the PDCP layer. EX1039; EX1040.

93. The RLC layer reordering has been specified in the LTE specifications since 2008 to manage the out-of-sequence data resulting from the ARQ/HARQ process. EX1039: 3GPP TS 36.322 V8.2.0 (2008-05) (section 5.1); EX1039, § 4.2.1, p. 10 and p. 12; EX1039, § 5.1.2, pp.13-14. The RLC reordering mechanism works well in scenarios involving a single eNB.

94. In the second scenario, since the UE cannot rely on the RLC layer reordering, the PDCP layer reordering is the feasible solution for the out-of-sequence PDU problem due to intra-LTE handovers. In fact, it has been employed in LTE since 2008. EX1040: 3GPP TS 36.323 V8.2.1 (2008-05) (section 5.5); EX1040, § 5.5.1.2, pp. 16-17.

95. The out-of-sequence data problem in multi-flow or dual connectivity was discussed in 3GPP meetings as early as in Jan. 2013. EX1017: 3GPP Tdoc R2-130324. Subsequently, both the RLC layer reordering and PDCP layer reordering were proposed and discussed as competing potential solutions. The requirement of

a timer was also proposed for PDCP reordering in the April 2013 meeting. EX1018: 3GPP Tdoc: R2-131327; EX1019: 3GPP Tdoc: R2-131621. Ultimately, the 3GPP Working Group adopted the PDCP layer reordering as the solution for the out-of-sequence problem in Release 12 specifications.

96. The reordering procedural steps are compared in the following table:

Reordering steps	At the RLC	At the PDCP	
		For intra-LTE handover (in 2008 spec). [EX1040, § 5.5.1.2, pp. 16-17]	For multi-flow (proposed in April 2013), [EX1030, § 5.1.2.1.4, pp. 14-15]
Detection of Missing Packets	Detects gaps in the sequence numbers of received PDUs	Detects gaps in the sequence numbers of received PDUs	Detects gaps in the sequence numbers of received PDUs
Buffering	Buffers packets until the missing PDUs are received	Buffers out-of-order PDUs until all preceding PDUs are received	Buffers out-of-order PDUs across the split bearer until all preceding PDUs are received
Timer Usage	Uses a "t-Reordering" timer to wait for missing PDUs before requesting retransmissions	Does not use a timer for reordering; relies on SN+HFN value management	Uses a t-Reordering timer to manage the reordering process
PDU Delivery	Delivers PDUs to PDCP once they are in the correct order	Delivers PDUs to higher layers once they are in the correct order	Delivers PDUs to higher layers once they are in the correct order

97. In LTE-Advanced,¹ RLC layer reordering is used to handle out-of-order packets resulting from HARQ operations, while PDCP layer reordering serves as a mechanism, particularly in intra-LTE handovers and dual connectivity scenarios where RLC cannot ensure in-sequence delivery.

VII. PUBLIC AVAILABILITY OF 3RD GENERATION PARTNERSHIP PROJECT (3GPP) TECHNICAL SPECIFICATIONS AND OTHER DOCUMENTS

98. Based on my years of experience, I am familiar with the regular business practices of the 3rd Generation Partnership Project (“3GPP”) relating to technical documents including specifications, draft standards and proposals, and standards-related technical contributions—including the business practices through which 3GPP makes these documents public.

99. 3GPP was begun in December 1998 with a purpose to develop Technical Specifications and Technical Reports for the 3G mobile system called Universal Mobile Telecommunications System (“UMTS”). EX1020: <https://www.3gpp.org/about-us>; EX1031: <https://en.wikipedia.org/wiki/3GPP>. 3GPP is a global initiative partnership made up of organizational partners, market representation partners, and individual member companies. EX1021: <https://www.3gpp.org/about-us/introducing-3gpp>. Over the last two decades, 3GPP

¹ This standard was adopted after May 10, 2013. EX1030.

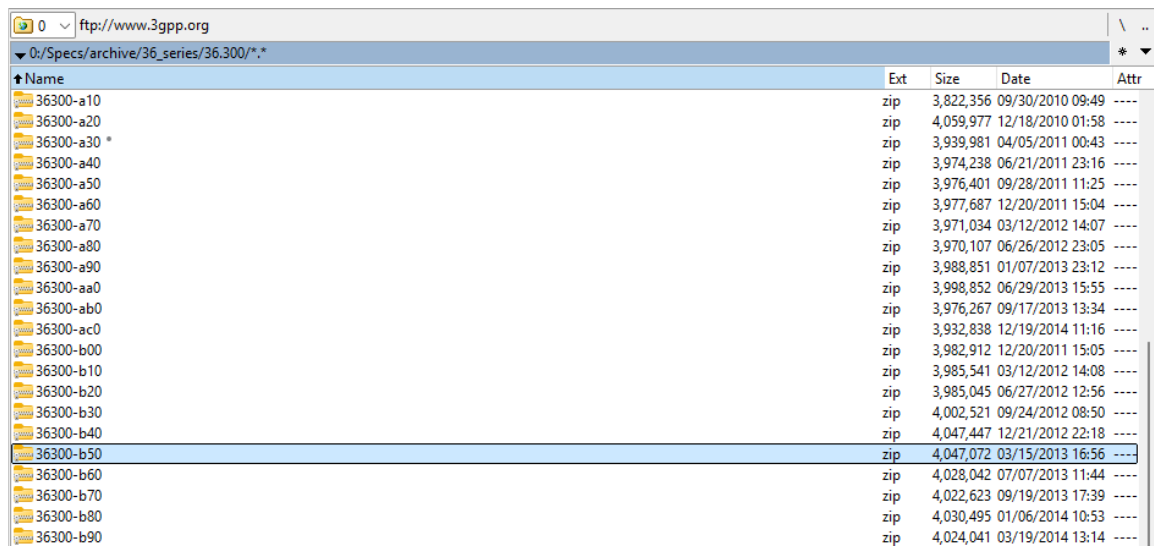
has developed and continues to maintain various cellular communications specifications, including GSM, GPRS/EDGE, UMTS, LTE/EPS, IMS, and 5G.

100. A primary goal of 3GPP is to provide an environment to produce technical specifications and technical reports that define and standardize technologies covering cellular telecommunications networks, including User Equipment or Mobile Device (UE) technologies, Radio Access Network (RAN) technologies, Core Network (CN) technologies, and service and system capabilities—including work on codecs, security, and quality of service. The specifications also provide hooks for interworking with non-3GPP networks including but not limited to Wi-Fi networks.

101. As I have done, interested POSITAs have been tracking the developments of 3GPP specifications and other submissions to ensure that the standards reflected their employers' technology visions, included their technological solutions and features, and that products and services developed by their companies were consistent with the standards being developed. It is my opinion that a POSITA in cellular communications would need to be familiar with 3GPP and the specification-related documents produced as part of the 3GPP process in order to properly perform his or her job.

102. I have been using the 3GPP official FTP server <ftp://www.3gpp.org/> to access 3GPP specifications for my work or for interest for more than 15 years. This

FTP server allows anyone to log in anonymously to download documents. For example, if I needed to learn about a specific version of a 3GPP specification, say 3GPP TS 36.300 V11.5.0 (2013-03), I could navigate to subfolder /Spec/archive/36_series/36.300/, where all the versions of 36.300 specifications are located from 07/05/2006 to present.



Name	Ext	Size	Date	Attr
36300-a10	zip	3,822,356	09/30/2010 09:49	----
36300-a20	zip	4,059,977	12/18/2010 01:58	----
36300-a30 *	zip	3,939,981	04/05/2011 00:43	----
36300-a40	zip	3,974,238	06/21/2011 23:16	----
36300-a50	zip	3,976,401	09/28/2011 11:25	----
36300-a60	zip	3,977,687	12/20/2011 15:04	----
36300-a70	zip	3,971,034	03/12/2012 14:07	----
36300-a80	zip	3,970,107	06/26/2012 23:05	----
36300-a90	zip	3,988,851	01/07/2013 23:12	----
36300-aa0	zip	3,998,852	06/29/2013 15:55	----
36300-ab0	zip	3,976,267	09/17/2013 13:34	----
36300-ac0	zip	3,932,838	12/19/2014 11:16	----
36300-b00	zip	3,982,912	12/20/2011 15:05	----
36300-b10	zip	3,985,541	03/12/2012 14:08	----
36300-b20	zip	3,985,045	06/27/2012 12:56	----
36300-b30	zip	4,002,521	09/24/2012 08:50	----
36300-b40	zip	4,047,447	12/21/2012 22:18	----
36300-b50	zip	4,047,072	03/15/2013 16:56	----
36300-b60	zip	4,028,042	07/07/2013 11:44	----
36300-b70	zip	4,022,623	09/19/2013 17:39	----
36300-b80	zip	4,030,495	01/06/2014 10:53	----
36300-b90	zip	4,024,041	03/19/2014 13:14	----

Fig. #6

103. If I believed that a 3GPP document might potentially contain some specific information of interest, I relied on the 3GPP official advanced search engine <http://isearch.3gpp.org/isysadvsearch.html>. EX1022. I have been using this search engine for many years as well until it was discontinued in 2023. EX1023. A powerful feature of this search engine was that one could specify a logical combination of keywords or phrases of interest, the time span of interest, technology task group, file format, etc.

1. 3GPP's Policy and Practice of Making Documents Public

104. 3GPP's policy was to make 3GPP documents available to the public, including to interested POSITAs. The free availability of 3GPP documents to any interested member of the public was widely recognized in the industry. For example, textbooks and other sources directed readers to the 3GPP website for information about relevant standards.² Making the documents available to the public was intended to enhance collaboration among 3GPP Working Group members and other interested POSITAs.

105. Because the purpose of 3GPP was worldwide adoption of a common standard, no restrictions on distribution or discussion were placed on 3GPP documents. For example, in the 2009 timeframe when LTE was in its early-stage development, as a wireless technology expert, I gave open seminars and held workshops on LTE technology to the local wireless community based on what I learned from the 3GPP specifications. I also provided the links to colleagues and peers for them to access 3GPP documents.

106. The technical specifications and reports developed by 3GPP were, and

² EX1024 at 1.1 ("3GPP documents are public and can be accessed via the 3GPP web site") available at

<https://web.archive.org/web/20070219081417/http://tools.ietf.org/html/rfc3314>.

are, driven by the technical contributions of 3GPP member companies. As part of that development process, various types of documents have been produced. As relevant to this proceeding, the 3GPP process involved the consideration of temporary documents (“TDocs,” also referred to as “technical contributions,” or “member contributions,” and in some cases referred to as “change requests”), resulting in the production of technical specifications.

107. All TDocs, technical reports, and technical specifications were and are freely available to interested POSITAs (and to any interested member of the public) through the public file repository on the 3GPP website.

108. In my opinion, an interested POSITA could have located relevant documents of interest on the 3GPP website using reasonable diligence based on the website’s indexing scheme. For example, the documents on the 3GPP website were (and remain) organized according to the relevant Working Groups within 3GPP (each of which focused on particular subject matter) and then further organized based on the meetings of those groups. POSITAs would have known which Working Groups focused on particular subject matter.

2. The 3GPP Public File Repository

109. There are several sites from which a POSITA could access the 3GPP public file repository to locate documents of interest. For example, a POSITA could have used 3GPP FTP server <ftp://www.3gpp.org/>. A POSITA could, using a file

explorer, navigate through the folders and files to look for documents of interest since the folder and files names tended to be self-explanatory. If the specifics of a document of interest are known, such as its document number, its file name, its series, and release version, one could go to a folder or subfolder in the FTP server to find the document. The FTP server contains archives of 3GPP documents, including: 3GPP specifications, including from 00_series to 55_series of all releases; 3GPP meeting information and documents; Email discussions by 3GPP member companies; Technical contributions (TDocs) by 3GPP member companies; and Workshop materials.

110. The FTP server has been accessible to the public for at least twenty years and is still currently accessible. I have reproduced a screenshot of the FTP server below.

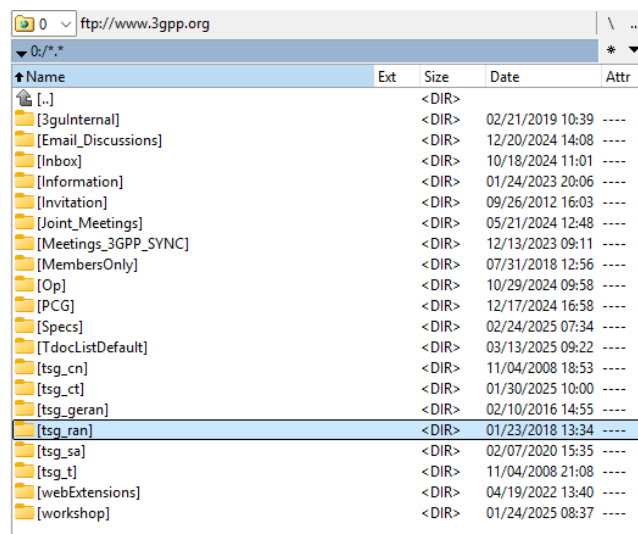


Fig. #7

111. A POSITA could have also used the 3GPP FTP directory available at <https://www.3gpp.org/ftp/>. This is an alternative way to access the 3GPP FTP server using a web browser. A quick way to find a document is to search by entering “file_name, 3GPP.org/ftp” if the file name is known. The link to the location of the document usually will show up if it exists. The FTP directory has been accessible to the public for at least twenty years and is still currently accessible. I have reproduced a screenshot of the FTP directory below.

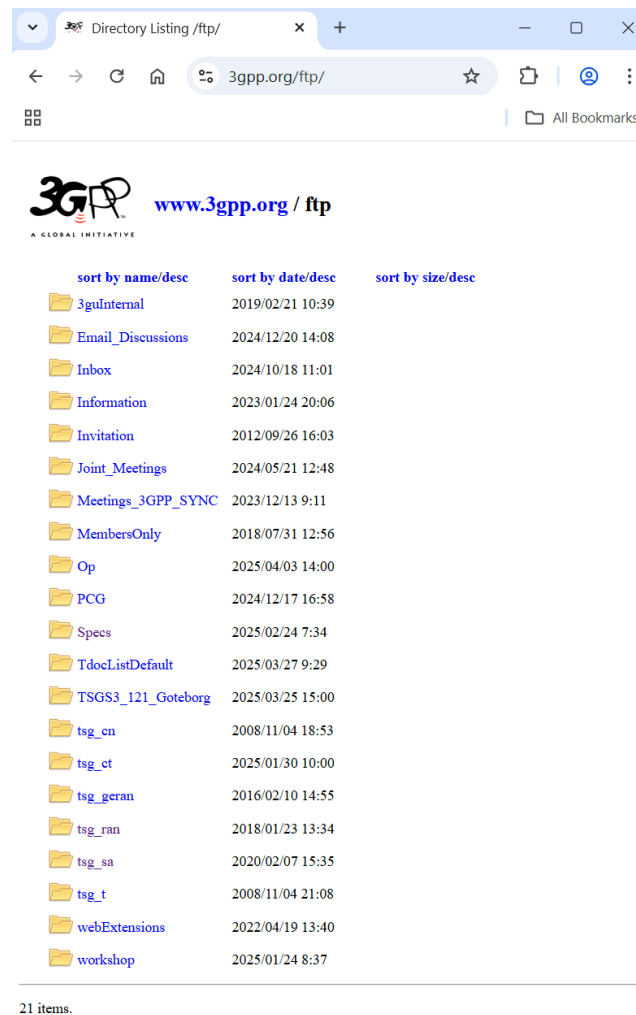


Fig. #8

112. The indexed navigation of the files follows a clear pattern—the top two levels of indexing within the file repository are based wholly on subject matter, as reflected by the division of subject matter among the various TSGs and Working Groups.

113. A POSITA could have also used the 3GPP official advanced search engine <http://isearch.3gpp.org/isysadvsearch.html>. EX1022. If a POSITA desired to look for files that might potentially contain the information of interest, the POSITA could have used the search engine to locate and extract the files. The search engine allowed the public to search for and extract, without restriction, 3GPP documents, including technical contributions and specifications. Using the search engine, anyone could search for any available file on the 3GPP website and file servers by logical combinations of keywords and by time periods. Unfortunately, as mentioned above, the search engine was discontinued in 2023. EX1023.

114. Most TDocs were uploaded to the public file server for public viewing prior to the relevant meeting (although some TDocs were submitted during or after meetings in which they were created). 3GPP's public file repository provides a reliable mechanism for identifying the date a document was uploaded to the website for public viewing. When a document is uploaded, the file server automatically assigns the document a time stamp, an accurate and automatically computer-generated electronic record of when the document was uploaded, as part of the

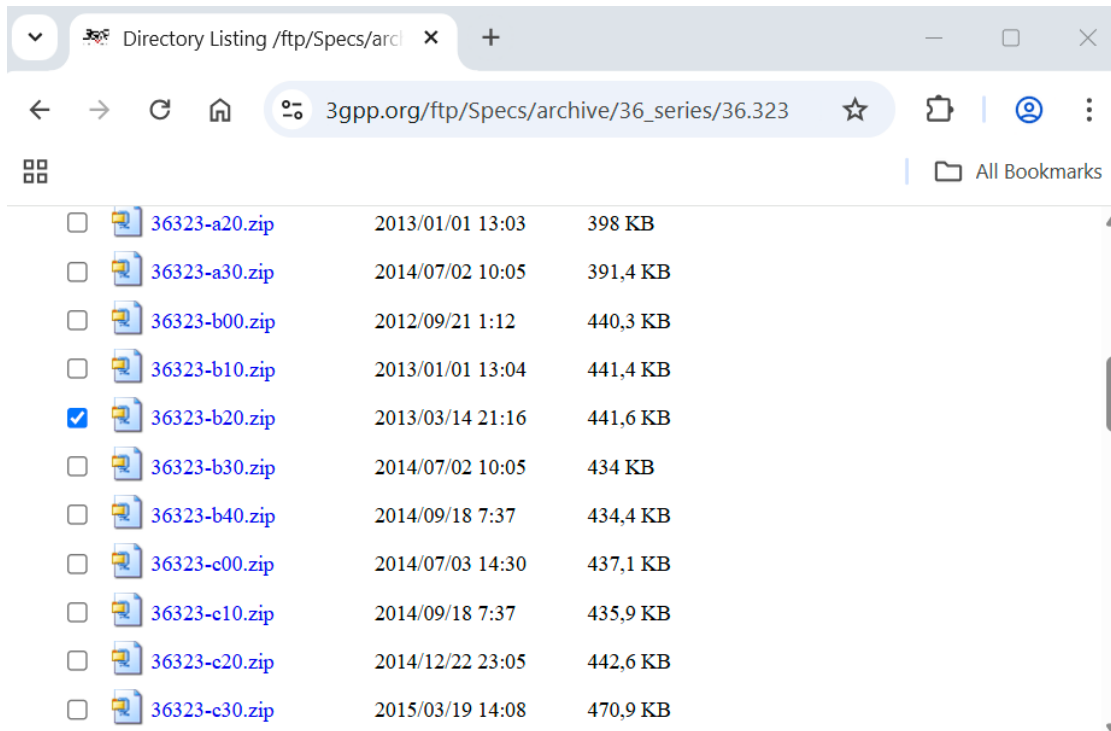
regular business practices of 3GPP. “[T]he time stamp of the Zip file can be relied upon to indicate when the upload occurred.” EX1025, at “Is it possible to determine the date and time of publication of a particular version of a 3GPP Spec?” (<https://www.3gpp.org/about-us/3gpp-faqs>). Thus, the documents are listed with the date of upload. As an example, in WG2_RL2/TSGR2_81bis/Docs, some documents were submitted before the April 15-19, 2013, meeting, while others were submitted after the meeting. EX1026.³ For example, R2-131327 was submitted April 6, 2013.

115. This has always been the practice regarding uploading documents to the 3GPP file repository, and my personal experience further confirms that the time stamps have always been a reliable way to indicate when a file was uploaded to the 3GPP website.

116. Accordingly, Exhibits EX1005-EX1008; EX1011-EX1014; EX1017-EX1018; EX1027-EX1028; and EX1037-EX1040 were all publicly accessible and available before May 10, 2013. In particular, per above procedure, I have accessed and produced screenshots of directory structures associated with Exhibits EX1011-EX1014; EX1017-EX1018; EX1027-EX1028; and EX1037-EX1040 below. A POSITA would have been able to readily access and download the relevant documents before May 10, 2013.

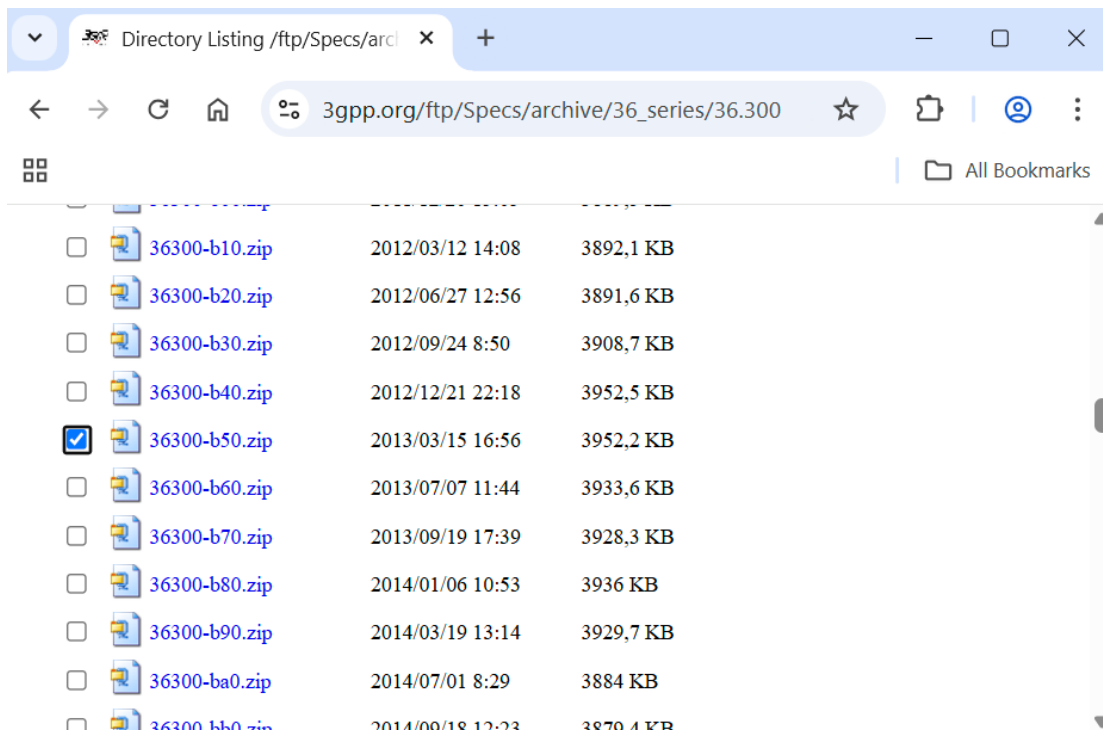
³ https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_81bis/Docs

EX1011 - 3GPP TS 36.323 v.11.2.0



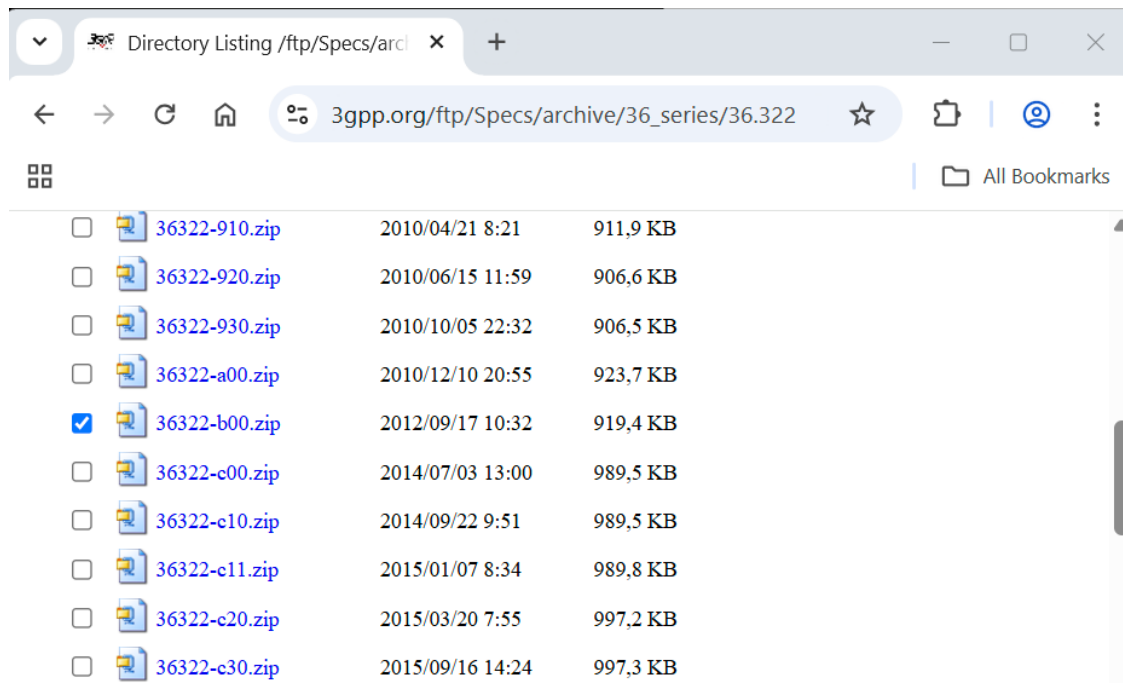
☐	36323-a20.zip	2013/01/01 13:03	398 KB
☐	36323-a30.zip	2014/07/02 10:05	391,4 KB
☐	36323-b00.zip	2012/09/21 1:12	440,3 KB
☐	36323-b10.zip	2013/01/01 13:04	441,4 KB
☒	36323-b20.zip	2013/03/14 21:16	441,6 KB
☐	36323-b30.zip	2014/07/02 10:05	434 KB
☐	36323-b40.zip	2014/09/18 7:37	434,4 KB
☐	36323-c00.zip	2014/07/03 14:30	437,1 KB
☐	36323-c10.zip	2014/09/18 7:37	435,9 KB
☐	36323-c20.zip	2014/12/22 23:05	442,6 KB
☐	36323-c30.zip	2015/03/19 14:08	470,9 KB

EX1012 - 3GPP TS 36.300 v.11.5.0



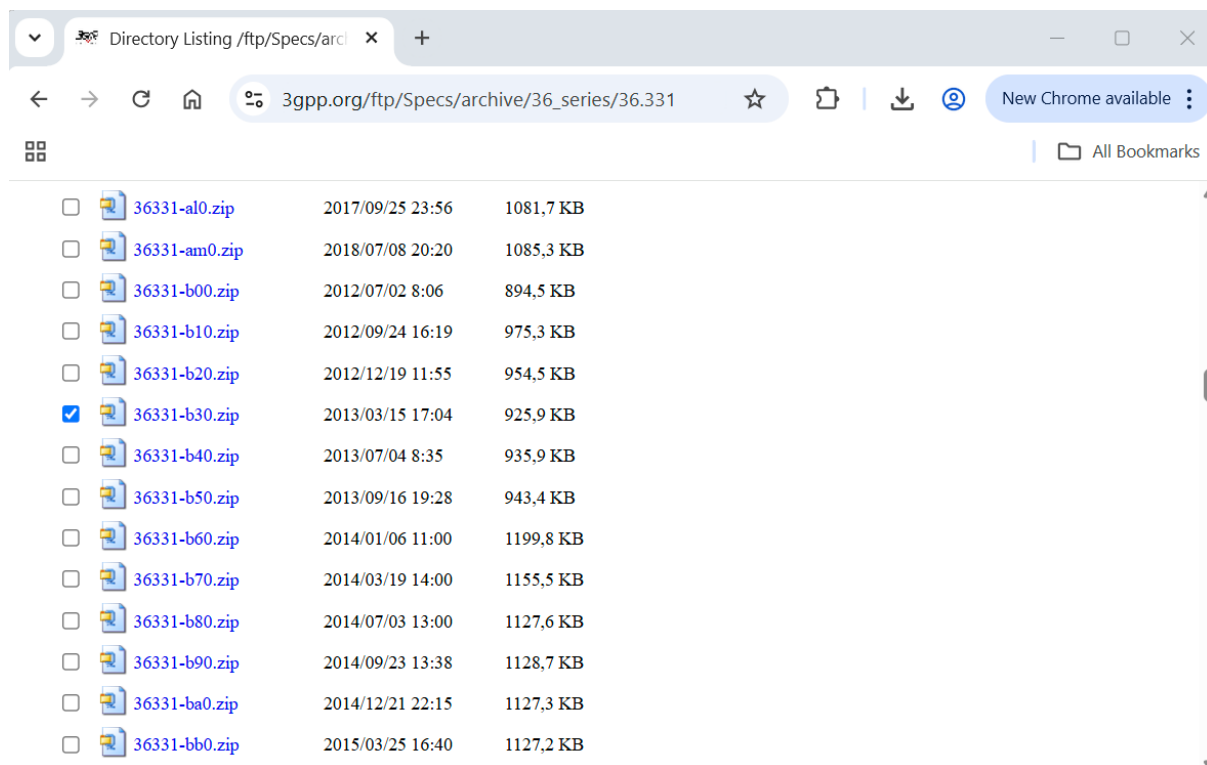
☐	36300-b10.zip	2012/03/12 14:08	3892,1 KB
☐	36300-b20.zip	2012/06/27 12:56	3891,6 KB
☐	36300-b30.zip	2012/09/24 8:50	3908,7 KB
☐	36300-b40.zip	2012/12/21 22:18	3952,5 KB
☒	36300-b50.zip	2013/03/15 16:56	3952,2 KB
☐	36300-b60.zip	2013/07/07 11:44	3933,6 KB
☐	36300-b70.zip	2013/09/19 17:39	3928,3 KB
☐	36300-b80.zip	2014/01/06 10:53	3936 KB
☐	36300-b90.zip	2014/03/19 13:14	3929,7 KB
☐	36300-ba0.zip	2014/07/01 8:29	3884 KB
☐	36300-bb0.zip	2014/09/18 12:22	3870,4 KB

EX1013 - 3GPP TS 36.322 v.11.0.0



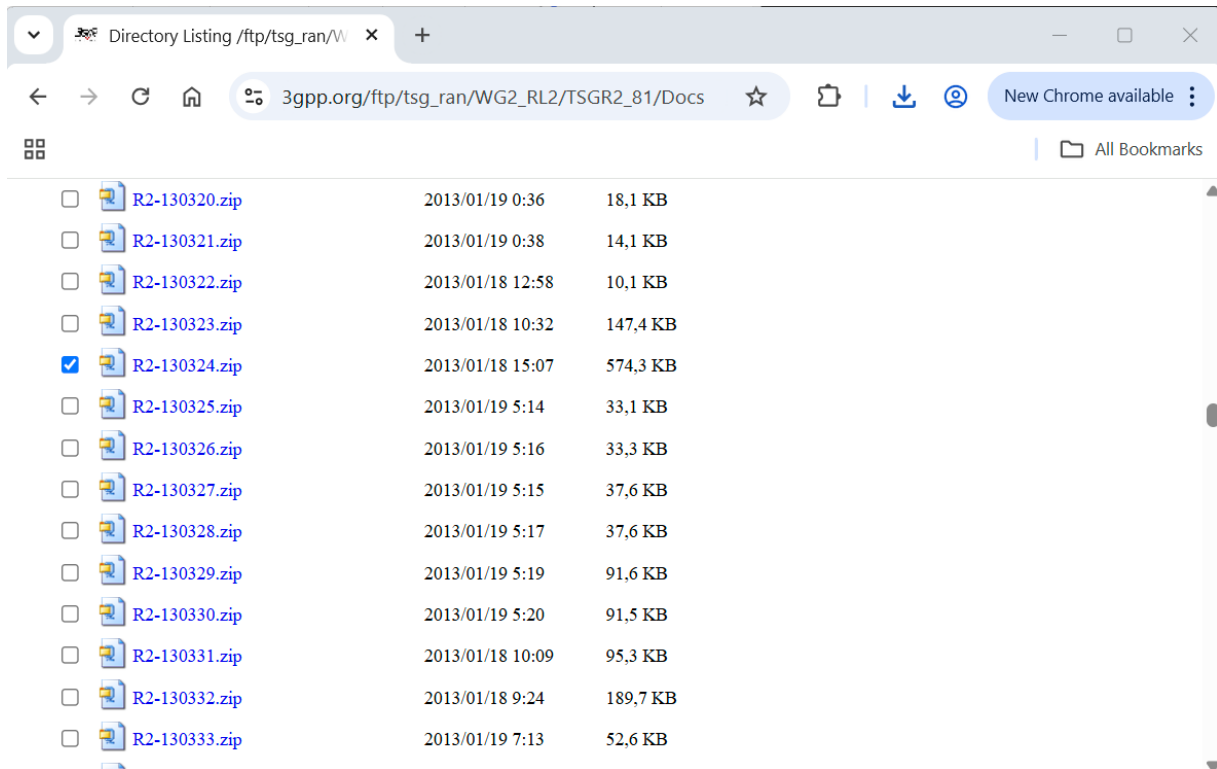
☐	36322-910.zip	2010/04/21 8:21	911,9 KB
☐	36322-920.zip	2010/06/15 11:59	906,6 KB
☐	36322-930.zip	2010/10/05 22:32	906,5 KB
☐	36322-a00.zip	2010/12/10 20:55	923,7 KB
☒	36322-b00.zip	2012/09/17 10:32	919,4 KB
☐	36322-c00.zip	2014/07/03 13:00	989,5 KB
☐	36322-c10.zip	2014/09/22 9:51	989,5 KB
☐	36322-c11.zip	2015/01/07 8:34	989,8 KB
☐	36322-c20.zip	2015/03/20 7:55	997,2 KB
☐	36322-c30.zip	2015/09/16 14:24	997,3 KB

EX1014 -3GPP TS 36.331 v.11.3.0



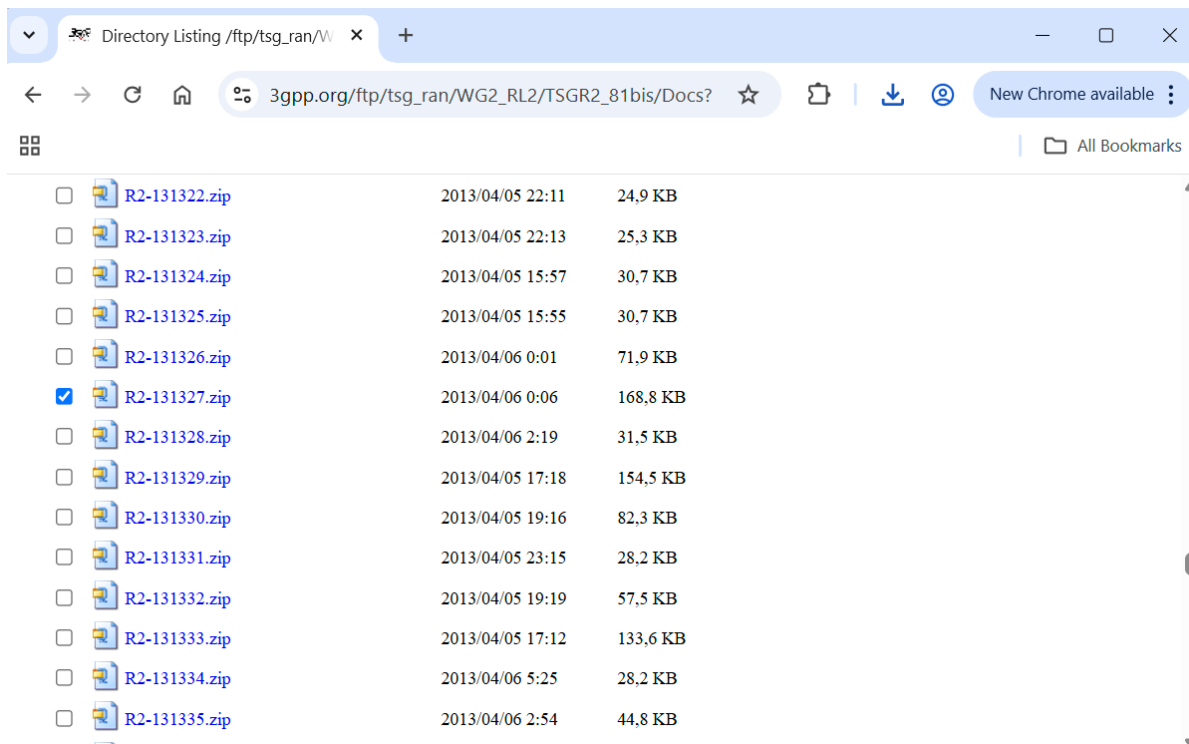
☐	36331-a10.zip	2017/09/25 23:56	1081,7 KB
☐	36331-am0.zip	2018/07/08 20:20	1085,3 KB
☐	36331-b00.zip	2012/07/02 8:06	894,5 KB
☐	36331-b10.zip	2012/09/24 16:19	975,3 KB
☐	36331-b20.zip	2012/12/19 11:55	954,5 KB
☒	36331-b30.zip	2013/03/15 17:04	925,9 KB
☐	36331-b40.zip	2013/07/04 8:35	935,9 KB
☐	36331-b50.zip	2013/09/16 19:28	943,4 KB
☐	36331-b60.zip	2014/01/06 11:00	1199,8 KB
☐	36331-b70.zip	2014/03/19 14:00	1155,5 KB
☐	36331-b80.zip	2014/07/03 13:00	1127,6 KB
☐	36331-b90.zip	2014/09/23 13:38	1128,7 KB
☐	36331-ba0.zip	2014/12/21 22:15	1127,3 KB
☐	36331-bb0.zip	2015/03/25 16:40	1127,2 KB

EX1017 - 3GPP Tdoc R2-130324



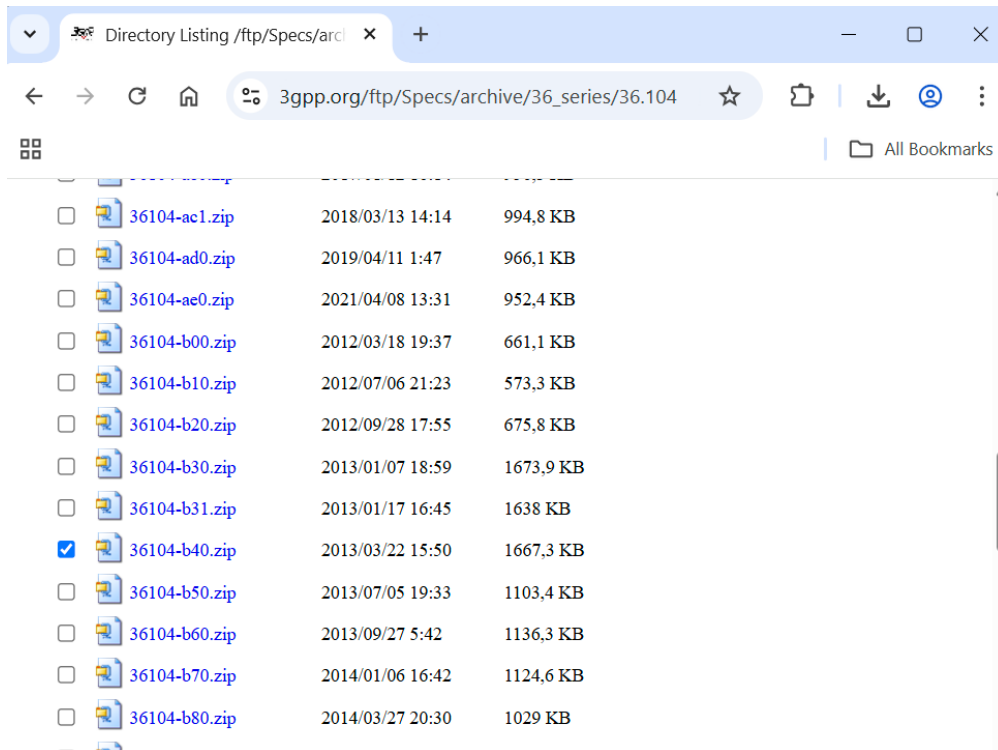
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EX1018 - 3GPP Tdoc R2-131327



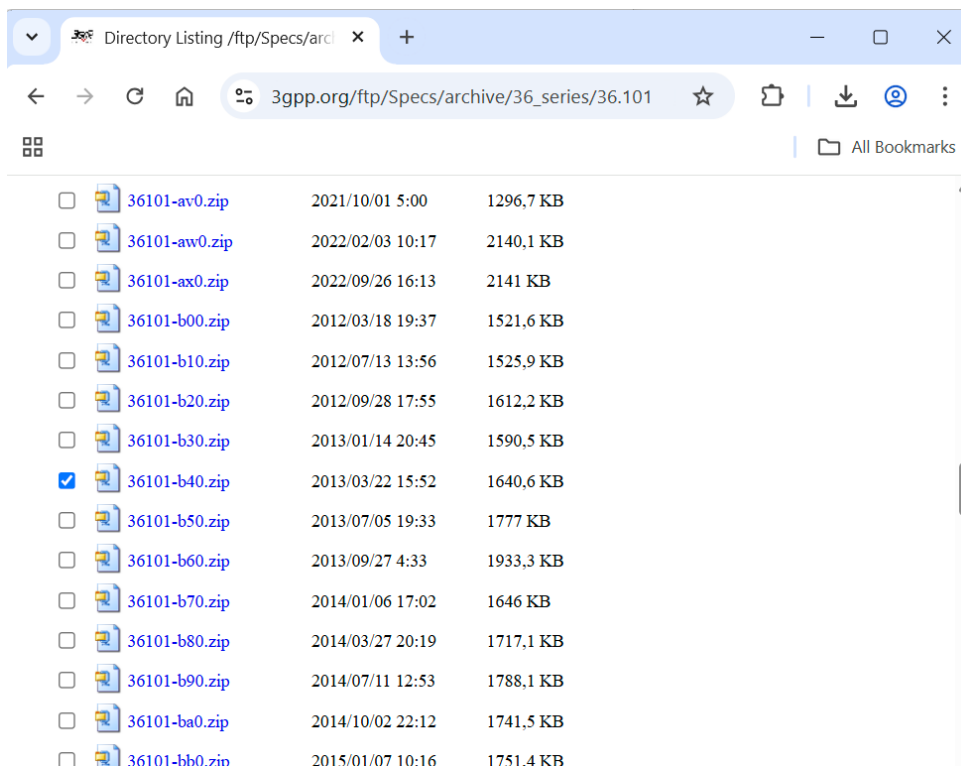
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EX1027 - 3GPP TS 36.104 v.11.4.0



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EX1028 - 3GPP TS 36.101 v.11.4.0



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EX1037 - 3GPP TS 36.932 v.12.1.0

Directory Listing /ftp/Specs/arch

3gpp.org/ftp/Specs/archive/36_series/36.932

 www.3gpp.org / [ftp](#) / [Specs](#) / [archive](#) / [36_series](#) / [36.932](#)

A GLOBAL INITIATIVE

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14 items.

EX1038 - 3GPP TS 23.401 v.11.5.0

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3gpp.org/ftp/Specs/archive/23_series/23.401

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EX1039 - 3GPP TS 36.322 v.8.2.0

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EX1040 - 3GPP TS 36.323 v.8.2.1

The screenshot shows a web browser window with the address bar displaying "3gpp.org/ftp/Specs/archive/36_series/36.323". The page title is "www.3gpp.org / ftp / Specs / archive / 36_series / 36.323". The 3GPP logo is visible in the top left. Below the header, there is a table of files with columns for "sort by name/desc", "sort by date/desc", and "sort by size/desc". The table lists files from 36323-100.zip to 36323-860.zip. The file 36323-821.zip is selected, indicated by a blue checkmark in the first column.

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☐	36323-840.zip	2009/01/05 8:52	352,8 KB
☐	36323-850.zip	2009/03/16 7:56	353,5 KB
☐	36323-860.zip	2009/06/18 6:13	356,6 KB

VIII. CLAIM CONSTRUCTION

117. It is my understanding that in order to properly evaluate the Challenged Patents, the terms of the claims must first be interpreted. It is my understanding that for the purposes of this inter partes review, the claims are to be construed under the so-called *Phillips* standard, under which claim terms are given their ordinary and customary meaning as would have been understood by one of ordinary skill in the art in light of the specification and prosecution history, unless the inventor has set forth a special meaning for a term. For the purposes of this declaration, I have given all the claim terms of the Challenged Claims their plain and ordinary meaning, as would have been understood by a person of ordinary skill in the art, at the time of the alleged invention, which I have been asked to assume is May 10, 2013, for all claims.

IX. CLAIMS 1-5 AND 8-12 ARE UNPATENTABLE

118. I have been asked to provide my opinion as to whether the Challenged Claims of the '573 Patent would have been obvious in view of the prior art. The discussion below provides a detailed analysis of how the prior art references identified below teach the limitations of the Challenged Claims of the '573 Patent.

119. As part of my analysis, I have considered the scope and content of the prior art and any differences between the alleged invention and the prior art. I describe in detail below the scope and content of the prior art, as well as any

differences between the alleged invention and the prior art, on an element-by-element basis for each Challenged Claims of the '573 Patent. As described in detail below, the alleged invention of the Challenged Claims would have been obvious in view of the teachings of the identified prior art references as well as the knowledge of a POSITA.

Grounds	Claim(s)	Basis
1	1-5 and 8-12	Koskinen
2	1-5 and 8-12	Koskinen, Sammour
3	1-5 and 8-12	Deenoo, Sammour

A. Ground 1: Claims 1-5 and 8-12 Are Obvious Over Koskinen

1. Summary of Koskinen

120. Koskinen (EX1005) is a US patent application publication titled “Delivery of Protocol Data Units,” with a filing date of April 4, 2013 [pub: 10/9/2014]. In Koskinen, an evolved packet system, such as LTE, includes base stations that utilize a single PDCP layer that transmits packets for a user equipment through multiple lower RLC layers prior to being transmitted to the user equipment (UE). The UE in Koskinen delivers the packets to a single higher PDCP layer after it receives the packets through at least two RLC layers. As packets may be lost during a handover from a source base station to a target base station causing gaps in the data, utilizing a reordering timer in the PDCP like the conventional reordering timer in the RLC layer is disclosed in Koskinen. In Koskinen, it is described that

utilizing a reordering timer in the PDCP layer, like in the RLC layer, will ensure that missing PDCP packets are not missed or that they do not block already received packets from being sent to the higher layers.

121. In my opinion, Koskinen (EX1005) is analogous art to the '573 Patent. For example, Koskinen and the '573 Patent are in the same field of endeavor. Both are directed to addressing analogous issues including “observing a gap in a sequence of protocol data units received from a plurality of lower-layer protocol entities providing data transfer” and “starting a timer upon the gap observation.” Koskinen, Abstract, ¶18. In Koskinen, like in the '573 Patent, a PDCP bearer is terminated at the eNB (eNodeB) and at the user equipment (UE), and the PDCP bearer is carried over two independent RLC bearers – one over each of the UE’s two radio interfaces. Koskinen, ¶¶15, 34, Fig. 1; '573Pat., 10:4-12, 11:1-10, Figs. 9, 11.

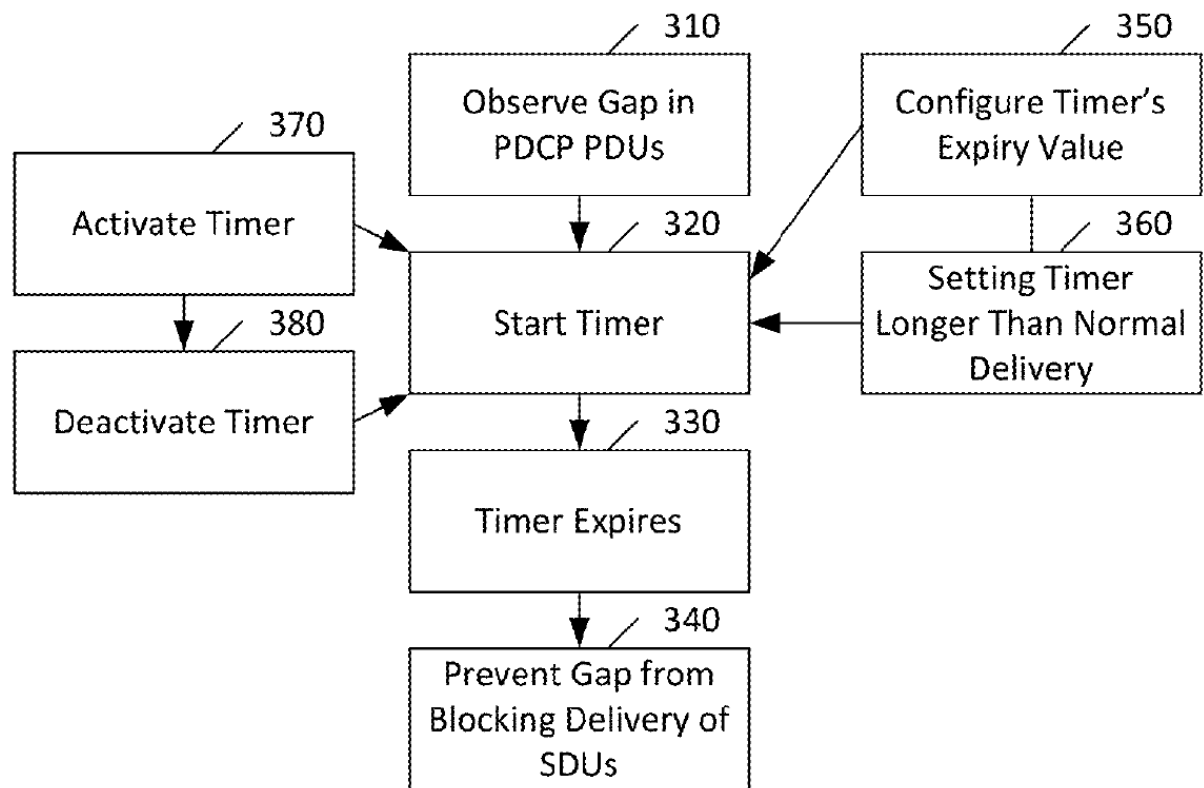
122. As described in Koskinen, when multiple RLC bearers are used to send the data of a PDCP bearer as depicted in Fig. 1 of Koskinen, PDCP protocol units from the multiple underlying RLC entities may be received in a highly interlaced manner at the PDCP entity of the UE. Koskinen, ¶35. Additionally, Koskinen describes that “the bearer may go into deadlock” during handover when a source eNB does not forward PDCP protocol data units that have not yet been successfully delivered to the UE, “because the gaps created by packets that were not forwarded will never be received.” *Id.* Hence, “apparatuses and methods for the PDCP entity at

provided by Koskinen. *Id.*, ¶36.



Koskinen, Fig. 1.

123. Koskinen describes that a timer such as a reordering timer, as depicted in Fig. 2 of Koskinen, is utilized by certain embodiments of apparatuses and methods for the PDCP entity at the UE. *Id.*, ¶37. Koskinen further describes that the timer, the handling of the timer and the related state variables can be repurposed from RLC to PDCP. *Id.* Also, radio resource control (RRC) can configure the expiry value of the timer. Koskinen, ¶39. Additionally, per Koskinen, “t-Reordering and a state variable like VR(UX) can be handled similar to” reordering in the RLC. *Id.*, ¶46.



Koskinen, Fig. 2.

2. Independent Claim 1

- a. **Claim 1[pre]: “A method for user equipment receiving multi-flow data with respect to one evolved packet system (EPS) bearer through a macro base station (macro eNB) and a small base station (small eNB) serving a single cell in a wireless communication system supporting dual connectivity, the method comprising:”**

124. To the extent the preamble is considered limiting, in my opinion, Koskinen discloses or suggests the preamble.

125. In Koskinen, the following are described and will be further discussed below:

- “*evolved packet system (EPS) bearer...supporting dual connectivity*”:

E-UTRAN

- “*macro base station (macro eNB)*”: source eNB
- “*small base station (small eNB)*”: target eNB (LTE Hi AP)
- “*user equipment receiving multi-flow data*”: user equipment receiving PDCP protocol data units from multiple underlying RLC entities

Koskinen, Abstract, ¶¶34-36.

126. Koskinen discloses the preamble because it describes an Evolved Universal Terrestrial Radio Access Network (E-UTRAN) with dual-connectivity, utilizing a user plane (U-plane) “having independent RLC in each node.” Koskinen, ¶¶4, 7. Figure 1 of Koskinen, below, shows the U-plane with multiple radios (e.g., radio bearers) where the “protocol stacks may be based on having independent RLC in each node for dual connectivity” and used for “offloading or inter carrier aggregation” of data. *Id.*, ¶7, Fig. 1. Also, in Figure 1 of Koskinen, an S-/P-GW (serving or packet data network gateway) that is connected and sending data to the system is shown. Data is transmitted to user equipment from the S-/P-GW through the eNB and LTE-Hi AP. It would have been understood by a POSITA that the combination of the eNB/LTE-Hi AP and gateways is an “evolved packet system bearer” because it provides a logical connection between the user equipment and the gateways, facilitating data traffic transport. see ’573Pat., 4:30-60 (“E-UTRAN and the EPC 30 [including S-/P-GW] are integrated to be called an evolved packet

system (EPS)’’).

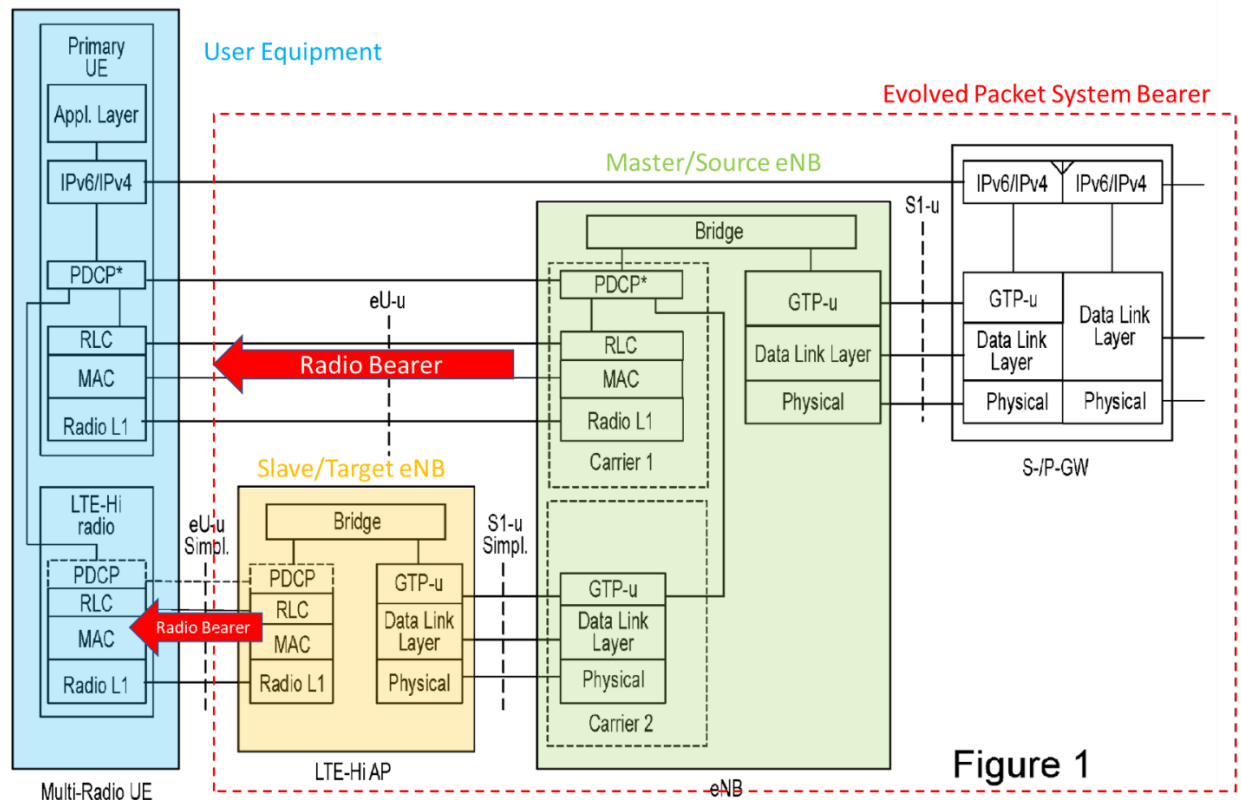


Figure 1

Koskinen, Fig.1 annotated

127. The dual-connectivity E-UTRAN of Koskinen provides connectivity through two separate eNBs, including a source eNB and a target eNB, where the source eNB “may forward in order to the target eNB all downlink PDCP SDUs [service data units] with their SN [sequence number] that have not been acknowledged by the [user equipment].” Koskinen, ¶8. A POSITA would have understood that Koskinen’s source and target eNBs correspond to the claimed “macro” and “small” eNBs, respectively. Koskinen further explains that in the configuration shown in Figure 1, where the target (LTE-Hi AP) is referred to as the

slave eNB and the source as the master eNB, the “PDCP entity at the eNB interfaces a co-located master RLC entity...[and] a slave RLC entity operating at the LTE-Hi AP.” *Koskinen*, ¶12. The “LTE-Hi AP” is an LTE access point that a POSITA would have recognized as a “*small base station*” within the context of the ’573 Patent because it is an evolved system [e.g., Long Term Evolution (LTE)] supporting dual-connectivity.’573Pat., 2:46-48. Additionally, the “LTE-Hi AP” is a lower power access point that receives data from the source eNB and is dependent on the source eNB; and a POSITA would have understood that a configuration such as this is consistent with the description of a small base station provided in ’573 Patent.’573Pat., 1:29-47, 4:37-48. This interpretation is supported because during prosecution of the ’573 Patent the Examiner rejected the same limitations based on Ohta (US 2012/0182971), disclosing source and target base stations. 573FH.

128. Also, in related *Koskinen*281 [EX1008], *Koskinen*281’s Figure 1 (reproduced below) is related to dual connectivity in E-UTRAN and shows distributed radio link control and independent radio link control options. Here, RLC PDUs are assigned by the macro eNB and a subset of the RLC PDUs are sent to the pico eNB as depicted in Figure 1 of *Koskinen*281. EX1008, ¶7, Fig. 1). Accordingly, a POSITA would have recognized based on this that *Koskinen*’s eNB and LTE Hi AP are a macro eNB and pico eNB (or similar structure) and operate in the same manner.

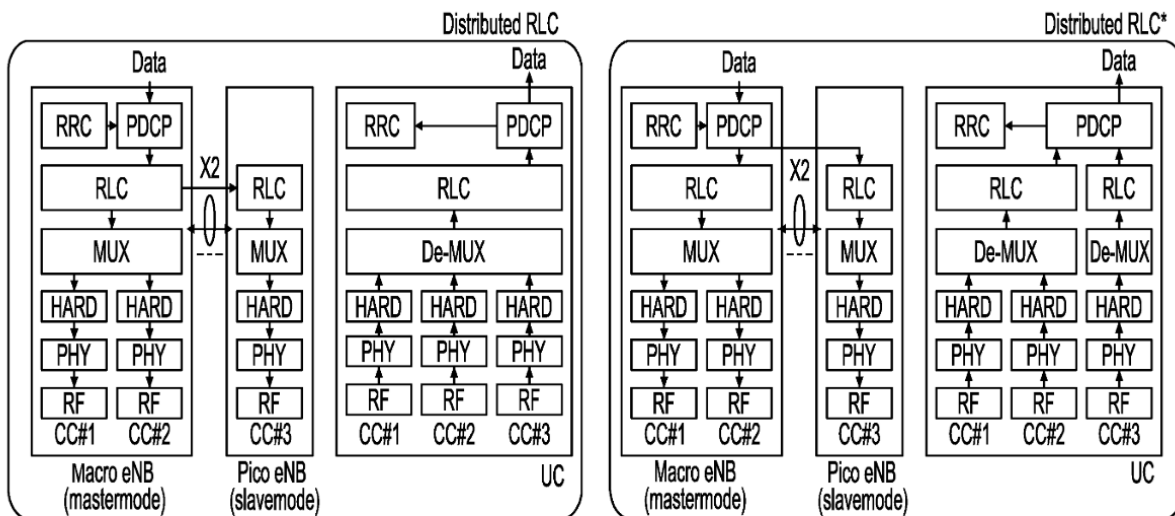


Figure 1

Koskinen281, Figure 1

129. Hence, Koskinen discloses an E-UTRAN receiving data from an S- or P-GW (“*evolved packet system (EPS) bearer*”) and comprising a source or master eNB (“*through a macro base station (macro eNB)*”), a target or slave eNB (an LTE-Hi AP) (“*a small base station (small eNB)*”) supporting “*dual connectivity*,” and user equipment.

130. The E-UTRAN of Koskinen sends sequential PDCP data to a user equipment (UE) by splitting the data and sending it through two radio links with independent RLCs. Koskinen, ¶¶4-17, Fig. 1. Because the “PDCP protocol data units [are sent] from multiple underlying RLC entities in a highly interlaced manner,” it would have been understood by a POSITA that the two RLC entities are part of the same cell. *Id.*, ¶35. Hence, the source or master eNB and target or slave eNB (“*a*

macro base station (macro eNB) and a small base station (small eNB)”) are a system of radio bearers sending a single stream of data to a user equipment (“serving a single cell in a wireless communication system”).

131. In Koskinen, it describes the user equipment (UE) “may be a mobile station (MS) such as a mobile phone or smart phone or multimedia device,” or other such wireless device. Koskinen, ¶50. Additionally, unlike in traditional E-UTRAN models, the user equipment receives PDCP data “over two independent RLC bearers, one over each of the two radio interfaces of the user equipment.” *Id.*, ¶¶34-35. That is, the user equipment receives “multi-flow data” as described by the ’573 Patent. ’573Pat., 1:65-2:6. Additionally, it is admitted by the ’573 Patent that each of the preamble’s elements were well-known to a POSITA at the time of priority date of the ’573 Patent. ’573Pat., 1:29-2:6.

132. Accordingly, it is my opinion that Koskinen (and applicant admitted prior art) discloses or suggests a method for a user equipment receiving sequential PDCP data through two radio links (“*user equipment receiving multi-flow data with respect to*”) the E-UTRAN comprising the source and target eNBs, Additionally, as mentioned above, the ’573 Patent also admits that the elements of the preamble were well known to a POSITA at the time of priority date of the ’573 Patent.

b. Claim 1[a]: “receiving packet data convergence protocol (PDCP) packet data units (PDUs) through the macro base station and the small base station;”

133. In my opinion, Koskinen discloses or suggests this limitation.

134. It is admitted by the '573 Patent that each element of 1[a] was well-known to a POSITA at the time of priority date of the '573 Patent based on the description in the background section of the '573 Patent. '573Pat., 2:7-18. For example, this section of the '573 Patent explains the well-known concept of reception of PDUs at the PDCP layer: “The RLC entity reassembles an RLC service data unit (SDU) based on the reordered RLC PDU and sequentially the reassembled RLC SDU to an upper layer (that is, PDCP entity). In the case of the RLC AM, the RLC PDUs can be sequentially delivered through reordering and retransmission methods of the RLC PDUs. In other words, the PDCP entity needs to be sequentially delivered with the RLC SDUs except for reestablishment of the lower layer.” Additionally, as discussed above for 1[pre], the user equipment of Koskinen receives “PDCP protocol data units [PDU] from multiple underlying RLC entities in a highly interlaced manner.” Koskinen, ¶¶4-15, 35. Additionally, as shown in Figure 1, the multiple underlying RLC entities described in Koskinen are part of the source and target eNBs (“*macro base station and the small base station*”). Koskinen, ¶¶8, 15, Fig. 1. Accordingly, it is my opinion that Koskinen discloses this limitation.

c. Claim 1[b]: “obtaining PDCP service data units (SDUs) corresponding to the PDCP PDUs; and”

135. In my opinion, Koskinen discloses or suggests this limitation.

136. Koskinen describes the receiving of downlink PDCP SDUs by the UE from the target eNB when the source eNB sends downlink PDCP SDUs (either itself or through the target eNB) in the downlink. Koskinen, ¶8. Koskinen further describes that after the UE receives the PDCP PDUs, PDCP SDUs may be delivered to upper layers. *Id.*, ¶¶10, 12, 45. Additionally, Koskinen incorporates by reference 3GPP TS 36.323 that describes the “Packet Data Convergence Protocol (PDCP) specification” and 3GPP TS 36.300 that provides the overall description of an E-UTRAN. *Id.*, ¶¶8, 10; EX1011; EX1012. In 3GPP TS 36.300, it explains that a PDCP PDU includes a PDCP header and a PDCP SDU. EX1012, §6.3.2. In 3GPP TS 36.323, it further explains that a PDCP PDU in the user plane includes a PDCP SDU sequence number (SN) and a compressed or uncompressed PDCP SDU. EX1011, §6.1. A POSITA with knowledge of the E-UTRAN structure and protocols would have thus understood that a PDCP SDU is obtained by removing the header from a PDCP PDU. The portion of the PDCP PDU delivered to the higher layers is the PDCP SDU. Koskinen, ¶¶8, 12, 45.

137. Additionally, it is admitted by the ‘573 Patent that each element of 1[b] was well-known to a POSITA at the time of priority date of the ‘573 Patent. ‘573Pat., 2:8-18. For example, this section explains obtaining SDUs from the received PDUs

were already known: “...in the case of the UE in which the multi-flows are constituted, the RLC entity for the small base station and the RLC entity for the macro base station are distinguished to receive the respective RLC SDUs and acquire the PDCP SDU and deliver the acquired PDCP SDU to the upper layer.”

138. Accordingly, Koskinen’s user equipment (UE) receives PDCP PDUs and obtains the corresponding PDCP SDUs to deliver the PDCP SDUs to higher layers (“*obtain[s] PDCP service data units (SDUs) corresponding to the PDCP PDUs*”). Hence, it is my opinion that Koskinen discloses this limitation.

d. Claim 1[c]: “receiving from the macro base station information related to an in-sequence timer for the PDCP SDUs through a radio resource control (RRC) message,”

139. In my opinion, Koskinen discloses or suggests this limitation.

140. In Koskinen, it describes that the RLC layer of the user equipment (UE) includes a reordering timer, *t-Reordering*, used as a time interval to determine whether ordering of received RLC data is out of order and must be reordered by waiting for in-sequence RLC data. Koskinen, ¶¶4, 16-17; EX1013, §5.1.2.2 (incorporated by reference). In Koskinen, it further describes that, by using a timer, the PDCP layer or entity of the UE can “deduce when not to expect reception gaps to be filled.” Koskinen, ¶¶36-37. Additionally, Koskinen discloses re-purposing the timer that operated at the RLC layer to be used at the PDCP layer (“*in-sequence timer*”). Per Koskinen, for the PDCP entity to determine that a gap will not be filled,

“the timer and its handling, along with the related state variables needed, that are currently specified for RLC-UM can be repurposed for AM data transfer.” *Id.*, ¶37. That is, the reordering timer from the RLC layer, and other state variables associated with it, is repurposed to be used in the PDCP layer. Because the timer is used by the PDCP layer, it would have been understood by a POSITA who would have found it obvious that the repurposed timer was a PDCP timer to determine reordering of SDUs for sequential delivery to higher layers (“*in-sequence timer for the PDCP SDUs*”). Koskinen, ¶¶37-39.

141. In Koskinen, it is further described that radio resource control (RRC) can configure the expiry value of the timer; that is, the “timer's expiry value can be configured by radio resource control (RRC).” Koskinen, ¶39, Claims 2&16. Because Figure 1 of Koskinen (below) discloses a single PDCP entity in the Master/Source eNB, the Master/Source eNB transmits the RRC, since it is a higher layer than the PDCP and the RRC originates at the eNB controlling communication. EX1012, §4.1.

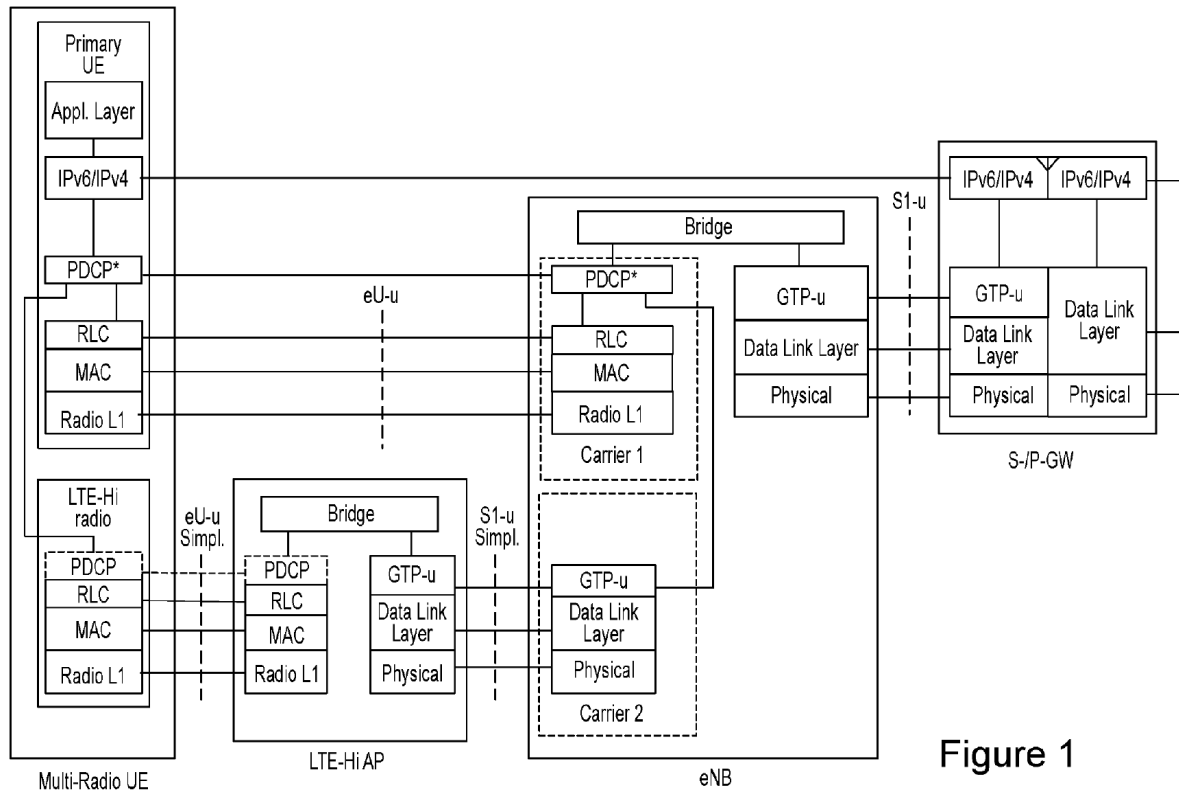


Figure 1

Koskinen, Figure 1

Accordingly, it is my opinion that Koskinen discloses this limitation. Per 3GPP TS 36.331, which describes the “procedures and messages” of RRC, Signalling Radio Bearers are used by the RRC to send RRC messages. EX1014, §§4.1, 4.2.2. At the time of priority date of the ’573 Patent, it was well-known that the RRC message was sent from the macro (or source/master) eNB (e.g., base station) because the macro (or source/master) eNB controls the transmission of data. For example, the other Koskinen reference, Koskinen281, shows the RRC entity at a higher layer than the PDCP and operating on the SRB in the control plane. See Koskinen281, Figure 1 below. EX1008, Figure 1. Koskinen281 illustrates a POSITA’s well understood

knowledge of the hierarchy of a macro/master eNB. EX1012, §4.1. A POSITA would have recognized and found it obvious that the UE receives RRC “messages” “from the macro base station” because Koskinen describes UE configuration by RRC and the RRC configures the UE by using messages sent from the macro base station.

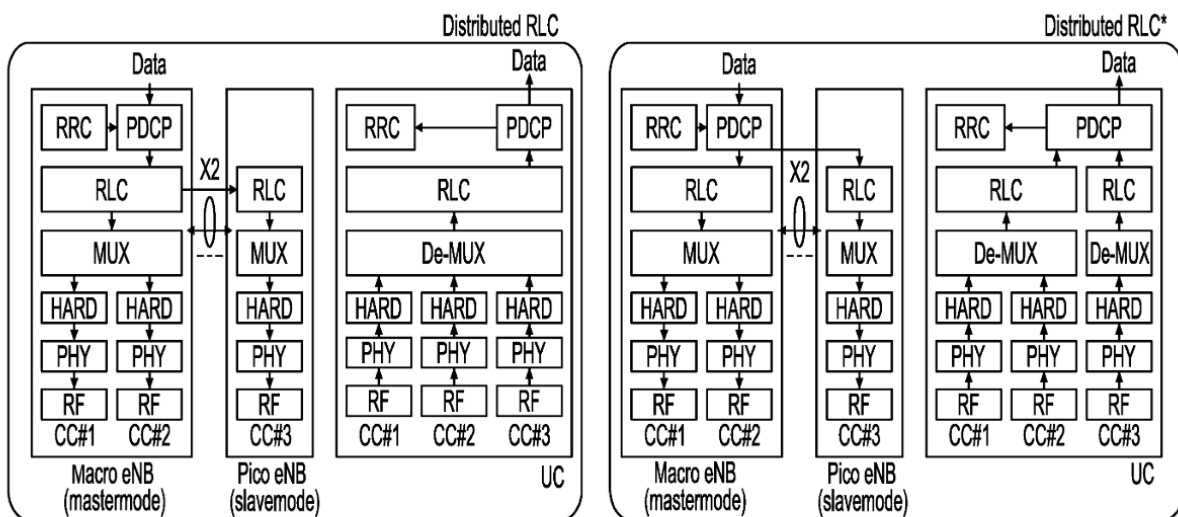


Figure 1

Koskinen281, Figure 1

e. Claim 1[d]: “wherein the PDCP SDUs are indicated by a predefined PDCP sequence number (SN),”

142. In my opinion, Koskinen discloses or suggests this limitation.

143. In Koskinen, it describes “the UE receives a PDCP SDU...deliver it to higher layer together with all PDCP SDUs with lower SNs.” Koskinen, ¶8 (quoting 3GPP TS 36.300 §§10.1.2.3 and 10.1.2.3.1). Hence, Koskinen describes that “downlink PDCP SDUs” have a sequence number (defined in Koskinen as “SN

Sequence Number”) (“*the PDCP SDUs are indicated by a...PDCP sequence number (SN)*”). Koskinen, ¶8, 56. It was well known at the time of the priority date of the ’573 Patent that each PDCP SDU had an associated sequence number. At the PDCP entity receiving side in the user equipment (UE), reordering uses the PDCP Sequence Number (SN) that is part of the PDCP header. The reordering process relies on the PDCP header being intact so that the sequence number (SN) can be extracted from the PDCP header. The PDCP PDU is received by the PDCP layer/entity at the UE and the SN is extracted from the PDCP header. The PDCP SDU is extracted from the PDCP PDU (e.g., header removed from the PDCP PDU) and the extracted PDCP SDU is sent up to the higher layer. EX1011, §5.2.1.2. Additionally, 3GPP TS 36.300, which is incorporated by reference in Koskinen, describes that “[t]he PDU sequence number carried by the RLC header is independent of the SDU sequence number (i.e. PDCP sequence number).” EX1012, §6.2.2.

144. Additionally, this same understanding is presented by the ’573 Patent as shown in Figures 12 and 13. In Figure 12, it shows the receiving of PDCP PDUs with sequence numbers (SNs). ’573Pat., 12:30-42. And Figure 13 “illustrates an example of sequential upper layer transmission depending on the PDCP sequence number (SN) in the PDCP entity of the UE.” ’573Pat., 14:15-17. The ’573 Patent consistently refers to the SN of the SDU and the same SN of the received PDU.

‘573Pat.,14:23-55, Figs. 12, 13. With respect to Figure 14, it is described in the ‘573 Patent that the “acquired PDCP SDUs are sequentially present in the order of the PDCP SN.” ‘573Pat., 15:50-53. These are in fact well known aspects of the packet units, and would have been understood by a POSITA, based on the 3GPP specifications and operation of E-UTRAN systems, and confirmed by the ‘573 Patent, that the sequence number (SN) associated with the PDCP PDU that is received from the lower layer was also associated with the PDCP SDU. The PDCP SDU is the portion of the PDCP PDU not including the header information (“*the PDCP SDUs are indicated by a...PDCP sequence number (SN)*”).

145. Also, the “PDCP SN is maintained on a bearer basis and the source eNB informs the target eNB about the next DL PDCP SN to allocate to a packet which does not have a PDCP sequence number yet (either from source eNB or from the Serving Gateway).” EX1012, §10.1.2.1.2. And the specification (3GPP TS 36.300) describes that “[a] sequence number (COUNT) is used as input to the ciphering and integrity protection” and “[a] given sequence number must only be used once for a given eNB key.” *Id.*, §14.1. Hence, it would have been recognized by a POSITA that the sequence number was “*predefined*,” at least because it cannot be reused and thus must be defined before it can be assigned to the PDCP PDU/SDU. Accordingly, it is my opinion that Koskinen discloses or suggests this limitation.

f. Claim 1[e]: “wherein the RRC message includes a PDCP-configuration information element (IE), and”

146. In my opinion, Koskinen discloses or suggests this limitation.

147. As discussed above for 1[c], Koskinen describes that the eNB and the user equipment (UE) include a PDCP layer, and the timer used for PDCP reordering in the UE is in the PDCP layer. Koskinen, ¶¶4, 36-39. Per Koskinen, radio resource control (RRC) configures the timer. Koskinen, ¶39, Claims 2 and 16. As discussed above for 1[c], a POSITA would have recognized that Koskinen’s source eNB sends an RRC message to configure the UE. As the UE includes a PDCP layer and is configured by RRC, a POSITA would have recognized and found it obvious that the RRC included a PDCP configuration information element. PDCP information elements were well known at the time of priority date of the ’573 Patent and were specified in the 3GPP technical specification 36.331 (shown below). EX1014, p.202. A POSITA would have referred to the specification for information regarding the RRC. I have reproduced below an example PDCP configuration IE from TS 36.331. The IE includes various parameters such as time and sequence values and header compression. *Id.*, ¶147. The IE *PDCP-Config* is used to set the configurable PDCP parameters for data radio bearers. *Id.*

```

-- ASN1START
PDCP-Config ::=
    discardTimer
    }
    rlc-AM
        statusReportRequired
    }
    rlc-UM
        pdcp-SN-Size
    }
    headerCompression
        notUsed
        rohc
            maxCID
            profiles
                profile0x0001
                profile0x0002
                profile0x0003
                profile0x0004
                profile0x0006
                profile0x0101
                profile0x0102
                profile0x0103
                profile0x0104
            },
            ...
        }
    },
    ...,
    [[ rn-IntegrityProtection-r10
    ]],
    [[ pdcp-SN-Size-v1130
    ]],
}

SEQUENCE {
    ENUMERATED {
        ms50, ms100, ms150, ms300, ms500,
        ms750, ms1500, infinity
    } OPTIONAL, -- Cond Setup
    SEQUENCE {
        BOOLEAN
    } OPTIONAL, -- Cond Rlc-AM
    SEQUENCE {
        ENUMERATED {len7bits, len12bits}
    } OPTIONAL, -- Cond Rlc-UM
    CHOICE {
        NULL,
        SEQUENCE {
            INTEGER (1..16383) DEFAULT 15,
            SEQUENCE {
                BOOLEAN,
                BOOLEAN,
                BOOLEAN,
                BOOLEAN,
                BOOLEAN,
                BOOLEAN,
                BOOLEAN,
                BOOLEAN,
                BOOLEAN,
                BOOLEAN
            }
        }
    }
}

[[ rn-IntegrityProtection-r10
]]
[[ pdcp-SN-Size-v1130
]]

-- ASN1STOP

```

148. Additionally, Koskinen describes that “the PDCP bearer terminated at the user equipment and the eNB is carried over two independent RLC bearers”. Koskinen, ¶15. A POSITA would have understood that a PDCP bearer is a logical connection between the UE and eNB that is always configured by the PDCP configuration information element (IE) in RRC messages.

ONEPLUS - EX. 1003

g. Claim 1[f]: “the PDCP-configuration IE includes a field indicating a value of the in-sequence timer.”

150. In my opinion, although Koskinen does not explicitly describe a configuration IE field for the in-sequence timer, this limitation would have been obvious based on Koskinen’s disclosures.

151. As discussed above for 1[c] and 1[e], Koskinen describes a PDCP reordering timer that is configured by RRC. Additionally, Koskinen discloses that the PDCP timer uses variables like those used for the RLC-UM (radio link control – unacknowledged mode). Koskinen, ¶¶37-38, 56. Hence, information elements (IEs) that specified an RLC reordering timer would have been known by and familiar to a POSITA based on (1) the POSITA’s general familiarity that IEs carried information in RRC messages, and (2) 3GPP technical standards, for example, 3GPP TS 36.331 that described an IE that carried reordering timer duration information for the RLC layer, as shown below (EX1014, 219-220). Therefore, it would have been obvious to a POSITA that the PDCP timer information, which used similar variables as its RLC counterpart (Koskinen, ¶¶37-38), would also be carried in a PDCP-configuration IE.

```
T-Reordering ::=
ENUMERATED {
    ms0, ms5, ms10, ms15, ms20, ms25, ms30, ms35,
    ms40, ms45, ms50, ms55, ms60, ms65, ms70,
    ms75, ms80, ms85, ms90, ms95, ms100, ms110,
    ms120, ms130, ms140, ms150, ms160, ms170,
    ms180, ms190, ms200, spare1}
```

EX1014, 219-220.

152. Additionally, a POSITA would have been motivated and would have had a reasonable expectation of success to include a variable or a field in the PDCP configuration sent by the RRC message to specify the timer expiration duration. A reason for this is that it would have allowed the UE timer to be reliably set through a known methodology that was already included in the 3GPP specification. Including such a variable as part of an IE would have required nothing more than the application of known, conventional techniques, such as using the RRC message to set parameters in a UE conveyed through a field in a configuration element, to yield predictable results, such as setting parameters to set timers in the UE, as explained in Koskinen. Using such a technique was well within the skill of a POSITA.

153. Additionally, Koskinen describes that “[t]he timer's expiry value can be configured by radio resource control (RRC).” Koskinen, ¶39, Fig. 2. A POSITA would have reasonably inferred that, given the timer's association with PDCP, its expiry value would be a parameter, or sub-element, within the PDCP configuration IE conveyed via RRC messaging. As such, a POSITA would have recognized that this parameter would necessarily be represented as a distinct field within the IE.

154. Accordingly, it is my opinion that Koskinen discloses or suggests this limitation.

3. Claim 2: “The method of claim 1, further comprising: confirming the respective PDCP SNs of the obtained PDCP SDUs and performing in sequence delivery of the PDCP SDUs to an upper layer from a PDCP entity according to the PDCP SN.”

155. In my opinion, Koskinen discloses or suggests this limitation.

156. Claim 2 states the unremarkable and well-understood principle within E-UTRAN systems of the user equipment (UE) forwarding sequential PDCP data packets to higher levels. That said, Koskinen also discloses this well-known PDCP function or “in-sequence delivery of upper layer PDUs at re-establishment of lower layers” where “protocol stacks may be based on having independent RLC in each node for dual connectivity.” Koskinen, ¶¶6-7.

157. For example, at stage-3 (i.e., PDCP layer), “this principle looks as follows in 3GPP TS 36.323 [Packet Data Convergence Protocol (PDCP) specification] §§5.1.2, 5.1.2.1, and 5.1.2.1.2:

‘. . . if the PDCP PDU received by PDCP is not due to the re-establishment of lower layers: **deliver to upper layers in ascending order of the associated COUNT value:** all stored PDCP SDU(s) with an associated COUNT value less than the COUNT value associated with the received PDCP SDU; **all stored PDCP SDU(s) with consecutively associated COUNT value(s) starting from the COUNT value associated with the received PDCP SDU**’”

Id., ¶10. That is, the 3GPP specification describes that delivering sequential SDUs to upper layers as normal. The reason is that “the system assumes that no PDU with lower SN will follow after the one received, and deliver SDUs to higher layer accordingly.” Koskinen, ¶11. Additionally, “the system refrains from any SDU delivery to higher layer that would leave a hole in the SN sequence of delivered SDUs.” *Id.*, ¶12-13. [In Koskinen, PDCP SN is associated/equivalent to the COUNT value. Koskinen, ¶47.]

158. Hence, in accordance with the 3GPP specifications, Koskinen discloses tracking PDCP SDU sequence numbers (“*confirming the respective PDCP SNs of the obtained PDCP SDUs*”) and delivering them sequentially to higher levels (“*performing in sequence delivery of the PDCP SDUs to an upper layer from a PDCP entity according to the PDCP SN*”). Accordingly, it is my opinion that Koskinen discloses or suggests this limitation.

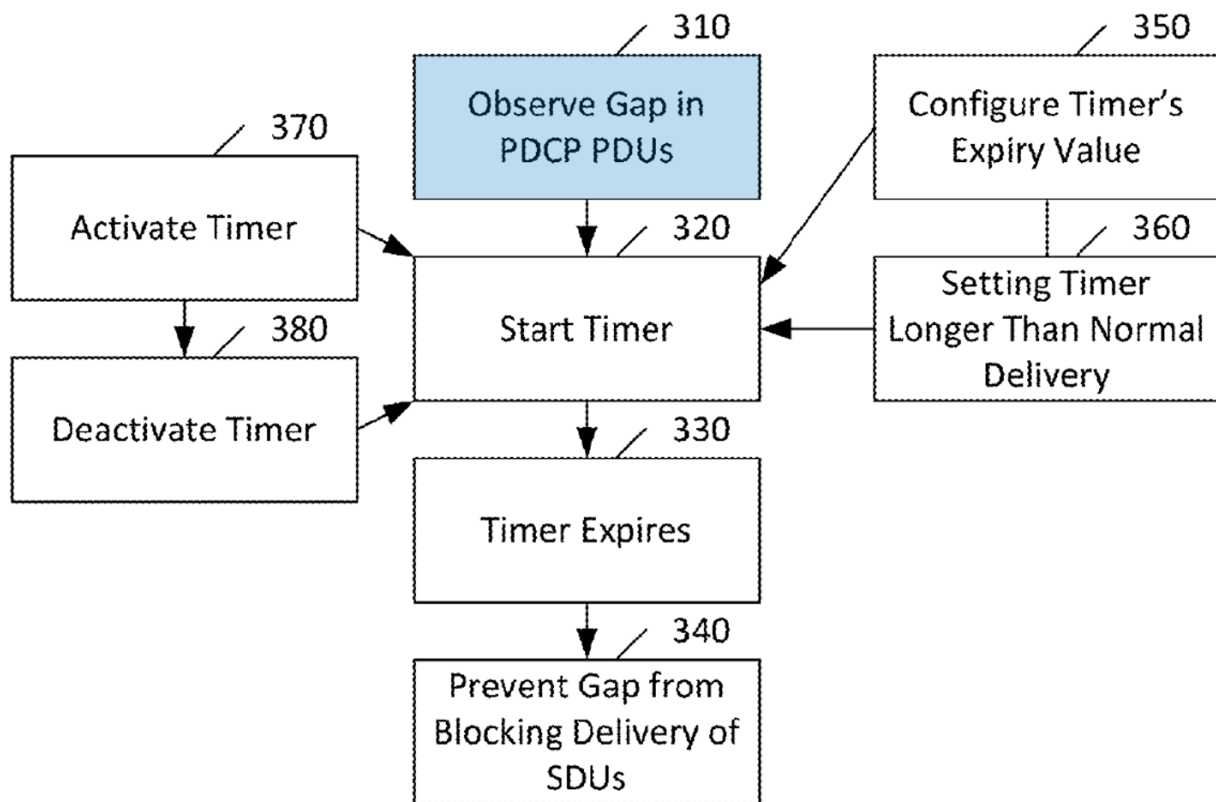
4. Claim 3

- a. **Claim 3[a]: “The method of claim 2, further comprising: confirming whether there is a PDCP SDU of PDCP SN #n−1 which is missed notwithstanding obtaining a PDCP SDU of PDCP SN #n; and”**

159. In my opinion, Koskinen discloses or suggests this limitation.

160. In Koskinen, it is contemplated that the PDCP data units are received out of order by the UE of Koskinen (Koskinen, ¶35) and it describes “observing a gap in a sequence of protocol data units received from a plurality of lower-layer

protocol entities providing data transfer.” Koskinen, ¶¶18, 21, 24. For instance, as shown in Figure 2 of Koskinen below, the “gap in the received protocol data units is observed at 310, such as by observing a gap in a sequence of protocol data units.” *Id.*, ¶38. As described in Koskinen, gap detection occurs at the user equipment (UE). *Id.*, ¶35-36.



Koskinen, Fig. 2 annotated.

161. As discussed above in 1[d], on the receiving side such as when data is received at the UE from a base station, the data packets that are passed up from a current layer to the layer above are considered SDUs from the perspective of the current layer, and these data packets are considered PDUs from the perspective of the receiving layer. Hence, in Koskinen Figure 2 that shows the process at the PDCP layer, the received PDUs by the PDU layer correspond to the SDUs sent by the RLC

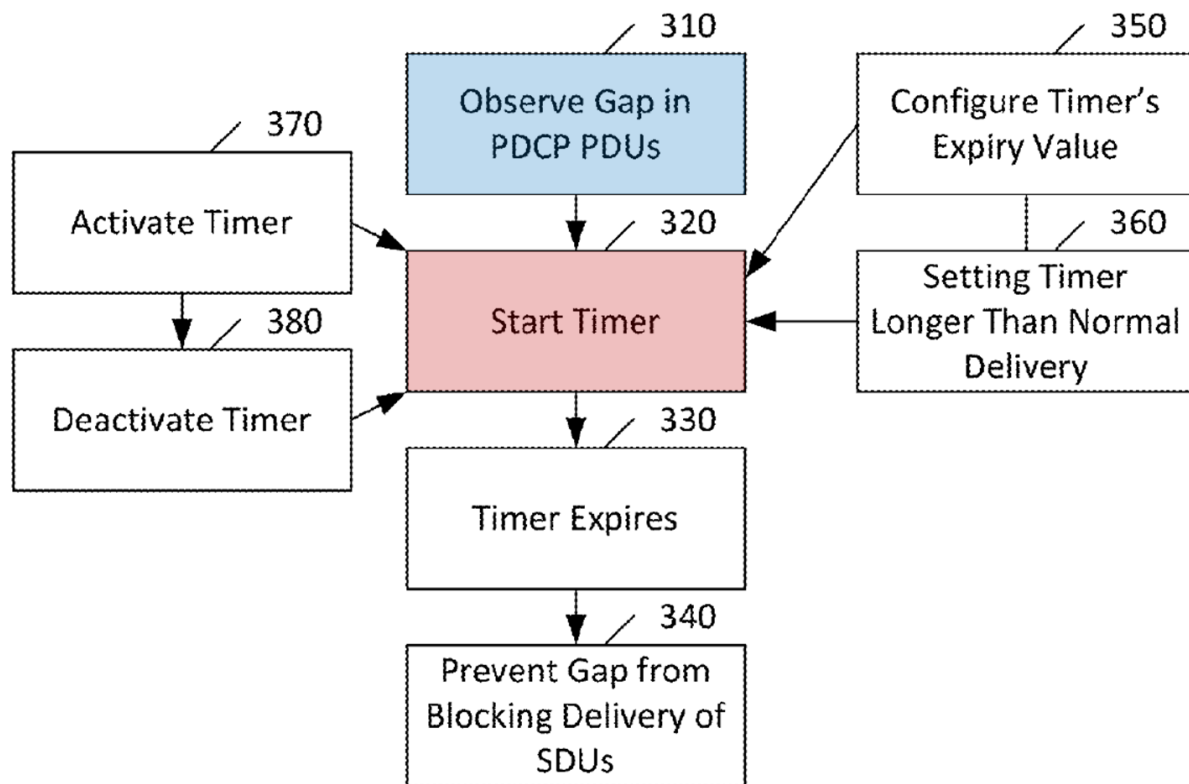
layer. *Id.* Thus, when Koskinen references PDCP data units in connection to element 310 in Figure 2, Koskinen is referring to SDUs that are passed up by the RLC layer, and received at the PDCP layer.

162. Koskinen discloses using sequence numbers to identify PDCP SDUs (see element 1[d] in Ground 1). Therefore, it would have been understood and would have been found obvious by a POSITA that detecting gaps in the sequence of PDCP PDUs (and the corresponding SDUs) indicates that previous data packet (i.e., with “SN #n-1”) was not received, while the current data packet (i.e., with “SN #n”) has been received. Hence, by detecting gaps in PDU reception at the UE, the current PDU is received but the previous PDU is missed (“*PDCP SN #n-1 which is missed notwithstanding obtaining a PDCP SDU of PDCP SN #n*”). Accordingly, it is my opinion that Koskinen discloses or suggests this limitation.

b. Claim 3[b]: “driving the in-sequence timer with respect to the PDCP SDU of PDCP SN #n when there is the PDCP SDU of PDCP SN #n-1 which is missed.”

163. In my opinion, Koskinen discloses this limitation.

164. In Koskinen, it further describes that “certain embodiments utilize a timer, such as a reordering timer” that “can be started at 320 whenever a gap in the received protocol data units is observed at 310, such as by observing a gap in a sequence of protocol data units” as shown below in Figure 2. Koskinen, ¶¶ 37-38.



Koskinen, Fig. 2 annotated.

165. As discussed above in 1[c], a POSITA would have recognized and found it obvious that the reordering timer is an “*in-sequence*” timer. Additionally, a POSITA would have found it obvious that to “*drive*” a timer is to start the timer, which is consistent with the disclosure of the ’573 Patent. ’573Pat., 13:4-7 (when an SDU is received a timer starts); 13:18-27 (driving the timer for every SDU processed). Accordingly, it is my opinion that Koskinen discloses this limitation.

5. Claim 4

- a. **Claim 4[a]: “The method of claim 3, wherein before the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, when the PDCP SDU of PDCP SN #n-1 is obtained,”**

166. In my opinion, Koskinen discloses this limitation.

167. In Koskinen, it describes that the timer can be set “long enough **so that**

the timer does not expire during normal delivery delay of protocol data units sent by the eNB to the user equipment via a small-cell node, for example, including all possible HARQ and ARQ retransmissions at MAC and RLC level therein, respectively.” Koskinen, ¶39. That is, the timer duration should be set longer than a normal delay in the transmission of the PDU so that the missing PDU is received before the timer expires. Additionally, Koskinen describes a “forwarding-status report [that] can be a new PDCP control PDU” from the eNB to “tell the user equipment (after handover) at 410, which protocol data unit sequence numbers (PDU SNs) the user equipment should expect to receive.” Koskinen, ¶40. Hence, Koskinen discloses the timer is set longer than an expected delay, and the eNB tells the UE to expect certain missed PDCP PDUs (as determined by the gap). Koskinen further describes that the procedures utilizing the timer are part of the PDCP procedure. Koskinen, ¶¶45-46. Furthermore, TS 36.322 section 5.1.2.2.3 describes the PDU reordering operation of the RLC entity before the expiration of the *t-Reordering* timer. EX1013, §5.1.2.2.3.

168. Therefore, a POSITA would have recognized that, at least in certain circumstances, the UE will receive the missing PDCP PDU (“*the PDCP SDU of PDCP SN #n-1 is obtained*”) because the eNB has indicated that the PDU was sent and the timer would not expire before it is received (“*before the in-sequence timer for the PDCP SDU of PDCP SN #n has expired*”). Accordingly, it is my opinion that

Koskinen discloses this limitation.

b. Claim 4[b]: “the PDCP SDU of PDCP SN #n-1 and the PDCP SDU of PDCP SN #n are delivered to the upper layer according to the order of the PDCP SN.”

169. In my opinion, Koskinen discloses or suggests this limitation.

170. In Koskinen, it describes “apparatuses and methods for when a PDCP entity receiving protocol data units from multiple RLC-AM entities should and should not assume gap-less reception of protocol data units, and how to deliver Service data units to higher layer accordingly.” Koskinen, ¶44. As discussed above for claim 2, when the correct sequence of PDCP SDUs is received, they are delivered to higher layers. Delivering consecutive PDCP PDUs without gaps is further described in “embodiments in which both a timer and a forwarding-status report are included.” Koskinen, ¶45. For example, before the expiry of a reordering timer that can be started when a gap in the sequence numbers (SNs) of the PDCP PDUs is detected and where the gap is no longer permitted to block delivery of the PDCP SDUs to the upper layer upon expiry of the reordering timer, the following may be implemented to deliver the PDCP SDUs to the upper layer in order according to the SN. Koskinen, ¶38, 45. Based on the received PDCP SDU, first transmit to the upper layer in ascending order of the associated COUNT value all stored PDCP SDU(s) with an associated COUNT value less than the COUNT value associated with the received PDCP SDU. [i.e., this means to check if there are any stored PDCP SDU

that arrived before the PDCP SDU that was just received and deliver them in order.]

Second, beginning with the COUNT value associated with the received PDCP SDU, transmit all stored PDCP SDU(s) with consecutively associated COUNT value(s) to the upper layer in ascending order of the associated COUNT value. [i.e., if received PDCP SDU (e.g. PDCU SDU 101) arrives, and e.g., PDCP SDU 102 and PDCP SDU 103 are already stored in the PDCP entity, transmit PDCP SDUs 101, 102 and 103 in order to the upper layer.] Then set Last_Submitted_PDCP_RX_SN to the PDCP SN of the last PDCP SDU delivered to the upper layer, to track the last SN delivered to the upper layer and to know what to expect next. Also, if the received PDCP SN = Last_Submitted_PDCP_RX_SN + 1 or received PDCP SN = Last_Submitted_PDCP_RX_SN — Maximum PDCP SN, transmit to the upper layer in ascending order of the associated COUNT value all stored PDCP SDU(s) with consecutively associated COUNT value(s) starting from the COUNT value associated with the received PDCP SDU. Koskinen, ¶45. [Received PDCP SN = Last_Submitted_PDCP_RX_SN — Maximum PDCP SN is to account for the wrap-around case when received PDCP SN=0 if Last_Submitted_PDCP_RX_SN is equal to the Maximum PDCP SN possible]. Accordingly, it is my opinion that Koskinen discloses or suggests this limitation.

6. Claim 5: “The method of claim 2, wherein when the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, the PDCP SDU of PDCP SN #n is delivered to the upper layer of the PDCP entity even though there is no PDCP SDU of PDCP SN #n-1.”

171. In my opinion, Koskinen discloses or suggests the limitations of Claim 5.

172. In Koskinen, it describes that “[o]nce the timer expires at 330, that gap is no longer allowed to block delivery of service data units to higher layer, at 340.” Koskinen, ¶38. That is, “[p]reventing the block of delivery can be carried out by **proceeding with the delivery of service data units to the higher layer** without a delay caused by waiting for protocol data units.” *Id.* Hence, the PDCP layer may “deliver other Service data units to higher layer, as if a PDCP Data PDU with that PDCP SN was received.” *Id.*, ¶47. Koskinen further describes that the procedures utilizing the timer are part of the PDCP procedure. Koskinen, ¶¶45-46. Furthermore, TS 36.322 section 5.1.2.2.4 describes the PDU reordering operation of the RLC entity when the *t-Reordering* timer expires. EX1013, §5.1.2.2.4.

173. Accordingly, it would have been found obvious by a POSITA that all of the stored PDCP SDUs are delivered to the higher layer and that the delivered SDUs include the received SDU that triggered the detected gap (“*the PDCP SDU of PDCP SN #n is delivered to the upper layer of the PDCP entity even though there is no PDCP SDU of PDCP SN #n-1*”). Accordingly, it is my opinion that Koskinen

discloses or suggests the limitations of Claim 5.

7. Independent Claim 8

Claim 8: “A user equipment (UE) for receiving multi-flow data with respect to one evolved packet system (EPS) bearer through a macro base station (macro eNB) and a small base station (small eNB) serving a single cell in a wireless communication system supporting dual connectivity, the UE comprising: a receiving unit receiving packet data convergence protocol (PDCP) packet data units (PDUs) through the macro base station and the small base station and receiving from the macro base station information related to in-sequence timer for the PDCP SDUs through a radio resource control (RRC) message; and a processor obtaining PDCP service data units (SDUs) corresponding to the PDCP PDUs, wherein the PDCP SDUs are indicated by a predefined PDCP sequence number (SN), wherein the RRC message includes a PDCP-configuration information element (IE), and the processor determines the value of in-sequence timer based on the PDCP-configuration IE.”

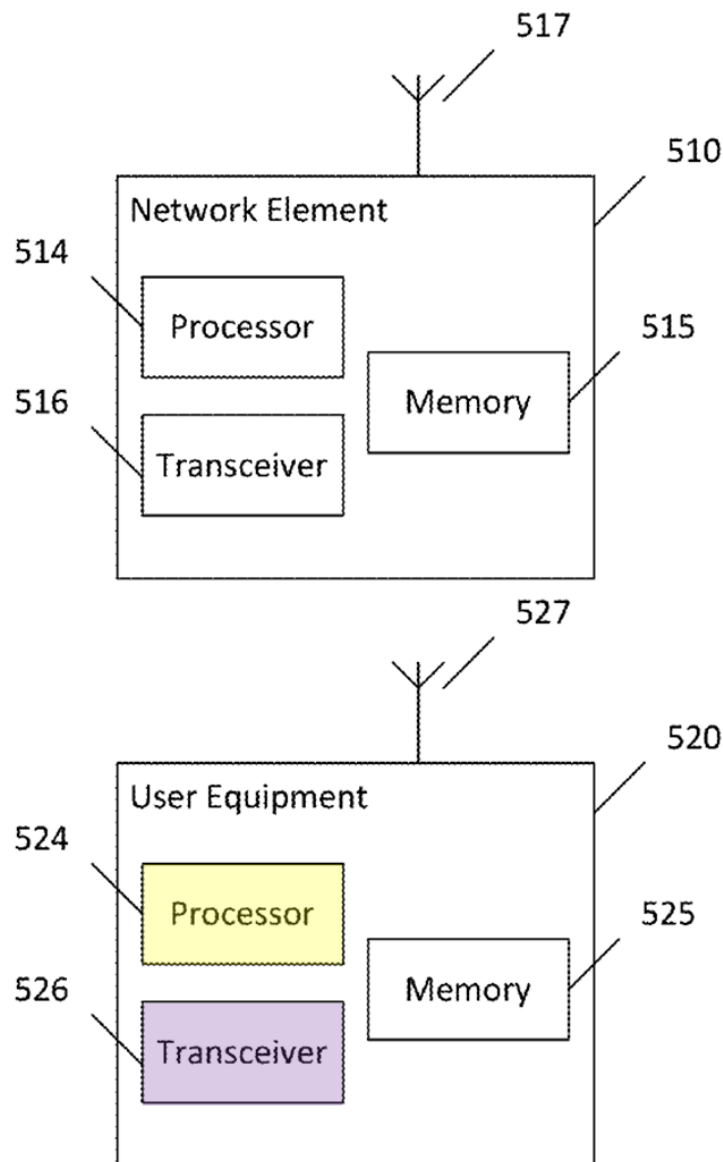
174. In my opinion, Koskinen discloses or suggests the limitations of Claim 8.

175. Koskinen discloses claim 8 for substantially the same reasons as claim 1 (see elements 1[pre]-1[f] in Ground 1) because the claims are substantively identical and Koskinen further discloses a user equipment including a receiving unit and a processor. Koskinen, ¶48; *compare* claim limitations 1[pre]-1[f] *with* claim limitations 8[pre]-8[f].

176. Claim 8[pre] is substantially similar to 1[pre], except it recites a “user equipment” for performing functions instead of a “method.” As discussed above,

Koskinen describes the recited steps are performed by a UE.

177. Additionally, with regards to limitation 8[a], Koskinen describes a transceiver is included in the UE, as shown below in Figure 4. Koskinen, ¶48, Fig. 4. The transceiver may be “a transmitter, a receiver, or both a transmitter and a receiver, or a unit or device that may be configured both for transmission and reception.” *Id.*, ¶49. Koskinen also describes that the UE receives PDCP PDUs and RRC messages. *Id.*, ¶¶8-14, 35, 39, 42. Moreover, 3GPP TS 36.331 expressly specifies that the Radio Resource Control (RRC) protocol is for the radio interface between UE and E-UTRAN. EX1014, p. 14. It would have been understood by a POSITA that the RRC messages used to configure the UE are received over a radio interface by Koskinen’s receiver as part of the transceiver.



Koskinen, Fig. 4 annotated.

178. Regarding limitation 8[c] and 8[f], Koskinen describes the UE includes a processor, shown above in Figure 4. Koskinen, ¶48, Fig. 4. In Koskinen, it describes that the processor carries out the embodiments described in Koskinen. *Id.*, ¶51. For instance, Koskinen explains that the processor performs the following

functions: “observing a gap in received protocol data units, starting a timer upon the gap observation and preventing the gap from blocking delivery of service data units to a higher layer, when the timer expires.” *Id.*, ¶51. Additionally, the processor executes software that may perform a process such as one of the processes disclosed in Koskinen. *Id.*, ¶¶52-54. Hence, it would have been understood by a POSITA that the processor processes the received data from the macro and small base stations because it executes software that perform those functions.

179. The table below provides a correlation of the reasons why Koskinen discloses the limitations of claim 1 with limitations 8[a]-8[f].

Claim 8	
Limitation	Substantially Similar Limitation(s)
8[pre]	1[pre]
8[a]	1[a]
8[b]	1[c]
8[c]	1[b]
8[d]	1[d]
8[e]	1[e]
8[f]	1[f]

8. Claim 9: “The UE of claim 8, wherein the processor confirms the processor confirms the respective PDCP SNs of the obtained PDCP SDUs and performs in-sequence delivery of the PDCP SDUs to an upper layer from a PDCP entity according to the PDCP SN.”

180. In my opinion, Koskinen discloses the limitations of claim 9.

181. In Koskinen, it discloses claim 9’s additional limitations for the reasons

discussed for claim 2. Claim 9 is substantially similar to claim 2, except that the processor performs functions equivalent to the method steps in claim 2. As explained above for claim 8, the processor executes software to perform the embodiments and functions disclosed in Koskinen. Hence, it would have been understood by a POSITA that the processor in the UE of Koskinen performs the functions of claim 9 for the same reasons Koskinen discloses the limitations of claim 2.

9. Claim 10: “The UE of claim 9, wherein the processor confirms whether there is a PDCP SDU of PDCP SN #n-1 which is missed notwithstanding obtaining a PDCP SDU of PDCP SN #n; and drives the in-sequence timer with respect to the PDCP SDU of PDCP SN #n when there is the PDCP SDU of PDCP SN #n-1 which is missed.”

182. In my opinion, Koskinen discloses the limitations of claim 10.

183. In Koskinen, it discloses claim 10’s additional limitations for the reasons discussed for claim 3. Claim 10 is substantially similar to claim 3, except that the processor performs functions equivalent to the method steps in claim 3. As explained above for claim 8, the processor executes software to perform the embodiments and functions disclosed in Koskinen. Hence, a POSITA would have understood that the processor in the UE of Koskinen performs the functions of claim 10 for the same reasons Koskinen discloses the limitations of claim 3.

10. Claim 11: “The UE of claim 10, wherein the processor delivers, when the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, the PDCP SDU of PDCP SN #n to the upper layer of the PDCP entity even though there is no PDCP SDU of PDCP SN #n-1.”

184. In my opinion, Koskinen discloses the limitations of claim 11.

185. In Koskinen, it discloses claim 11’s additional limitations for the reasons discussed for claim 5. Claim 11 is substantially similar to claim 5, except that the processor performs functions equivalent to the method steps in claim 5. As discussed above for claim 8, the processor executes software to perform the embodiments and functions disclosed in Koskinen. Hence, it would have been understood by a POSITA that the processor in the UE of Koskinen performs the functions of claim 11 for the same reasons Koskinen discloses the limitations of claim 5.

11. Claim 12: “The UE of claim 10, wherein the processor delivers, before the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, when the PDCP SDU of PDCP SN #n-1 is obtained, the PDCP SDU of PDCP SN #n-1 and the PDCP SDU of PDCP SN #n to the upper layer according to the order of the PDCP SN.”

186. In my opinion, for the reasons discussed for claim 4, Koskinen discloses the limitations of claim 12. Claim 12 is substantially similar to claim 4, except that the processor performs functions equivalent to the method steps in claim 4. As discussed above for claim 8, the processor executes software to perform the embodiments and functions disclosed in Koskinen. Hence, it would have been

understood by a POSITA that the processor in the UE of Koskinen performs the functions of claim 12 for the same reasons Koskinen discloses the limitations of claim 4.

B. Ground 2: Claims 1-5 and 8-12 Are Obvious Over Koskinen and Sammour

187. As discussed in Ground 1 for claim element 1[c], Koskinen discloses a PDCP reordering timer used to account for gaps in received PDCP PDUs from multiple RLC layers. Koskinen further discloses that RRC is used to configure the timer. *Id.* And as also discussed in 1[f], a POSITA would have found it obvious that the PDCP configuration IE in the RRC message would have a variable or a field specifying the duration of the reordering timer.

188. The obviousness of the claims and specifically elements 1[e] and 1[f] are further confirmed by the combination of Koskinen and Sammour, which renders obvious the duration of the timer being used as a variable in the PDCP configuration section of the RRC. A POSITA would have been motivated to look to Sammour to implement the timer of Koskinen because Sammour is in the same field as Koskinen. Provided below are additional reasons as to why a POSITA would have been motivated to combine these references.

1. Sammour

189. Sammour (EX1006) is a US patent application publication titled “Method and Apparatus for Supporting Configuration and Control of the RLC and

PDPC Sub-layers,” with a filing date of December 5, 2008 [pub: 6/11/2009]. In my opinion, Sammour (EX1006) is analogous art to the ’573 Patent because it is in the same field. Sammour. Both are directed to addressing similar problems by implementing “support configuration and/or control of the radio link control (RLC) and packet data convergence protocol (PDPC) sub-layers by defining and utilizing radio resource control (RRC) parameters and procedures, and by including information elements (IEs) in RRC messages in both the uplink and downlink for RLC and PDPC configuration.” *Id.*, Abstract. For instance, per Sammour, “[i]n evolved UMTS systems including LTE systems, there is need to define and configure new...PDPC parameters...and/or the procedures and messages that will carry those parameters so that the communication devices in the system, including WTRUs and eNBs, operate properly, and their various functions and sub-layers are controlled and configured properly.” Sammour, ¶14. In that regard, Sammour discloses “a PDPC Flush Timer IE to indicate to the WTRU the value of the flush timer that the WTRU should use to stop reordering for” the particular radio bearer. *Id.*, ¶152

2. Motivation to Combine Koskinen and Sammour

190. A POSITA would have found it obvious and would have been motivated to combine Koskinen with Sammour, and specifically to use Sammour’s PDPC timer operations (e.g., “flush timer”) in Koskinen’s RRC. In Koskinen, it

describes that its PDCP reordering timer's "expiry value can be configured by radio resource control (RRC)." Koskinen, ¶39. Even if it is argued or found that Koskinen's disclosure does not render obvious a "PDCP-configuration IE" that provides the value for Koskinen's PDCP reordering timer, a POSITA would have consulted additional references that provided further information on methods and techniques to deliver the timer information for Koskinen's PDCP timer to the user equipment (UE).

191. Koskinen and Sammour are in the same field of technology and a POSITA would have consulted Sammour, which is particularly directed to providing "new...PDCP parameters" to enable the proper operation of user equipment in "evolved UMTS systems including LTE systems." Sammour, ¶¶14, 20. Evolved packet systems (LTE) and RRC configuration of a UE (e.g., wireless transmit/receive unit [WTRU]) are both disclosed by Sammour and Koskinen. Sammour, ¶¶4, 6-9, 14; Koskinen, ¶¶4-7, 39. Sammour describes an E-UTRAN LTE wireless communication system that includes a WTRU (*i.e.* UE) and an evolved Node B (eNB). Sammour, ¶¶6-8. Sammour's UE/WTRU and base station (eNB) each includes radio resource control (RRC) layer/entity(s) where the "RRC sublayer..., part of layer 3, handles the control signaling of layer 3 between the WTRU and the eNB." Sammour, ¶7. And, Koskinen also discloses a E-UTRAN system supporting eNBs and UE where a UE parameter (e.g., timer expiry value) can be configured

using RRC. ¶¶4-9, 39, 48

192. Like Koskinen, Sammour utilizes RRC to configure a PDCP timer for reordering at the UE (WRTU) including the value for the PDCP timer. Sammour, ¶¶148-153; Koskinen, ¶39. Sammour discloses a PDCP “Reordering Stop Mode IE,” included in an RRC message, that is used by the eNB to indicate to the UE and the UE’s PDCP entity “whether it should use the timer mechanism (e.g. Flush Timer) to stop reordering following handover, or whether it should use stop reordering after all stored PDCP SDUs have been delivered to upper layers.” Sammour, ¶¶148-150. Additionally, Sammour discloses a PDCP “Flush Timer IE,” also included in an RRC message, that is used by the eNB to indicate to the UE (WTRU) “the value of the flush timer that the WTRU should use to stop reordering.” Sammour, ¶¶151-153. Sammour’s PDCP flush timer is quite similar to Koskinen’s PDCP reordering timer as they are both used to stop reordering at the PDCP layer and their expiry values are both configured via RRC. Sammour, ¶¶151-153; Koskinen, ¶¶36-39. A POSITA would have recognized the similarities between Sammour’s PDCP “flush timer” and Koskinen’s PDCP reordering timer and would have been motivated to combine the teachings of Sammour and Koskinen and would have found it obvious to also use a PDCP configuration IE in an RRC message, just like Sammour, to deliver Koskinen’s timer information to the UE. Accordingly, a POSITA would have been guided by Sammour’s explanation that RRC information elements (IEs) were used

to provide PDCP configuration information to similarly provide PDCP timer information of Koskinen through a PDCP configuration IE delivered via a RRC message.

193. Also, a POSITA would have been motivated to combine the teachings of Sammour and Koskinen because the combination would have provided a way to reliably provide Koskinen's timer information to the UE using nothing more than known and conventional methods that would lead to predictable results. According to Koskinen, it had been already well known (e.g., via 3GPP TS 36.322) to use a reordering timer at the RLC layer such as "t-Reordering" that "is a timer that is used by the receiving side of an AM RLC entity and receiving UM RLC entity in order to detect loss of RLC PDUs " and deliver stored and undelivered RLC SDUs to the "upper layer in ascending order of the RLC SN" upon expiry of the timer. Koskinen ¶¶16-17. And Koskinen teaches that the reordering timer that had been known and used at the RLC layer can also be implemented/"repurposed" at the PDCP layer in a similar way. Koskinen ¶¶37-39. And Sammour discloses that it had been previously known that "[t]he RRC sublayer provides PDCP and RLC configuration parameters...as part of the radio resource configuration for configuration of the PDCP and RLC in the receiving entity (WTRU or eNB) by the transmitting entity (eNB or WTRU)." Sammour, ¶13. Sammour also discloses in Table 1 of Sammour "a **conventional** radio resource configuration including PDCP and RLC

configuration parameters.” Sammour, ¶14. And Sammour also provides for supporting configuration and control of the PDCP at the UE using RRC parameters via for example its PDCP “Reordering Stop Mode IE” and PDCP “Flush Timer” IE discussed above. Sammour, ¶¶15. 148-153. Hence, the combination of Koskinen and Sammour would have provided known and reliable conventional methods and techniques such as the reordering timer and using a RRC message to deliver PDCP configuration parameters to the UE.

194. Accordingly, a POSITA would have also been motivated to combine the teachings of Sammour and Koskinen because it would have been obvious that this combination would have provided a reliable and established way to provide Koskinen’s timer information to the UE using nothing more than known and conventional methods (using the PDCP configuration IE delivered via the RRC message to set parameters in a UE) to yield predictable results (setting parameters to set timers in the UE) as described in Koskinen and Sammour. Koskinen, ¶¶14-17, 37-39; Sammour, ¶¶14-15.

195. A POSITA would have also reasonably expected to have been successful in using the enhanced RRC information elements (IEs) of Sammour for controlling the start and expiry of the PDCP reordering timer of Koskinen, as Sammour showed that using such a technique of adding information elements (IEs) to an RRC [e.g., adding its PDCP Flush Timer IE to a RRC message] was well within

the capabilities of someone skilled in the art. Sammour, ¶¶151-153. Moreover, as discussed above, sending a value for the reordering timer to a UE would have been a merely routine application of known, conventional configuration of a UE, in an evolved packet system. Applying Sammour's disclosures to Koskinen would have been merely applying Sammour's known technique expanding the RRC message to include new information elements (IEs) to enhance Koskinen's gap detection and PDCP SDU forwarding system and methods in a similar way.

3. Independent Claims 1 and 8

196. In my opinion, the combination of Koskinen and Sammour renders obvious 1[e] (*"the RRC message includes a PDCP-configuration information element (IE)"*) and/or 1[[f] (*"the PDCP-configuration IE includes a field indicating a value of the in-sequence timer"*).

197. Koskinen describes that its PDCP reordering timer is configured using RRC. Koskinen, ¶39. Koskinen further describes that activation of the timer is also controlled by RRC. *Id.*, ¶42.

198. Sammour describes similar evolved UTRANs communicating with UEs. Sammour, ¶4. In Sammour, the UE is equivalent to a WTRU (wireless transmit/receive unit) and is referred to as WTRU throughout Sammour. Sammour, ¶¶4, 20. Sammour further describes a need to expand the RRC with respect to the PDCP to properly control and configure the functions of the UE. *Id.*, ¶14. Sammour

describes that “[i]nformation elements (IEs) are introduced herein for some of the features and functions of PDCP, and/or certain procedures that will make use of those IEs.” Sammour, ¶21. These IEs are transmitted in a downlink RRC message to the user equipment (UE). *Id.*, ¶23. In that regard, Sammour discloses PDCP IEs that “can be applied on a per-Radio Bearer basis.” *Id.*, ¶141.

199. For example, Sammour discloses the “Reordering Stop Mode IE.” *Id.*, 148. Just as with the activation of the reordering timer in Koskinen (Koskinen, ¶42), Sammour describes that “[t]he eNB uses a PDCP Reordering Stop Mode IE to indicate to the WTRU that the WTRU PDCP entity whether it should use the timer mechanism (e.g. Flush Timer) to stop reordering following handover, or whether it should use stop reordering after all stored PDCP SDUs have been delivered to upper layers” (Sammour, ¶149). Additionally, Sammour discloses a “Flush timer IE...to indicate to the WTRU the value of the flush timer that the WTRU should use to stop reordering for this RB.” Sammour, ¶152. Hence, Sammour discloses a timer duration to be used for reordering in the PDCP.

200. Per the reasons that I discussed earlier, a POSITA would have found it obvious and would have been motivated to incorporate Sammour’s PDCP timer activation and duration in Koskinen so that “WTRUs and eNBs, operate properly, and their various functions and sub-layers are controlled and configured properly.” Sammour, ¶14.

201. Hence, it is my opinion that the combination of Koskinen and Sammour renders limitations 1[e] and 1[f], and the entire claim 1, obvious.

4. Dependent Claims 2-5, 8-12

202. Regarding dependent claims 2-5 and 9-12, in my opinion the combination of Koskinen and Sammour discloses these dependent claims for the reasons discussed above.

C. Ground 3: Obvious Over Deenoo and Sammour

1. Deenoo

203. Deenoo (EX1007) is a US patent application publication titled “Packet Data Convergence Protocol (PDCP) Placement,” with a filing date of January 17, 2013 [pub: 7/21/2016]. In my opinion, Deenoo (EX1007) is analogous art to the ’573 Patent because it is in the same field and directed to addressing similar problems, including “Small Cell Enhancements such as PDCP Placement and impact on control and data plane procedures.” *Id.*, Abstract. Also, Deenoo describes “[s]mall-cell enhancements such as they relate to dual-connectivity scenarios.” Deenoo, Abstract. In Deenoo, these enhancements are applied to many communications systems, including “Evolved UMTS Terrestrial Radio Access (E-UTRA).” *Id.*, ¶43. Just as with the ’573 Patent, Deenoo describes that the PDCP may be in the macro cell and may also be terminated there in some embodiments. *Id.*, ¶104; ’573Pat., 10:4-12. Additionally, just as with the ’573 Patent, Deenoo considers single radio

bearer and multiple radio bearer [e.g., split bearer] models (corresponding to the '573 Patent's single-flow and multi-flows). Deenoo, ¶105; ¶573Pat., 10:13-15, Figs. 10-11.

204. In Deenoo, it describes that for a single DRB “split between a macro and a small cell...a PDCP in a macro can have two underlying corresponding RLC protocol set entities, one set in macro and/or another set in the small cell.” Deenoo, ¶114, Figs. 4-5. [The split bearer concept is the core of multi-flow operations.] For this type of system, Deenoo describes “one or more aspects of reconfiguration of traffic from one small cell node to another small cell node.” *Id.*, ¶115. This can include “PDCP re-ordering, and/or security for reconfiguration of small cells.” *Id.*, ¶116. Deenoo describes the macro cell can reconfigure the UE using RRC, in the case of a macro cell with the PDCP and small cells sharing the single DRB,. *Id.*, ¶¶143, 151-153.

205. Particularly, for reordering in the PDCP, Deenoo describes the WTRU (e.g., UE) “may be configured to start a timer...upon determining that the first packet may be an out-of-sequence packet.” Deenoo, ¶14. The UE may then wait for the missing packet while the timer is running or flush the PDCP data to a higher layer if the timer expires. Deenoo, ¶¶14, 208-211, Fig. 8. [In Deenoo, it is explained that the UE may also be referred to as a WTRU (wireless transmit/receive unit). Deenoo, ¶78.]

2. Motivation to Combine Deenoo and Sammour

206. A POSITA would have found it obvious and would have been motivated to combine Deenoo and Sammour, to specifically include Sammour's "flush timer" configuration in Deenoo's RRC. For the single DRB case, Deenoo describes the UE may "receive one or more reordering procedures." Deenoo, ¶123. Also, Deenoo describes using an RRC message to configure a WTRU (e.g., user equipment), where the "the Macro eNB may configure the measurement parameters/events/triggers for the UE in an RRC CONNECTED mode." *Id.*, ¶¶12, 143, 173, 198. For example, when a small cell is added, an RRC reconfiguration message "may include a timing advance to be applied to the small cell, radio bearer configuration for the small cell, offset to the sub frame containing resource allocation, and/or a response window." Deenoo, ¶251. The "[m]acro can also provide the propagation delay estimated by the small cell to the UE." *Id.*, ¶248. Furthermore, in Deenoo, it describes to "start the PDCP re-ordering timer as soon as out of sequence PDCP Data PDU" is detected. *Id.*, ¶208. Even though this is obvious, Deenoo does not explicitly disclose how the expiration time for the reordering timer is delivered to the UE, as discussed below in connection with claim 1 limitations.

207. As mentioned above, Deenoo discloses the timer operations in the PDCP reordering process. Deenoo, ¶¶208-210. Deenoo further discloses that "[t]he Macro may also send an RRC Connection reconfiguration to the UE with macro

and/or the small cell configuration.” Deenoo, ¶153; Fig. 6. Figure 6 explicitly shows that RRC Connection Reconfiguration messages can include bearer configurations. Given the well-established principle in the LTE standard that a PDCP configuration information element is a component of a bearer configuration, a POSITA would naturally recognize that all necessary PDCP information, including reordering timer settings, is conveyed to the UE via the RRC message. However as Deenoo's disclosure lacks explicit detail, a POSITA would have consulted other references to determine the specifics of how reordering timer information is transmitted to the UE for further information on how to implement Deenoo's timer.

208. Deenoo and Sammour are in the same field of technology and a POSITA would have consulted Sammour, which is particularly directed to providing “new...PDCP parameters” to enable the proper operation of user equipment in “evolved UMTS systems including LTE systems.” Sammour, ¶¶14, 20; Deenoo, ¶43. Evolved packet systems (LTE) and RRC configuration of a UE (e.g., wireless transmit/receive unit [WTRU]) are both disclosed by Sammour and Deenoo. Sammour, ¶¶4, 6-9, 14; Deenoo, ¶¶43-45, 173, 198. As mentioned above, Sammour describes an E-UTRAN LTE wireless communication system that includes a WTRU (*i.e.* UE) and an evolved Node B (eNB). Sammour, ¶6-8. Sammour's UE/WTRU and base station (eNB) each includes radio resource control (RRC) layer/entity(s) where the “RRC sublayer..., part of layer 3, handles the control signaling of layer 3

between the WTRU and the eNB.” Sammour, ¶7. And, Deenoo also describes an Evolved UMTS Terrestrial Radio Access (E-UTRA) LTE and/or LTE-Advanced system with a base station and WTRUs (UEs) where a configuration can be sent to a UE using RRC. Deenoo ¶¶43, 149, 153, FIG. 1D.

209. As mentioned above, Sammour utilizes RRC message(s) to configure a PDCP timer for reordering at the UE (WTRU) including the value for the timer. Sammour, ¶¶148-153. Sammour discloses a PDCP “Reordering Stop Mode IE,” included in an RRC message, that is used by the eNB to indicate to the UE and the UE’s PDCP entity “whether it should use the timer mechanism (e.g. Flush Timer) to stop reordering following handover, or whether it should use stop reordering after all stored PDCP SDUs have been delivered to upper layers.” Sammour, ¶¶148-150. Additionally, Sammour discloses a PDCP “Flush Timer IE,” also included in an RRC message, that is used by the eNB to indicate to the UE (WTRU) “the value of the flush timer that the WTRU should use to stop reordering.” Sammour, ¶¶151-153. Sammour’s PDCP “flush timer” is quite similar to the PDCP re-ordering timer of Deenoo as both are used at the PDCP layer and used to stop reordering at the PDCP layer when the timer expires. Sammour, ¶¶151-153; Deenoo, ¶¶14, 207-210. A POSITA would have recognized the similarities between Sammour’s PDCP “flush timer” and Deenoo’s PDCP re-ordering timer and would have been motivated to combine the teachings of Sammour and Deenoo, and would have found it obvious

to also use a PDCP configuration IE in an RRC message, just like in Sammour, to deliver the PDCP timer information (including a timer expiry value) for Deenoo's PDCP re-ordering timer to the UE.

210. A POSITA would have also been motivated to combine the teachings of Sammour's new PDCP reordering IEs with Deenoo to configure Deenoo's reordering timer in a reliable manner especially when small cells are present with the macro cell and with both the small cell and macro cell sending data to the UE, in a dual-connectivity configuration. Deenoo, ¶¶89-90. Moreover, Sammour and Deenoo share applicants, content, and field of use. That is, both Deenoo and Sammour share the same assignee for their patent applications, InterDigital Patent Holdings. (EX1006; EX1007); and, both pertain to E-UTRA[N] LTE systems and PDCP layer operations. Moreover, they also both seek to enhance LTE system functionality regarding configuration of the PDCP layer in dual-connectivity, such as through the implementation of a reordering timer to address missing and/or delayed PDCP PDUs. Deenoo, Abstract, ¶¶89-90, 207-210; Sammour, Abstract, ¶¶14, 21, 150-153. Thus, it would have been understood by a POSITA that Deenoo and Sammour were combinable and would have been motivated to combine them.

211. A POSITA would have also been motivated to combine Deenoo and Sammour because the combination would have required nothing more than the application of known, conventional techniques (using RRC information elements to

configure a UE) to yield predictable results (configuring the UE) as described in Deenoo and Sammour. Deenoo, ¶198; Sammour, ¶¶14-15. For instance, as discussed above, Sammour discloses that it had been previously known that RRC is used to provide PDCP and RLC configurations to a receiving entity such as a WTRU (UE). Sammour, ¶13. Sammour also discloses a table showing “a **conventional** radio resource configuration including PDCP and RLC configuration parameters.” Sammour, ¶14, Table 1. Additionally, Deenoo also teaches that a configuration can be sent to a UE using RRC. Deenoo, ¶¶149, 153, 198.

212. A POSITA would have also reasonably expected to have been successful in using the enhanced RRC information elements (IEs) of Sammour for controlling the start and expiry of the PDCP reordering timer for Deenoo, as Sammour showed that using such a technique of adding information elements (IEs) to an RRC [e.g., adding its PDCP Flush Timer IE to a RRC message] was well within the capabilities of someone skilled in the art. Sammour, ¶¶151-153. Moreover, sending a value for the reordering timer to a UE would have been a merely routine application of known, conventional configuration of a UE in an evolved packet system, as discussed above. Applying Sammour’s disclosures to Deenoo would have been merely applying Sammour’s known technique of expanding the RRC message to include new information elements (IEs) to enhance Deenoo’s gap detection and PDCP SDU forwarding system and methods in a similar way.

3. Independent Claim 1

- a. Claim 1[pre]: “A method for user equipment receiving multi-flow data with respect to one evolved packet system (EPS) bearer through a macro base station (macro eNB) and a small base station (small eNB) serving a single cell in a wireless communication system supporting dual connectivity, the method comprising:”**

213. To the extent the preamble is considered limiting, in my opinion, Deenoo discloses or suggests the preamble.

214. For instance, Deenoo “contemplate[s] Small Cell Enhancements such as PDCP Placement and impact on control and data plane procedures.” Deenoo, Abstract. In Deenoo, it describes “[d]ifferent RAN, protocol stack and radio bearer (RB) architectures,” including “a small-cell that may be capable of supporting RLC modes.” *Id.* The RAN of Deenoo includes “a macro enhanced Node-B (MeNB) device and a small cell enhanced Node-B (SCeNB) device.” *Id.*, ¶16. In Deenoo, it describes that base stations in the RAN “may implement a radio technology such as Evolved UMTS Terrestrial Radio Access (E-UTRA), which may establish the air interface 115/116/117 using Long Term Evolution (LTE) and/or LTE-Advanced (LTE-A).” *Id.*, ¶43, Figs. 1A (“a system diagram of an example communications system in which one or more disclosed embodiments may be implemented”), C-E. Deenoo further describes that the small cells may use the same spectrum as macro cells, and that the small cells may be low power devices, such as Pico or Femto eNBs. *Id.*, ¶80. As depicted in Figures 1C through 1E, the system of Deenoo includes a

“RAN” connected to a “Core Network,” with the RANs including base stations and the Core Networks with gateways and MME. *Id.*, ¶¶58-78. In Deenoo, it describes that each of these examples “may be used within the communications system illustrated in FIG. 1A.” Deenoo, ¶¶21-23. In such as system, data is transmitted to user equipment from the Core Network through the base stations. A POSITA would have understood the combination of the base stations and gateways/MME as an “evolved packet system bearer” because it provides a logical connection between the user equipment and the gateways, facilitating data traffic transport. see ’573Pat., 4:30-60 (“E-UTRAN and the EPC 30 [including S-/P-GW and MME] are integrated to be called an evolved packet system (EPS)”).

215. Regarding the transmission of data packets, Deenoo “contemplate[s] PDCP in a macro cell” with “RLC, MAC and/or PHY in small cell.” *Id.*, ¶104. Additionally, embodiments of Deenoo consider at least two alternatives, single RB model or separate RB model, “where the “single DRB may be split between a macro and a small cell.” *Id.*, ¶¶105, 114. Deenoo also describes that the “PDCP in a macro can have two underlying corresponding RLC protocol set entities, one set in macro and/or another set in the small cell.” *Id.*, ¶114, Figs. 4, 4A, 5. A POSITA would have understood that such a single DRB model with the PDCP in the macro cell with RLC entities in the macro and small cells would have included a single cell of the E-UTRA. A POSITA would have also understood that a single DRB split between a

macro and small cell with separate radio bearers (RB) is consistent with “*multi-flow*” as described by the ’573 Patent. ’573Pat., 9:65-67 (“in the case where one EPS bearer provides the service to the UE through two or more RBs, it regarded that the multi-flows are configured”).

216. Hence, Deenoo discloses an E-UTRA comprising a Core Network, RAN, and wireless transmit/receive units (WTRUs), where “a user equipment (UE) may also be referred to as a wireless transmit/receive unit (WTRU).” Deenoo, ¶¶38, 78. Data is transmitted to a UE through a bearer between the Core Network and the UE (“*one evolved packet system (EPS) bearer*”), the bearer between the Core Network and the UE comprising a DRB radio bearer which is split between a macro eNB (“*through a macro base station (macro eNB)*”) and a small cell (SCeNB) (“*and a small base station (small eNB) serving a single cell in a wireless communication system supporting dual connectivity*”). Deenoo, ¶¶38, 78.

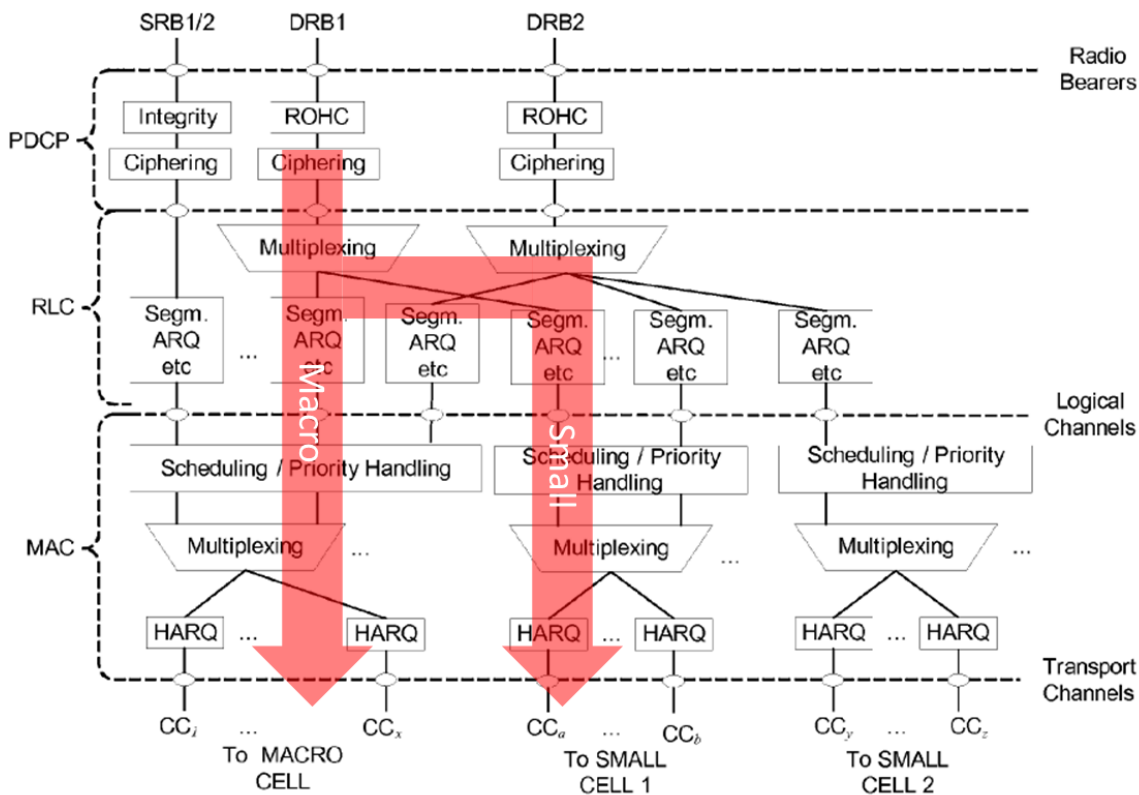
217. Deenoo also describes that “[e]mbodiments contemplate a usefulness for dual connectivity, where UE (or WTRU) may be connected to both the macro and the small-cell layer simultaneously.” Deenoo, ¶84. That is, “dual-connectivity may be also meant to cover scenarios where the user equipment ((UE) or wireless transmit/receive unit (WTRU)) may be connected to the macro-layer and one or more small-cells simultaneously (e.g. UE might be actively receiving data from the cells it may be connected to).” *Id.*, ¶90.

218. Moreover, in the '573 Patent, it was admitted that each element of the preamble was well-known to a POSITA at the time of priority date of the '573 Patent. '573Pat., 1:29-2:6. I discussed this earlier in connection with claim 1. Accordingly, it is my opinion that Deenoo alone or in view of applicant admitted prior art (AAPA) discloses a UE simultaneously receiving data from the macro and small eNB of the E-UTRA (*“user equipment receiving multi-flow data”*) and that the *“system support[s] dual connectivity.”*

b. Claim 1[a]: “receiving packet data convergence protocol (PDCP) packet data units (PDUs) through the macro base station and the small base station;”

219. In my opinion, Deenoo discloses or suggests this limitation.

220. In the '573 Patent, it was admitted that each element of 1[a] was well-known to a POSITA at the time of priority date of the '573 Patent. '573Pat., 2:7-18. Moreover, as discussed above, the PDCP may be in the macro cell with underlying RLC entities in both the macro and small cell. Deenoo, ¶¶104, 114. A POSITA would have understood the PDCP data (PDUs) is transmitted to the UE through the radio bearers of the macro and small cells because the PDCP is in the macro cell, which sends the downlink data to the RLCs in both the macro and small cells. Deenoo, ¶¶205-212. In Figure 5 of Deenoo below, Deenoo shows the PDCP packets transmitted to the UE through the macro and small cells.

**FIG. 5**

Deenoo, Fig. 5

221. Accordingly, it is my opinion that Deenoo discloses or suggests this limitation.

c. Claim 1[b]: “obtaining PDCP service data units (SDUs) corresponding to the PDCP PDUs; and”

222. In my opinion, Deenoo discloses or suggests this limitation.

223. Deenoo discloses PDCP Placement in an E-UTRA and transmission of PDCP packets to a UE, as discussed above. Deenoo, Abstract, ¶43. Deenoo further discloses that its system is based on the 3GPP specifications. Deenoo, ¶¶80, 112,

122, 164, 202. And Deenoo describes that the UE may receive “out of order PDCP SDUs” during handover (Deenoo, ¶122), but regardless PDCP data is delivered to higher layers of the UE (*Id.*, ¶¶208-210).

224. The 3GPP TS 36.323 describes the “Packet Data Convergence Protocol (PDCP) specification” and 3GPP TS 36.300 provides the overall description of an E-UTRA. EX1011; EX1012. 3GPP TS 36.300 specifies that a PDCP PDU includes a PDCP header and a PDCP SDU. EX1012, §6.3.2. And 3GPP TS 36.323 specifies that a PDCP PDU in the user plane includes a PDCP SDU sequence number (SN) and a compressed or uncompressed PDCP SDU. EX1011, §6.1. Hence, a POSITA with knowledge of the E-UTRAN structure and protocols would have understood that a PDCP SDU is obtained by stripping the header from a PDCP PDU. The portion of the PDCP PDU delivered to the higher layers is the PDCP SDU. Koskinen, ¶¶8, 12, 45.

225. Moreover, in the '573 Patent, it was admitted that each element of 1[b] was well-known to a POSITA at the time of priority date of the '573 Patent. '573Pat., 2:8-18. I have previously explained this in the Koskinen ground. Accordingly, a POSITA would have understood that the UE of Deenoo “*obtain[s] PDCP service data units (SDUs) corresponding to the PDCP PDUs*” because Deenoo’s UE receives PDCP PDUs and delivers PDCP data to higher layers.

d. Claim 1[c]: “receiving from the macro base station information related to an in-sequence timer for the PDCP SDUs through a radio resource control (RRC) message,”

226. In my opinion, Deenoo discloses or suggests this limitation.

227. In Deenoo, it describes that the macro cell may “send an RRC Connection reconfiguration to the UE with macro and/or the small cell configuration.” Deenoo, ¶153. Additionally, the “[m]acro eNB may configure the measurement parameters/events/triggers for the UE in an RRC CONNECTED mode.” Deenoo, ¶¶143, 173, 198. Hence, Deenoo discloses the macro eNB configuring the UE through RRC, where the UE receives the RRC message (“*receiving from the macro base station...a radio resource control (RRC) message*”).

228. Additionally, Deenoo discloses a “re-ordering algorithm” in the PDCP of the UE utilizing a reordering timer. Deenoo, ¶¶205-212. A POSITA would have found it obvious that the RRC message to the UE in RRC CONNECTED mode would be used to set the duration of the reordering timer because the RRC message “configure[s] the measurement parameters/events/triggers for the UE.” Deenoo, ¶153. Accordingly, the RRC message would have contained “*information related to an in-sequence timer for the PDCP SDUs.*”

229. Thus, while Deenoo does render obvious “*information related to an in-sequence timer for the PDCP SDUs through a radio resource control (RRC)*”

message,” Sammour further confirms that this operation was known and explicitly discloses this limitation.

230. Just as with Deenoo, Sammour discloses E-UTRANs communicating with UEs. Sammour, ¶4. [Like Deenoo, Sammour also discloses that a UE is equivalent to a wireless transmit/receive unit (WTRU) and is referred to as such throughout Sammour. Sammour, ¶¶4, 20.] Sammour further identifies the need to expand the RRC message with respect to the PDCP to properly control and configure new functions of the UE. Sammour, ¶14. Sammour, as discussed in Ground 2, describes introducing new information elements for the PDCP, as well as making use of the new IEs, and transmitting them in downlink RRC message. Sammour, ¶¶21, 23, 141.

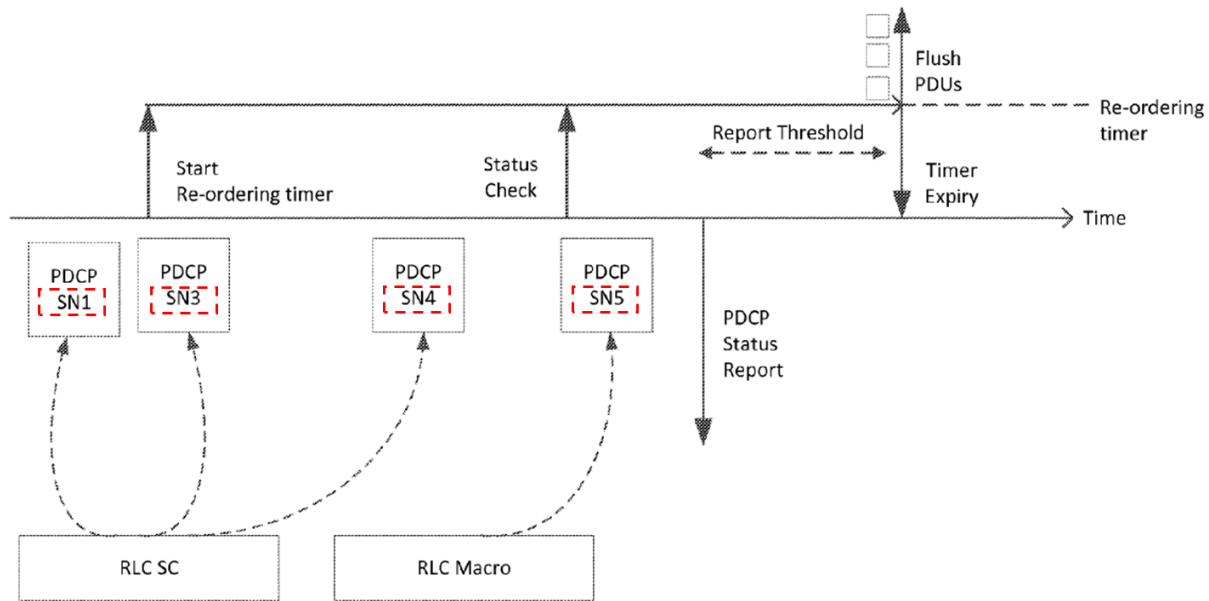
231. Sammour, for example, discloses a “Reordering Stop Mode IE” in the PDCP. *Id.*, ¶148. Sammour describes that “[t]he eNB uses a PDCP Reordering Stop Mode IE to indicate to the WTRU that the WTRU PDCP entity whether it should use the timer mechanism (e.g. Flush Timer) to stop reordering following handover, or whether it should use stop reordering after all stored PDCP SDUs have been delivered to upper layers.” Sammour, ¶149. Also, Sammour discloses a “Flush timer IE...to indicate to the WTRU the value of the flush timer that the WTRU should use to stop reordering for this RB.” Sammour, ¶151-153. Hence, Sammour discloses a timer duration to be utilized for reordering in the PDCP. Deenoo, as discussed above,

utilizes a timer to determine when to stop waiting for missing PDCP packets and flush the received packets to a higher layer. Deenoo, ¶¶14, 208-211, Fig. 8. A POSITA would have recognized that Deenoo's timer (e.g., reordering timer) and Sammour's "flush timer" operated in the same way and for the same purpose and, thus, would have been motivated to incorporate Sammour's RRC configuration of the timer into Deenoo. Per the reasons discussed in section 2 above, a POSITA would have been motivated to incorporate Sammour's PDCP timer activation and duration in Deenoo so "WTRUs and eNBs, operate properly, and their various functions and sub-layers are controlled and configured properly." Sammour, ¶14. Hence, the combination of Deenoo and Sammour discloses the claimed "*information related to an in-sequence timer for the PDCP SDUs through a radio resource control (RRC) message.*"

e. Claim 1[d]: "wherein the PDCP SDUs are indicated by a predefined PDCP sequence number (SN),"

232. In my opinion, Deenoo discloses or suggests this limitation.

233. In Deenoo, it describes that the UE may determine missing PDCP PDU sequence numbers. Deenoo, ¶¶14, 206-211, Fig. 8. Additionally, as shown below in Figure 8, the UE receives unique PDCP SNs from the macro and small cells. *Id.*, Fig. 8. Furthermore, assigning predetermined sequence numbers to downlink PDCP PDUs was general knowledge in the industry and specified by 3GPP. EX1012, pp.53, 67, 100; *see my explanations in Koskinen ground.*



Deenoo, Fig. 8 annotated.

234. Accordingly, a POSITA would have thus understood that the PDCP PDU (and correspondingly SDUs, *see* element 1[b] in Ground 3) are assigned sequence numbers (e.g., in an ascending sequence based on the order of the PDUs), such that the UE can determine when a particular PDU is missing (i.e., missing SN) (“the PDCP SDUs are indicated by a predefined PDCP sequence number (SN)”).

f. Claim 1[e]: “wherein the RRC message includes a PDCP-configuration information element (IE), and”

235. In my opinion, Deenoo discloses this limitation.

236. Deenoo, as discussed above, discloses using an RRC message to configure the UE, including PDCP features. Deenoo, ¶¶143, 173, 198. Additionally, Sammour explicitly discloses configuration of a UE “utilizing radio resource control (RRC) parameters...including information elements (IEs) in RRC messages in both

the uplink and downlink for RLC and PDCP” (Sammour, Abstract) and “Other PDCP IEs” (*id.*, ¶141).

237. Accordingly, it is in my opinion, Deenoo alone and/or the combination of Deenoo and Sammour discloses this limitation.

g. Claim 1[f]: “the PDCP-configuration IE includes a field indicating a value of the in-sequence timer.”

238. In my opinion, Deenoo discloses this limitation.

239. Deenoo discloses, as discussed above (C.2.), an RRC Connection Reconfiguration message includes a PDCP configuration IE, which encompasses the timer setting parameter. A POSITA would reasonably infer and find it obvious that any PDCP configuration parameter would be represented as a distinct field within the IE.

240. As I discussed above for 1[c], a POSITA would have been motivated to modify Deenoo to incorporate Sammour’s new PDCP IEs. In particular, recognizing that Deenoo uses RRC messages to configure a reordering timer of its UE, a POSITA would have incorporated Sammour’s “Reordering Stop Mode IE” and “Flush Timer IE” into Deenoo’s RRC message to properly configure Deenoo’s reordering timer functionality (*see* element 1[c] and §2 in Ground 3).

241. Accordingly, the combination of Deenoo and Sammour discloses a PDCP reordering timer (e.g., “flush timer”) that is configured using an RRC message (“PDCP-configuration IE includes a field indicating a value of the in-sequence

timer”).

4. Claim 2: “The method of claim 1, further comprising: confirming the respective PDCP SNs of the obtained PDCP SDUs and performing in sequence delivery of the PDCP SDUs to an upper layer from a PDCP entity according to the PDCP SN.”

242. In my opinion, Deenoo discloses the limitations of Claim 2.

243. As discussed in Ground 1, delivering sequential PDCP SDUs is an unremarkable and well-known technique, well within the knowledge of a POSITA. That said, Deenoo also discloses this well-known PDCP function “in a case of a PDCP in macro (single DRB).” Deenoo, ¶207. For instance, during handover, where gaps in SNs may be detected, Deenoo describes the “[m]acro eNB may configure the measurement parameters/events/triggers for the UE in an RRC CONNECTED mode.” Deenoo, ¶198. Also, Deenoo discloses following “reordering algorithm” performed at the UE:

	UE PDCP RECEIVER OPERATION:
	[0208] Normal case: re-ordering algorithm:
SN #n-1	0) Receive the PDCP data PDU from lower layers
	1) Let the next in-sequence PDU SN be N.
	2) If it is duplicate or PDU out of re-ordering window. Discard the packet and go to line 0.
Confirm	3) If received PDCP Data PDU SN=N goto line 7.
SN #n	4) If re-ordering timer is not running, start the PDCP re-ordering timer as soon as out of sequence PDCP Data PDU SN>N (from say RLC1/RLC2) is received.
	5) When the re-ordering timer is running, if PDCP Data PDU (from say RLC2/RLC1 respectively) is received with SN>N, then
	[0209] a. If the remaining re-ordering time is greater than threshold, trigger a PDCP status report and wait for in-sequence PDCP PDU with SN=N. goto line 0.
	[0210] b. Stop re-ordering timer and perform same actions as re-ordering timer expiry.
	6) If the re-ordering timer expires goto 7.
Send queued SDUs to higher layer	7) Deliver the queued packets to the higher layer, starting from closest received SN to N in order until the next SN gap and, for example, perhaps if there is any SN gap, start re-ordering timer similar to line 4.
	8) Set N=1+SN of PDCP data PDU last delivered to higher layer in line 7.
	9) Goto line 0.

Deenoo, ¶¶208-210 annotated.

244. Per Deenoo’s “reordering algorithm” above, two sequential PDCP PDUs (#n-1 and #n) are received at the UE (“*confirming the respective PDCP SNs of the obtained PDCP SDUs*”). *Id.*, ¶208. After receiving the packets (i.e., PDCP SDUs), the UE delivers the packets to the higher layer in order based on the SN of the received PDCP PDUs (“*performing in sequence delivery of the PDCP SDUs to an upper layer from a PDCP entity according to the PDCP SN*”). [PDCP PDUs

contain PDCP SDUs and the SDUs are delivered to higher layers, as described above in Ground 1 for limitation 1[b].]

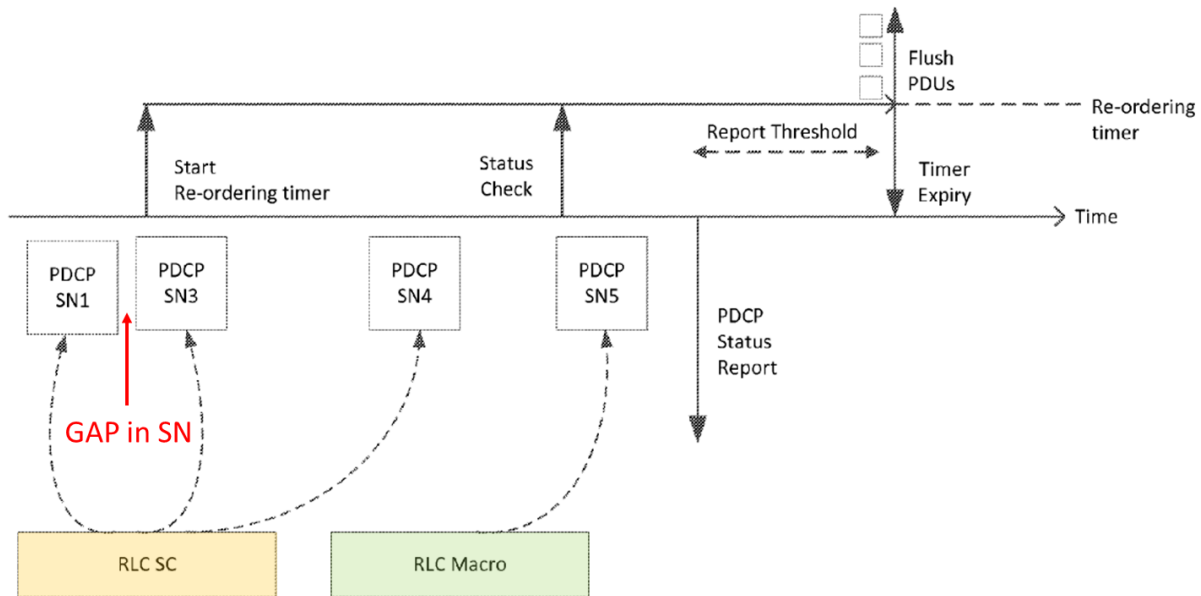
245. Accordingly, it is my opinion that Deenoo discloses the limitations of Claim 2.

5. Claim 3

a. Claim 3[a]: “The method of claim 2, further comprising: confirming whether there is a PDCP SDU of PDCP SN #n−1 which is missed notwithstanding obtaining a PDCP SDU of PDCP SN #n; and”

246. In my opinion, Deenoo discloses this limitation.

247. Per the “reordering algorithm” of Deenoo ¶¶208-210, above, the UE confirms at step 3 if the SN of the next received PDCP PDU (and respective SDU) from either RLC1 or RLC2 is greater than the next expected SN. Deenoo, ¶208; *see* element 1[b] in Ground 3. Hence, a POSITA would have understood that a gap exists in the received PDUs if the next received PDU is #n+1, where PDU #n was missed. In Figure 8 of Deenoo, the gap in PDCP SN reception is depicted. Deenoo, ¶¶211-212, Fig. 8.



Deenoo, Fig. 8 annotated.

248. A POSITA would have understood that the designators # n and # $n-1$ as used in the claim to modify “*PDCP SN*” were merely for convenience and used to distinguish the claimed missing *PDCP SN* from the received *PDCP SN*. A POSITA would have also understood that the designators $SN=N$ and $SN>N$ in Deenoo were also merely convenient labels intended to distinguish between multiple instances of *PDCP SNs*. That is, a POSITA would have recognized that the claimed “*SN # $n-1$* ” could be mapped onto any *PDCP SN*, so long as the *SN* in Deenoo meets all other claim limitations ascribed to or associated with “*SN # $n-1$* ” (and the same with respect to the claimed “*SN # n* ”).

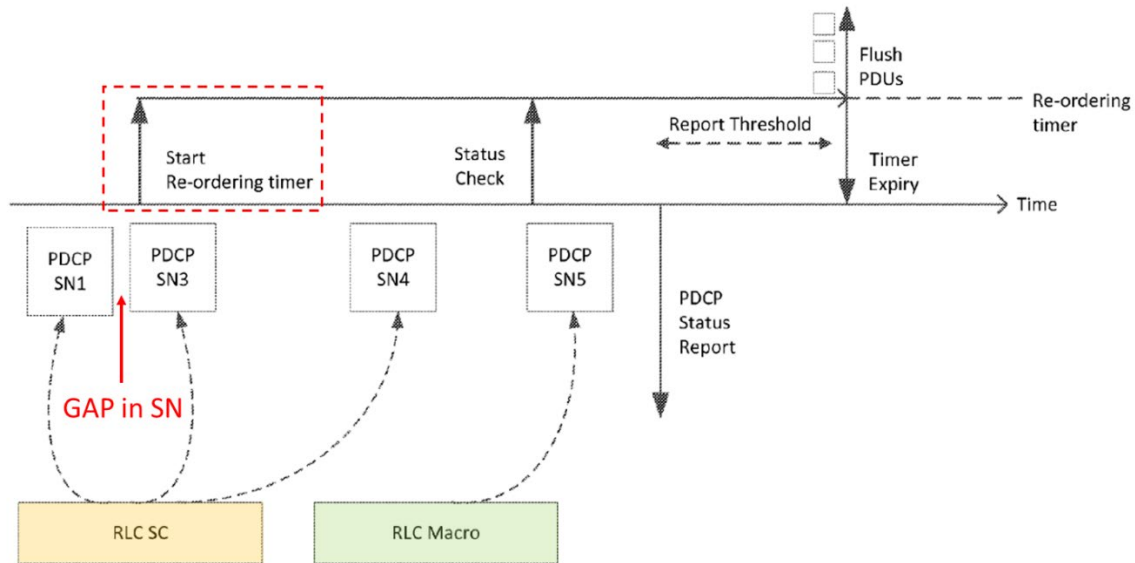
249. Accordingly, it is my opinion that Deenoo discloses confirming a gap of $SN=N$ (“*confirming whether there is a PDCP SDU of PDCP SN # $n-1$ which is*

missed") when the received PDCP is SN>N (*"notwithstanding obtaining a PDCP SDU of PDCP SN #n"*).

b. Claim 3[b]: "driving the in-sequence timer with respect to the PDCP SDU of PDCP SN #n when there is the PDCP SDU of PDCP SN #n-1 which is missed."

250. In my opinion, Deenoo discloses or suggests this limitation.

251. For example, per the "reordering algorithm" of Deenoo ¶¶208-210, Deenoo describes at step 4 that "[i]f re-ordering timer is not running, start the PDCP re-ordering timer as soon as out of sequence PDCP Data PDU...is received." Deenoo, ¶208. In annotated Figure 8 below, starting the timer is represented where the timer is started when PDCP SN3 is received (*"driving the in-sequence timer with respect to the PDCP SDU of PDCP SN #n"*) after receiving SN1 and missing SN2 (*"when there is the PDCP SDU of PDCP SN #n-1 which is missed"*). Deenoo, ¶¶211-212. As described above in Ground 1 for claim 3[b], "driving" a timer is equivalent to starting a timer.



Deenoo, Fig. 8 annotated.

252. Accordingly, it is my opinion that Deenoo discloses or suggests this limitation.

6. Claim 4

- a. **Claim 4[a]: “The method of claim 3, wherein before the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, when the PDCP SDU of PDCP SN #n-1 is obtained,”**

253. In my opinion, Deenoo discloses or suggests this limitation.

254. Per the “reordering algorithm” of Deenoo ¶¶208-210, after receiving $SN > N$, the UE “wait[s] for in-sequence PDCP PDU with $SN = N$ ” and returns to line 0 of the algorithm. Deenoo, ¶209. As explained for claim 2, Deenoo describes at step 3 that $SN = N$ is received (“when the PDCP SDU of PDCP SN #n-1 is obtained”). *Id.*, ¶208. Also, it would have been understood by a POSITA that the timer is still

running when the PDCP PDU SN=N is received (“wherein before the in-sequence timer for the PDCP SDU of PDCP SN #n has expired”) because the step is immediately after checking whether the “remaining re-ordering time is greater than threshold.” *Id.*, ¶209.

255. Accordingly, it is my opinion that Deenoo discloses or suggests this limitation.

b. Claim 4[b]: “the PDCP SDU of PDCP SN #n-1 and the PDCP SDU of PDCP SN #n are delivered to the upper layer according to the order of the PDCP SN.”

256. In my opinion, Deenoo discloses or suggests this limitation.

257. Per the “reordering algorithm” of Deenoo ¶¶208-210 and as explained for Claim 2, the UE delivers the received packets (i.e., PDCP SDUs) to the higher layer in order when PDCP SN=N is received at step 3.

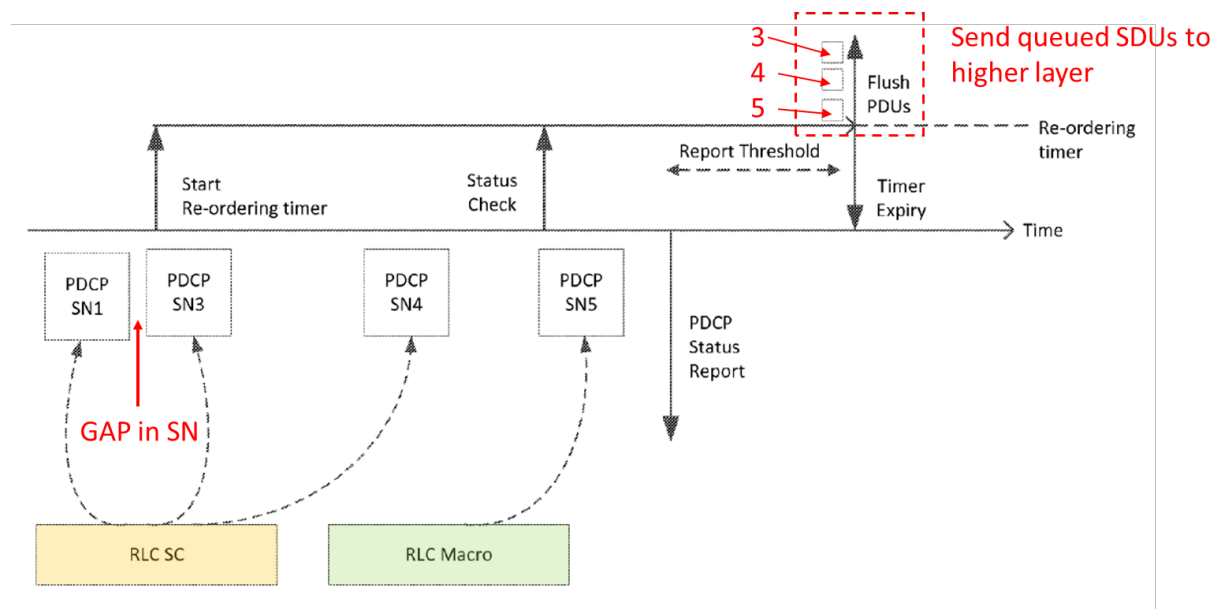
258. Accordingly, it is my opinion that Deenoo discloses or suggests this limitation.

7. Claim 5: “The method of claim 2, wherein when the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, the PDCP SDU of PDCP SN #n is delivered to the upper layer of the PDCP entity even though there is no PDCP SDU of PDCP SN #n-1.”

259. In my opinion, Deenoo discloses or suggests these limitations of claim 5.

260. In Deenoo, it discloses that “[i]f the re-ordering timer

expires...[d]eliver the queued packets to the higher layer.” Deenoo, ¶210. Delivery of the packets “start[s] from closest received SN to N in order until the next SN gap.” *Id.* It would have been understood by a POSITA that the “closest received SN to N” (where N is the claimed “#n-1”) is either the next SN>N, which is the claimed “#n” because the packets are delivered “in order until the next SN gap.” As shown in annotated Figure 8 of Deenoo below, the PDUs (and corresponding SDUs) are flushed to the higher layer when the timer expires. Deenoo, ¶¶211-212.



Deenoo, Fig. 8 annotated.

261. Accordingly, it is my opinion that Deenoo discloses or suggests that when the re-ordering timer that started after the gap was detected expires (“*wherein when the in-sequence timer for the PDCP SDU of PDCP SN #n has expired*”), all of the PDCP SDUs after the gap are delivered to the higher layers, including the SN

immediately after the gap (“*the PDCP SDU of PDCP SN #n is delivered to the upper layer of the PDCP entity even though there is no PDCP SDU of PDCP SN #n-1*”).

8. Independent Claim 8

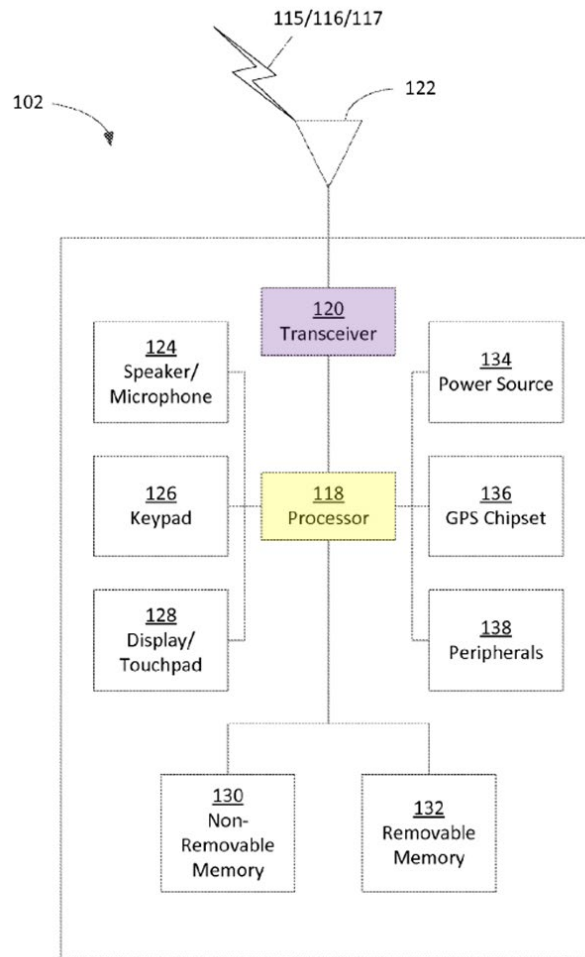
- a. Claim 8[pre]: “A user equipment (UE) for receiving multi-flow data with respect to one evolved packet system (EPS) bearer through a macro base station (macro eNB) and a small base station (small eNB) serving a single cell in a wireless communication system supporting dual connectivity, the UE comprising:”**
- b. Claim 8[a]: “a receiving unit receiving packet data convergence protocol (PDCP) packet data units (PDUs) through the macro base station and the small base station and”**
- c. Claim 8[b]: “receiving from the macro base station information related to in-sequence timer for the PDCP SDUs through a radio resource control (RRC) message; and”**
- d. Claim 8[c]: “a processor obtaining PDCP service data units (SDUs) corresponding to the PDCP PDUs,”**
- e. Claim 8[d]: “wherein the PDCP SDUs are indicated by a predefined PDCP sequence number (SN),”**
- f. Claim 8[e]: “wherein the RRC message includes a PDCP-configuration information element (IE), and”**
- g. Claim 8[f]: “the processor determines the value of in-sequence timer based on the PDCP-configuration IE.”**

262. In my opinion, the combination of Deenoo and Sammour discloses claim 8 for substantially the same reasons as claim 1 because the claims are substantively identical and Deenoo further discloses a user equipment including

receiving unit and processor. Deenoo, ¶49; *compare* claim limitations 1[pre]-1[f] *with* claim limitations 8[pre]-8[f].

263. Claim 8[pre] is substantially similar to claim 1[pre], except it recites a “user equipment” for performing functions instead of a “method.” As discussed above, Deenoo describes that a user equipment performs the recited steps.

264. Additionally, regarding limitation 8[a], the UE of Deenoo is disclosed to include a transceiver, as shown in Figure 1B below. Deenoo, ¶¶49-53, Fig. 1B. “The transceiver 120 may be configured to modulate the signals that are to be transmitted by the transmit/receive element 122 and to demodulate the signals that are received by the transmit/receive element 122.” *Id.*, ¶53. Additionally, Deenoo describes that “the eNode-B 160 a, for example, may use multiple antennas to transmit wireless signals to, and receive wireless signals from, the WTRU 102 a.” *Id.*, ¶65. Hence, it would have been understood by a POSITA that PDCP PDUs and RRC messages are received by the UE through the transceiver. *Id.*, ¶¶143, 208-212.

**FIG. 1B**

Deenoo, Fig. 1B annotated

265. For example, a POSITA would have recognized that Deenoo's Figure 1F below shows signaling (e.g., RRC) and data (e.g., PDCP packets) sent from the macro and small eNB base stations to the UE. Deenoo, Fig. 1F. It would have been understood by a POSITA that the PDCP data packets (e.g., PDUs) and RRC messages used to configure the UE are received over a radio interface by Deenoo's receiver as part of the transceiver. Moreover, 3GPP TS 36.331 expressly specifies

that the Radio Resource Control (RRC) protocol is for the radio interface between UE and E-UTRAN. EX1014, p. 14.

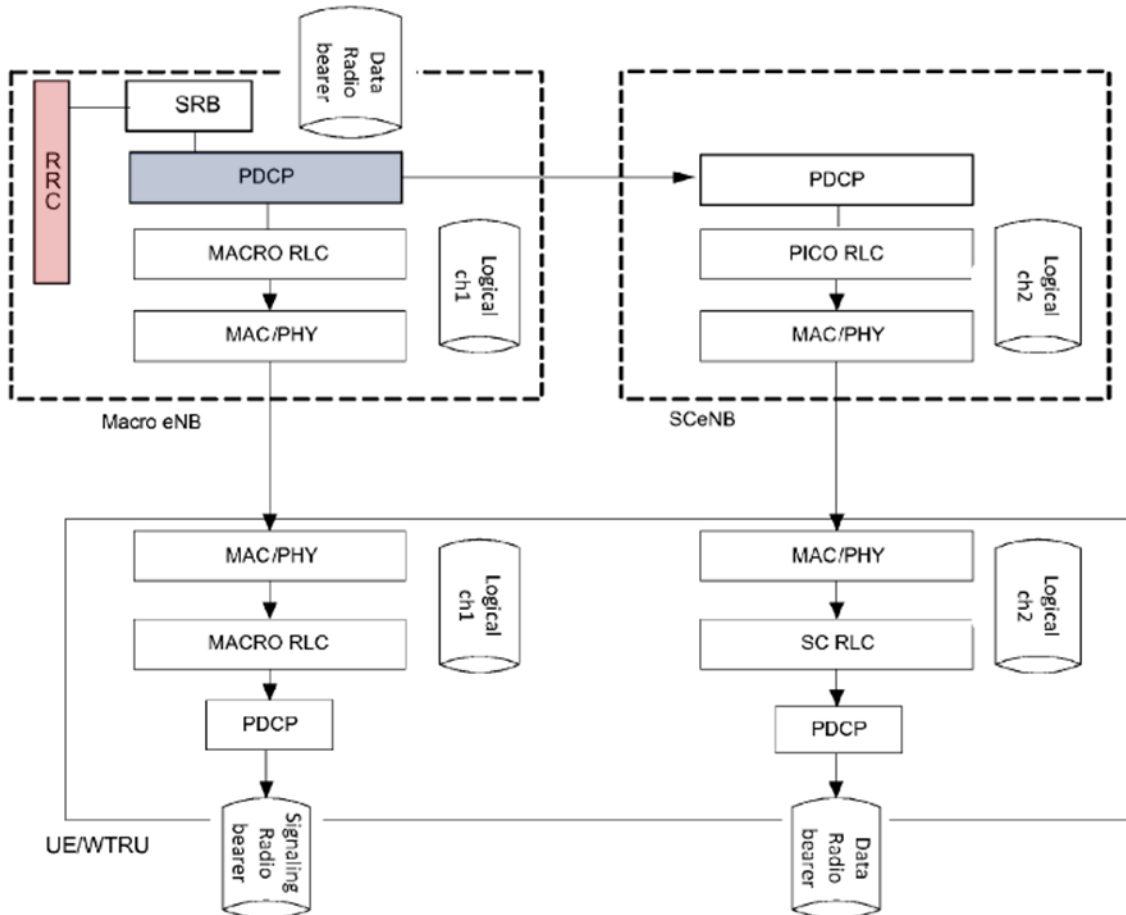


FIG. 1F

Deenoo, Fig. 1F

266. Regarding limitation 8[c] and 8[f], Deenoo discloses that a processor is included in the UE as shown in Figure 1B above. Deenoo, ¶¶49-50, 54-57, Fig. 1B. In Deenoo, it describes that “[t]he processor 118 may perform signal coding, data processing, power control, input/output processing, and/or any other functionality that enables the WTRU 102 to operate in a wireless environment.” *Id.*, ¶50. “The

processor 118 may be coupled to the transceiver 120, which may be coupled to the transmit/receive element 122.” *Id.* Deenoo further discloses that its methods “may be implemented in a computer program, software, or firmware incorporated in a computer-readable medium for execution by a computer or processor.” *Id.*, ¶262. Hence, it would have been understood by a POSITA that the processor processes the data received from the macro and small base stations because the processor executes software for performing those functions.

267. The table below provides a correlation of the reasons why the combination of Deenoo and Sammour discloses the limitations of claim 1 with limitations 8[a]-8[f].

Claim 8	
Limitation	Substantially Similar Limitation(s)
8[pre]	1[pre]
8[a]	1[a]
8[b]	1[c]
8[c]	1[b]
8[d]	1[d]
8[e]	1[e]
8[f]	1[f]

268. Accordingly, it is my opinion that the combination of Deenoo and Sammour discloses all the limitations of claim 8.

9. **Claim 9: “The UE of claim 8, wherein the processor confirms the processor confirms the respective PDCP SNs of the obtained PDCP SDUs and performs in-sequence delivery of the PDCP SDUs to an upper layer from a PDCP entity according to the PDCP SN.”**

269. In my opinion, Deenoo discloses the additional limitations of claim 9 for the reasons discussed for claim 2. Claim 9 is substantially the same as claim 2, except that the processor performs functions equivalent to the method steps in claim 2. As discussed above for claim 8, the processor of Deenoo executes software to perform the embodiments and functions of Deenoo. Hence, it would have been understood by a POSITA that the processor included in the UE (or WTRU) of Deenoo performs the functions of claim 9 for the same reasons Deenoo discloses the limitations of claim 2.

10. **Claim 10: “The UE of claim 9, wherein the processor confirms whether there is a PDCP SDU of PDCP SN #n-1 which is missed notwithstanding obtaining a PDCP SDU of PDCP SN #n; and drives the in-sequence timer with respect to the PDCP SDU of PDCP SN #n when there is the PDCP SDU of PDCP SN #n-1 which is missed.”**

270. In my opinion, Deenoo discloses the additional limitations of claim 10 for the reasons discussed for claim 3. Claim 10 is substantially the same as claim 3, except that the processor performs functions equivalent to the method steps in claim 3. As discussed above for claim 8, the processor of Deenoo executes software to perform the embodiments and functions of Deenoo. Hence, it would have been understood by a POSITA that the processor included in the UE (or WTRU) of

Deenoo performs the functions of claim 10 for the same reasons Deenoo discloses the limitations of claim 3.

11. Claim 11: “The UE of claim 10, wherein the processor delivers, when the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, the PDCP SDU of PDCP SN #n to the upper layer of the PDCP entity even though there is no PDCP SDU of PDCP SN #n-1.”

271. In my opinion, Deenoo discloses the additional limitations of claim 11 for the reasons discussed for claim 5. Claim 11 is substantially the same as claim 5, except that the processor performs functions equivalent to the method steps in claim 5. As discussed above for claim 8, the processor of Deenoo executes software to perform the embodiments and functions of Deenoo. Hence, it would have been understood by a POSITA that the processor included in the UE (or WTRU) of Deenoo performs the functions of claim 11 for the same reasons Deenoo discloses the limitations of claim 5.

12. Claim 12: “The UE of claim 10, wherein the processor delivers, before the in-sequence timer for the PDCP SDU of PDCP SN #n has expired, when the PDCP SDU of PDCP SN #n-1 is obtained, the PDCP SDU of PDCP SN #n-1 and the PDCP SDU of PDCP SN #n to the upper layer according to the order of the PDCP SN.”

272. In my opinion, Deenoo discloses the additional limitations of claim 12 for the reasons discussed for claim 4. Claim 12 is substantially the same as claim 4, except that the processor performs functions equivalent to the method steps in claim 4. As discussed above for claim 8, the processor of Deenoo executes software to

perform the embodiments and functions of Deenoo. Hence, it would have been understood by a POSITA that the processor included in the UE (or WTRU) of Deenoo performs the functions of claim 12 for the same reasons Deenoo discloses the limitations of claim 4.

X. CONCLUSION

273. Based on the foregoing analysis, it is my opinion that the challenged claims of the '573 patent are invalid.

274. This declaration and my opinions herein are made to the best of my knowledge and understanding, and based on the material available to me, at the time of signing this declaration. I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, 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 or Title 18 of the United States Code.

Date: April 23, 2025



Titus Lo