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

APEX BEAM TECHNOLOGIES LLC, Plaintiff, v. ZTE CORPORATION, Defendant.	§ § § § § § § § § § § §	Case No. 2:22-cv-00031-JRG-RSP (LEAD CASE) **JURY TRIAL DEMANDED**
APEX BEAM TECHNOLOGIES LLC, Plaintiff, v. SAMSUNG ELECTRONICS CO., LTD., ET AL., Defendants.	§ § § § § § § § § § § §	Case No. 2:22-cv-00188-JRG (MEMBER CASE) **JURY TRIAL DEMANDED**

DEFENDANTS' INVALIDITY CONTENTIONS

Pursuant to Local Patent Rules 3-3 and 3-4 and the Court's Docket Control Order (Dkt. 32), Defendants Samsung Electronics Co., Ltd. ("SEC") and Samsung Electronics America, Inc. ("SEA") (collectively, "Samsung" or Defendants) provide these Preliminary Invalidity Contentions and accompanying document production to Plaintiff Apex Beam Technologies LLC ("Apex," "ABT," or Plaintiff).

I. Overview

In this action, Plaintiff asserted in its P.R. 3-1 and 3-2 Disclosures of January 5, 2023 ("Infringement Contentions") that Defendants infringe claims 1-5 and 11-15 of U.S. Patent No. 10,462,767 (the "'767 patent"), claims 1-5 and 11-15 of U.S. Patent No. 10,568,113 (the "'113 patent"), claims 1-4 and 9-10 of U.S. Patent No. 10,912,081 (the "'081 patent"), claims 1-5 and 11-15 of U.S. Patent No. 10,944,527 (the "'527 patent"), and claims 1-5 and 11-15 of U.S. Patent No. 10,951,271 (the "'271 patent") (collectively, the "Patents-in-Suit" and the "Asserted Claims").

This Court has not yet construed any of the terms in the Patents-in-Suit. Defendants' Invalidity Contentions are based on Defendants' present understanding of Plaintiff's apparent interpretation of the Asserted Claims, as advanced by Plaintiff in its Complaint and Infringement Contentions, and Defendants' own understanding of the scope of the Asserted Claims. Defendants take no position on any matter of claim construction or interpretation in these contentions. Defendants' contentions herein are not, and should in no way be seen as, admissions about or adoptions of any particular claim scope or construction, or as any admission that any particular element is met in any particular way. Defendants object to any attempt to imply claim constructions from any identification or application of potential prior art. Any statement herein describing or tending to describe any claim element is provided solely for the purpose of understanding the relevant prior art. By including prior art that anticipates or renders obvious claims based on Plaintiff's apparent claim construction, Defendants do not thereby adopt Plaintiff's apparent claim construction.

Moreover, nothing herein should be construed as an admission that Defendants agree with Plaintiff's claim interpretations or that Plaintiff has a plausible basis to allege infringement. Similarly, nothing herein shall be construed as an admission regarding the application of the

Asserted Claims to any of Defendants' accused products. Defendants do not agree with Plaintiff's application of the claims to the accused products, and Defendants deny infringement. Furthermore, these contentions do not represent an agreement with Plaintiff's views as to the meaning, definiteness, written description support for, or enablement of any of the Asserted Claims. In fact, Defendants provide grounds for invalidity under § 112 below. Pursuant to the Court's Docket Control Order (Dkt. 32), Defendants reserve the right to include arguments directed to indefiniteness in their *Markman* briefing. Nothing stated herein shall be construed as a waiver of any argument available under 35 U.S.C. §§ 101, 102, 103, and/or 112. Defendants expressly reserve the right to propose alternative interpretations to those advocated by Plaintiff and to rebut Plaintiff's actual claim interpretation and infringement positions. Defendants reserve the right to modify or supplement these contentions in response to the Court's construction of the claim terms at issue.

Prior art not included in this disclosure may also become relevant. Defendants are currently unaware of the extent, if any, to which Plaintiff may contend that certain limitations of the Asserted Claims are not disclosed in the prior art identified by Defendants. Defendants reserve the right to identify other relevant prior art with respect to such allegedly missing limitation(s).

Defendants' invalidity claim charts attached hereto cite to exemplary portions, teachings, and disclosures of the prior art as applied to limitations of the Asserted Claims. Persons skilled in the art, however, would recognize these as exemplary and may view an item of prior art in the context of other publications, literature, products, and understanding. Again, this is because the cited portions of prior art identified herein are exemplary only. The citations and discussion in the charts are organized by claim (and claim limitation) for convenience, but each limitation or claim section applies to the larger context of each claim, to any related dependent or independent claims,

as well as all claims containing similar limitations or elements in the particularly asserted patent or other related patents also being asserted by Plaintiff. For example, citations as to any recited limitation, step, or component in the claims apply wherever each such limitation, step, or component is repeated elsewhere in the claim of that patent or other related patent also being asserted by Plaintiff. Any and all citations to particular figures in the attached charts or elsewhere in these contentions shall be deemed to wholly incorporate the figure by reference, and include the figure as if it had been inserted into the chart itself, as well as any text discussing the figure. Similarly, where Defendants cite to particular text in a prior art reference concerning a drawing or figure, the citation encompasses that drawing or figure as well as any other associated information in the prior art reference. Defendants may therefore rely on the entirety of the prior art references listed herein, including uncited portions of those prior art references, as well as additional information including products, documents, materials, and expert testimony.

The references cited herein disclose the limitations of the Asserted Claims explicitly or inherently, and/or they may be relied upon to demonstrate how the state of the art in the relevant time frame invalidates each asserted patent claim. In the context of the knowledge of a person of ordinary skill in the art, each reference's disclosure applies in the context of both anticipation and obviousness. Therefore, any suggested single reference obviousness positions and obviousness combinations are provided in the alternative to Defendants' anticipation contentions and are not to be construed to suggest that any reference included in the combinations is somehow deficient or is not by itself anticipatory. Further, the combinations listed herein are exemplary and not exhaustive. There are many possible invalidating combinations of the references listed herein, and it is not practical, at this early stage, to identify and list all potentially relevant combinations without the benefit of further factual investigation and the Court's claim construction.

In addition to the positions and prior art identified below, and the accompanying invalidity claim charts, Defendants also incorporate by reference all invalidity contentions, prior art, and invalidity claim charts (including, without limitation, all anticipation positions, obviousness positions (including all prior art combinations and motivations to combine), indefiniteness positions, written description positions, and enablement positions) that have been or will be disclosed in any other action involving the Patents-in-Suit, including but not limited to any U.S. Patent and Trademark Office (USPTO) proceeding involving the Patents-in-Suit and that have or will be disclosed in any pending USPTO proceeding involving related patents. Such art and positions would have been obvious to combine with the prior art and combinations identified in these Invalidity Contentions. To the extent Plaintiff or the Board puts forth an argument in any USPTO proceedings contrary to the positions in the litigation, Defendants reserve the right to raise and/or address such argument or position in this litigation.

Defendants expect to rely on testimony of one or more expert witnesses and materials referenced by those expert witnesses in support of these contentions and incorporate those forthcoming expert reports as if fully set forth herein. Subsequent expert statements—including deposition and trial testimony, declarations, and reports—related to invalidity, interrogatory responses, and other discovery or pleadings may expand and elaborate upon the positions contained in these Invalidity Contentions as originally prepared or subsequently amended, and Defendants reserve the right to incorporate such by reference. Defendants may further rely on any inventor admissions concerning the scope of the prior art relevant to the Patents-in-Suit found in, *inter alia*: the patent prosecution histories for the Patents-in-Suit and related patents, patent applications, and/or re-examinations; deposition testimony of the named inventor on the Patents-in-Suit; and the papers and any evidence submitted by Plaintiff in these actions.

Discovery has only just begun, and Defendants' investigation into prior art—including third-party prior art, and related evidence, documents, and knowledgeable witnesses—remains ongoing. Moreover, prior art may become relevant depending on the claim interpretations and/or validity positions Plaintiff or its expert witness(es) may assert, Defendants' further understanding of Plaintiff's Infringement Contentions, and any findings as to the priority date of the Asserted Claims. Accordingly, Defendants reserve the right to supplement or modify these Invalidity Contentions based on further discovery and in a manner consistent with the Federal Rules of Civil Procedure and the Court's rules and schedule. To the extent Apex contends that any prior art presented in these contentions does not qualify as prior art to one or more Asserted Patents, the prior art remains relevant as evidence of simultaneous development as a secondary consideration of obviousness. *See George M. Martin Co. v. Alliance Mach. Sys. Int'l LLC,* 618 F.3d 1294, 1305 (Fed. Cir. 2010) ("Independently made, simultaneous inventions, made within a comparatively short space of time, are persuasive evidence that the claimed apparatus was the product only of ordinary mechanical or engineering skill.").

As set forth in detail below, and in the claim charts which accompany these Invalidity Contentions as exhibits A1-A6, B1-B10, C1-C8, D1-D7, and E1-E9, the Asserted Claims of the Patents-in-Suit are invalid over the cited prior art listed below under pre-AIA 35 U.S.C. §§ 102 and/or 103 and their post-AIA counterparts. Regarding the obviousness of certain claims under 35 U.S.C. § 103, one or more of the principles enumerated by the United States Supreme Court in *KSR International Co. v. Teleflex Inc.*, 550 U.S. 398 (2007) apply to the Asserted Claims of the Patents-in-Suit, including, for example:

(a) combining various claimed elements known in the prior art according to known methods to yield a predictable result;

(b) making a simple substitution of one or more known elements for another to obtain a predictable result;

(c) using a known technique to improve a similar device or method in the same way;

(d) applying a known technique, known device or method ready for improvement to yield a predictable result;

(e) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success or, in other words, the solution was one which was "obvious to try;

(f) a known work in one field of endeavor prompting variations of it for use either in the same field or a different based on given design incentives or other market forces in which the variations were predictable to one of ordinary skill in the art; and/or

(g) a teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the art to modify the prior art reference or to combine the teachings of various prior art references to arrive at the claimed invention.

The above criteria may be collectively referred to herein as the "*KSR* Criteria."

Based on these considerations, as further detailed below and/or in the attached exhibits, one of ordinary skill in the art would have combined the teachings of the prior art references discussed and charted in those exhibits. The combinations of these references would have rendered obvious to one of ordinary skill in the art the subject matter of the Asserted Claims. The references identified in the attached exhibits for the respective Asserted Claims are analogous prior art to the subject matter of the Asserted Claims and, for at least the reasons set forth below and/or in the claim chart exhibits, are properly combinable. Because these prior art references exist within a single field of art, particularly one in which individuals in the field often shared and/or collaborated

on their work, it would have been obvious for one of ordinary skill in the art to look from one piece of prior art to another in order to find any missing functionality they desired to implement. Therefore, these references provide interrelated teachings and one of ordinary skill would have looked to the concepts in any of these references when seeking to solve the problems purportedly addressed by the Patents-in-Suit.

Numerous prior art references, including in the attached exhibits, reflect common knowledge and the state of the prior art before the earliest effective priority date of the Patents-in-Suit. As it would be unduly burdensome to create detailed claim charts for all of the invalidating combinations, for at least the reasons described in these Invalidity Contentions, it would have been obvious to one of ordinary skill in the art to combine any of a number of prior art references, including any combination of those identified in the attached exhibits, to meet the limitations of the Asserted Claims. Defendants' inclusion of exemplary combinations, in view of the factors and motivations identified here, does not preclude Defendants from identifying other invalidating combinations and/or motivations as appropriate.

No showing of a specific motivation to combine prior art is required to combine the references disclosed above and in the attached charts, because each combination of art would have no unexpected results, and at most would simply represent a known alternative to one of ordinary skill in the art. *See KSR*, 127 S. Ct. at 1739-40 (rejecting the Federal Circuit's "rigid" application of the teaching, suggestion, or motivation to combine test, instead espousing an "expansive and flexible" approach). That said, the Supreme Court's rationale, that a person of ordinary skill in the art is "a person of ordinary creativity, not an automaton" and "in many cases a person of ordinary skill in the art will be able to fit the teachings of multiple patents together like pieces of a puzzle," applies equally here. *Id.* at 1742.

Additional evidence that there would have been a motivation or reason to combine the prior art references identified herein includes but is not limited to the interrelated teachings of multiple prior art references; the effects of demands known to the design community or present in the marketplace; the existence of a known problem for which there was an obvious solution; the existence of a known need or problem in the field of endeavor at the time of the alleged inventions; and the background knowledge that would have been possessed by one of ordinary skill in the art. For example, the prior art references are generally directed to the same problems. Thus, a skilled artisan seeking to solve these problems would look to these cited references in combination.

Defendants contend there are no secondary considerations of non-obviousness evidencing the validity of any of the Asserted Claims. If Plaintiff presents any alleged evidence of secondary considerations of non-obviousness, Defendants reserve their right to respond to any such alleged evidence. Further, to the extent Plaintiff identifies any product as allegedly practicing the claims and having been successful, there is no nexus between the claimed invention and the products' success and Defendants reserve their right to respond to any such alleged evidence.

II. P.R. 3-3(a): Identification of Prior Art

Pursuant to Patent Rule 3-3 and subject to Defendants' reservations of rights in these Invalidity Contentions, Defendants identify the following prior art that anticipates and/or renders obvious one or more Asserted Claims of the Patents-in-Suit as detailed in the claim chart exhibits and elsewhere in these Invalidity Contentions. Below are tables identifying individual items of prior art. The prior art references, systems, and products listed below and in the accompanying claim chart exhibits may be relied upon for certain limitations, state of the art, and background of the art; as evidence of the level of skill in the art at the time of the filing of the Patents-in-Suit; or in support of assertions that it is proper to combine certain prior art references in certain ways.

Defendants also incorporate by reference each and every prior art reference of record in the prosecution of the Patents-in-Suit and patents or patent applications related to the Patents-in-Suit, as well as the prior art referred to in the specifications of the Patents-in-Suit. In these Invalidity Contentions, Defendants have identified each item of prior art, based on currently available information, including:

(1) each patent, constituting prior art under 35 U.S.C. §§ 102(a)(1) and/or (a)(2), by its patent number, country of origin, and date of issue;

(2) each non-patent publication, constituting prior art under 35 U.S.C. §§ 102(a)(1) and/or (a)(2), by its title, date of publication, and, where feasible, author and publisher;

(3) sales or public disclosures, constituting prior art under 35 U.S.C. § 102(a)(1), by the item offered for sale or publicly used or known, the date the offer or use took place or the information became known, and the identity of the person or entity which made the use or which made and received the offer, or the person or entity which made the information known or to whom it was made known; and

(4) prior art references showing that the claimed invention was otherwise available to the public under 35 U.S.C. § 102(a)(1), by specifying the form and nature of the reference, the manner in which the reference was made public, and the date on which the reference was made public.

Defendants' identification of patents and publications as prior art herein and in the attached invalidity claim charts includes the publications themselves as well as the use of the products and systems described therein. Defendants' investigation continues, but information available to date indicates that such products and systems were in public use, on sale, and/or otherwise available to

the public more than one year before the effective filing date of the Patents-in-Suit. Upon information and belief, these prior art products and systems and their associated references anticipate and/or render obvious one or more of the Asserted Claims of the Patents-in-Suit.

A. Prior Art Patents, Patent Applications, and Publications

Table 1: Prior Art Patents and Patent Applications

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
EP	2712228	July 25, 2011	March 26, 2014	Chen et al.	PA-ABT_00014255 - PA-ABT_00014268
EP	2996378	June 19, 2013	March 16, 2016	Wang et al.	PA-ABT_00022826 - PA-ABT_00022885
CN	110062398	May 5, 2017	Jul 24, 2020	Guan et al.	PA-ABT_00023790 - PA-ABT_00023830 PA-ABT_00023924 – PA-ABT_00023977
CN	108809488	May 4, 2017	November 13, 2018	Chen et al.	PA-ABT_00023696 – PA-ABT_00023726 PA-ABT_00023997 – PA-ABT_00024028
U.S.	6,185,432	September 30, 1998	February 6, 2001	Vembu	PA-ABT_00009200 - PA-ABT_00009208
U.S.	7,945,222	March 14, 2008	May 17, 2011	Harel et al.	PA-ABT_00013967 - PA-ABT_00013984
U.S.	8,027,374	December 27, 2006	September 27, 2011	Sun et al.	PA-ABT_00013912 - PA-ABT_00013925
U.S.	8,116,693	May 6, 2011	February 14, 2012	Harel et al.	PA-ABT_00014169 - PA-ABT_00014178
U.S.	8,654,667	April 14, 2010	February 18, 2014	Li	PA-ABT_00013353 - PA-ABT_00013365
U.S.	9,131,490	February 25, 2011	September 8, 2015	Feng et al.	PA-ABT_00014791 - PA-ABT_00014835
U.S.	9,236,992	September 17, 2010	January 12, 2016	Chung et al.	PA-ABT_00010828 - PA-ABT_00010864
U.S.	9,264,195	September 17, 2013	February 16, 2016	Park et al.	PA-ABT_00013584 - PA-ABT_00013632

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	9,294,310	October 8, 2010	March 22, 2016	Wu et al.	PA-ABT_00014209 - PA-ABT_00014233
U.S.	9,380,568	August 1, 2013	June 28, 2016	Harrison et al.	PA-ABT_00015374 - PA-ABT_00015423
U.S.	9,425,934	May 7, 2013	August 23, 2016	Seo et al.	PA-ABT_00011246 - PA-ABT_00011283
U.S.	9,474,063	November 2, 2015	October 18, 2016	Han et al.	PA-ABT_00011593 - PA-ABT_00011617
U.S.	9,497,750	December 19, 2013	November 15, 2016	Li et al.	PA-ABT_00011321 - PA-ABT_00011347
U.S.	9,510,335	May 26, 2011	November 29, 2016	Ko et al.	PA-ABT_00010997 - PA-ABT_00011021
U.S.	9,520,973	July 12, 2013	December 13, 2016	Kim et al.	PA-ABT_00013938 - PA-ABT_00013966
U.S.	9,538,516	December 27, 2012	January 3, 2017	Seo et al.	PA-ABT_00010442 - PA-ABT_00010466
U.S.	9,572,149	September 3, 2014	February 14, 2017	Zhou et al.	PA-ABT_00011022 - PA-ABT_00011039
U.S.	9,603,081	February 21, 2013	March 21, 2017	Seo et al.	PA-ABT_00011403 - PA-ABT_00011436
U.S.	9,730,200	March 30, 2012	August 8, 2017	Qu et al.	PA-ABT_00011455 - PA-ABT_00011480
U.S.	9,787,387	May 13, 2016	October 10, 2017	Moon et al.	PA-ABT_00009526 - PA-ABT_00009549
U.S.	9,860,033	October 11, 2011	January 2, 2018	Kadous et al.	PA-ABT_00010140 - PA-ABT_00010177
U.S.	9,867,176	April 28, 2015	January 9, 2018	Li et al.	PA-ABT_00010369 - PA-ABT_00010393
U.S.	9,877,312	January 16, 2013	January 23, 2018	Kim et al.	PA-ABT_00009911 - PA-ABT_00009936
U.S.	9,882,691	October 10, 2013	January 30, 2018	Kang et al.	PA-ABT_00009406 - PA-ABT_00009431
U.S.	9,883,503	May 2, 2017	January 30, 2018	Seo et al.	PA-ABT_00010594 - PA-ABT_00010625
U.S.	9,900,891	August 24, 2017	February 20, 2018	Islam et al.	PA-ABT_00004596 - PA-ABT_00004634

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	9,923,613	February 21, 2014	March 20, 2018	Lee et al.	PA-ABT_00009764 - PA-ABT_00009806
U.S.	9,955,474	May 30, 2017	April 24, 2018	Lee et al.	PA-ABT_00010407 - PA-ABT_00010436
U.S.	10,050,758	January 31, 2013	August 14, 2018	Seo et al.	PA-ABT_00010016 - PA-ABT_00010041
U.S.	10,148,400	June 23, 2015	December 4, 2018	Zhang et al.	PA-ABT_00009550 - PA-ABT_00009569
U.S.	10,171,212	July 3, 2015	January 1, 2019	Park et al.	PA-ABT_00010042 - PA-ABT_00010071
U.S.	10,218,461	October 31, 2013	February 26, 2019	Wang et al.	PA-ABT_00010246 - PA-ABT_00010260
U.S.	10,298,372	November 5, 2015	May 21, 2019	Zhu et al.	PA-ABT_00011481 - PA-ABT_00011500
U.S.	10,299,267	August 1, 2014	May 21, 2019	Wang	PA-ABT_00017662 - PA-ABT_00017689
U.S.	10,425,139	September 15, 2017	September 24, 2019	Guo et al.	PA-ABT_00017690 - PA-ABT_00017736
U.S.	10,454,555	May 20, 2015	October 22, 2019	Kwak et al.	PA-ABT_00010109 - PA-ABT_00010139
U.S.	10,506,576	October 9, 2017	December 10, 2019	John Wilson et al.	PA-ABT_00011371 - PA-ABT_00011397
U.S.	10,567,057	December 18, 2015	February 18, 2020	Park et al.	PA-ABT_00010319 - PA-ABT_00010368
U.S.	10,631,291	October 5, 2015	April 21, 2020	Lee et al.	PA-ABT_00010261 - PA-ABT_00010296
U.S.	10,700,752	January 13, 2017	June 30, 2020	Jung et al.	PA-ABT_00012334 - PA-ABT_00012418
U.S.	10,778,303	March 27, 2017	September 15, 2020	Kim	PA-ABT_00011218 - PA-ABT_00011245
U.S.	10,785,747	December 10, 2019	September 22, 2020	Kim et al.	PA-ABT_00022665 - PA-ABT_00022689
U.S.	10,790,953	February 10, 2017	September 29, 2020	Kim et al.	PA-ABT_00011284 - PA-ABT_00011320
U.S.	10,972,974	September 4, 2015	April 6, 2021	Xiong et al.	PA-ABT_00010493 - PA-ABT_00010514

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	11,026,217	May 12, 2017	June 1, 2021	Chae et al.	PA-ABT_00009503 - PA-ABT_00009525
U.S.	11,044,744	July 25, 2017	June 22, 2021	Wang et al.	PA-ABT_00021535 - PA-ABT_00021545
U.S.	11,088,747	March 30, 2017	August 10, 2021	Islam et al.	PA-ABT_00010735 - PA-ABT_00010798
U.S.	11,088,749	June 27, 2016	August 10, 2021	Chang et al.	PA-ABT_00010970 - PA-ABT_00010996
U.S.	11,139,933	April 2, 2013	October 5, 2021	Xu et al.	PA-ABT_00010178 - PA-ABT_00010195
U.S.	11,159,213	December 26, 2015	October 26, 2021	Zhang et al.	PA-ABT_00011351 - PA-ABT_00011370
U.S.	11,223,394	November 12, 2015	January 11, 2022	Lee et al.	PA-ABT_00009359 - PA-ABT_00009395
U.S.	11,265,901	March 29, 2017	March 1, 2022	Freda et al.	PA-ABT_00014836 - PA-ABT_00014871
U.S.	11,310,764	March 23, 2018	April 19, 2022	Kim et al.	PA-ABT_00023497 - PA-ABT_00023521
U.S.	11,419,173	August 9, 2018	August 16, 2022	Deenoo et al.	PA-ABT_00016933 - PA-ABT_00016975
CN	108633047	March 24, 2017	October 9, 2018	Wang et al.	PA-ABT_00002097 - PA-ABT_00002149 PA-ABT_00023840 - PA-ABT_00023893
U.S.	2006/0164981	January 26, 2005	July 27, 2006	Olsson et al.	PA-ABT_00010630 - PA-ABT_00010646
U.S.	2010/0039970	August 14, 2009	February 18, 2010	Papasakellariou et al.	PA-ABT_00015833 - PA-ABT_00015850
U.S.	2010/0202382	September 11, 2008	August 12, 2010	Park et al.	PA-ABT_00014678 - PA-ABT_00014705
U.S.	2010/0202560	February 1, 2010	August 12, 2010	Luo et al.	PA-ABT_00010467 - PA-ABT_00010492
U.S.	2011/0038330	July 29, 2010	February 17, 2011	Luo et al.	PA-ABT_00006938 - PA-ABT_00006950
U.S.	2011/0096856	December 30, 2010	April 28, 2011	Sadowsky et al.	PA-ABT_00015473 - PA-ABT_00015484

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	2011/0176519	November 15, 2010	July 21, 2011	Vitthaladev uni et al.	PA-ABT_00008672 - PA-ABT_00008713
U.S.	2011/0286420	February 1, 2010	November 24, 2011	Cho et al.	PA-ABT_00012419 - PA-ABT_00012468
U.S.	2012/0122495	November 11, 2010	May 17, 2012	Weng et al.	PA-ABT_00002150 - PA-ABT_00002207
U.S.	2012/0257515	April 8, 2011	October 11, 2012	Hugl et al.	PA-ABT_00014129 - PA-ABT_00014148
U.S.	2012/0314711	August 22, 2012	December 13, 2012	Trachewsky et al.	PA-ABT_00015495 - PA-ABT_00015539
U.S.	2013/0083753	September 30, 2012	April 4, 2013	Lee et al.	PA-ABT_00014391 - PA-ABT_00014473
U.S.	2013/0148515	December 9, 2011	June 13, 2013	Ribeiro et al.	PA-ABT_00014234 - PA-ABT_00014254
U.S.	2013/0182594	June 16, 2013	July 18, 2013	Kim et al.	PA-ABT_00001534 - PA-ABT_00001560
U.S.	2013/0195067	January 27, 2012	August 1, 2013	Khoshnevis et al.	PA-ABT_00009976 - PA-ABT_00010003
U.S.	2013/0286960	March 15, 2013	October 31, 2013	Li et al.	PA-ABT_00017826 - PA-ABT_00017881
U.S.	2013/0301562	May 8, 2013	November 14, 2013	Liao et al.	PA-ABT_00010004 - PA-ABT_00010015
U.S.	2013/0308608	March 15, 2013	November 21, 2013	Hu et al.	PA-ABT_00000001 - PA-ABT_00000039
KR	2013-0130593	June 26, 2012	December 2, 2013	Kim et al.	PA-ABT_00010072 - PA-ABT_00010097
U.S.	2014/0036806	July 25, 2013	February 6, 2014	Chen et al.	PA-ABT_00002292 - PA-ABT_00002316
U.S.	2014/0140435	January 27, 2014	May 22, 2014	Zhang et al.	PA-ABT_00013683 - PA-ABT_00013694
U.S.	2014/0192917	January 7, 2014	July 10, 2014	Nam et al.	PA-ABT_00017534 - PA-ABT_00017563
U.S.	2014/0211656	September 5, 2012	July 31, 2014	Hu et al.	PA-ABT_00013333 - PA-ABT_00013352
WO	2014/074894	November 8, 2013	May 15, 2014	Lou et al.	PA-ABT_00013985 - PA-ABT_00014089

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
WO	2014/158255	December 16, 2013	October 2, 2014	Li et al.	PA-ABT_00014269 - PA-ABT_00014314
WO	2014/201638	June 19, 2013	December 24, 2014	Wang et al.	PA-ABT_00022693 - PA-ABT_00022786
U.S.	2015/0003343	June 26, 2014	January 1, 2015	Li et al.	PA-ABT_00010799 - PA-ABT_00010827
U.S.	2015/0009968	July 8, 2014	January 8, 2015	Yu et al.	PA-ABT_00015540 - PA-ABT_00015558
U.S.	2015/0036612	March 5, 2013	February 5, 2015	Kim et al.	PA-ABT_00006243 - PA-ABT_00006270
U.S.	2015/0055555	April 22, 2013	February 26, 2015	Kim et al.	PA-ABT_00013857 - PA-ABT_00013893
U.S.	2015/0063287	November 11, 2014	March 5, 2015	Mazzarese et al.	PA-ABT_00017644 - PA-ABT_00017661
U.S.	2015/0141026	November 15, 2013	May 21, 2015	Jover	PA-ABT_00009213 - PA-ABT_00009229
U.S.	2015/0195025	September 2, 2013	July 9, 2015	Kang et al.	PA-ABT_00001690 - PA-ABT_00001716
U.S.	2015/0230102	September 2, 2013	August 13, 2015	Kang et al.	PA-ABT_00009807 - PA-ABT_00009831
U.S.	2015/0282070	March 24, 2015	October 1, 2015	Salem et al.	PA-ABT_00009325 - PA-ABT_00009358
U.S.	2015/0341093	May 22, 2015	November 26, 2015	Ji et al.	PA-ABT_00014179 - PA-ABT_00014208
U.S.	2015/0358060	January 14, 2014	December 10, 2015	Park et al.	PA-ABT_00013633 - PA-ABT_00013682
U.S.	2015/0358848	January 27, 2014	December 10, 2015	Kim et al.	PA-ABT_00017611 - PA-ABT_00017643
WO	2015/113664	November 13, 2014	August 6, 2015	Webb et al.	PA-ABT_00015130 - PA-ABT_00015185
WO	2015/131494	August 15, 2014	September 11, 2015	Chen et al.	PA-ABT_00005407 - PA-ABT_00005448 PA-ABT_00023746 - PA-ABT_00023789
WO	2015/199414	June 23, 2015	December 30, 2015	Zhang et al.	PA-ABT_00001498 - PA-ABT_00001533

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	2016/0080052	September 10, 2015	March 17, 2016	Li et al.	PA-ABT_00010556 - PA-ABT_00010593
U.S.	2016/0105265	December 18, 2015	April 14, 2016	Wang et al.	PA-ABT_00021565 - PA-ABT_00021601
U.S.	2016/0112099	February 21, 2014	April 21, 2016	Lee et al.	PA-ABT_00000040 - PA-ABT_00000082
U.S.	2016/0142189	November 6, 2015	May 19, 2016	Shin et al.	PA-ABT_00013828 - PA-ABT_00013856
U.S.	2016/0182137	December 18, 2015	June 23, 2016	Onggosanusi et al.	PA-ABT_00014097 - PA-ABT_00014128
U.S.	2016/0183228	August 12, 2015	June 23, 2016	Song et al.	PA-ABT_00021546 - PA-ABT_00021564
U.S.	2016/0211902	October 24, 2014	July 21, 2016	Park et al.	PA-ABT_00001561 - PA-ABT_00001624
U.S.	2016/0277092	June 1, 2016	September 22, 2016	Pi et al.	PA-ABT_00014151 - PA-ABT_00014168
U.S.	2016/0323028	April 27, 2016	November 3, 2016	Cheng et al.	PA-ABT_00016602 - PA-ABT_00016625
WO	2016/126099	February 3, 2016	August 11, 2016	Park et al.	PA-ABT_00007072 - PA-ABT_00007154 PA-ABT_00008714 - PA-ABT_00008804 PA-ABT_00023534 - PA-ABT_00023617
WO	2016/015307	July 31, 2014	February 4, 2016	Liu et al.	PA-ABT_00008905 - PA-ABT_00008968 PA-ABT_00023618 - PA-ABT_00023679
WO	2016/025899	August 14, 2015	February 18, 2016	Stern-Berkowitz et al.	PA-ABT_00022093 - PA-ABT_00022194
WO	2016/122232	January 28, 2016	April 8, 2016	Park et al.	PA-ABT_00013441 - PA-ABT_00013539
WO	2016/130175	August 11, 2015	August 18, 2016	Fwu et al.	PA-ABT_00002245 - PA-ABT_00002291
WO	2016/136143	January 28, 2016	September 1, 2016	Basu Mallick et al.	PA-ABT_00003860 - PA-ABT_00003918

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	2017/0070277	August 18, 2016	March 9, 2017	Si et al.	PA-ABT_00013700 - PA-ABT_00013744
U.S.	2017/0085303	August 15, 2014	March 23, 2017	Chen et al.	PA-ABT_00008969 - PA-ABT_00008985
U.S.	2017/0086195	September 16, 2016	March 23, 2017	Yum et al.	PA-ABT_00013366 - PA-ABT_00013388
U.S.	2017/0094547	September 23, 2016	March 30, 2017	Yum et al.	PA-ABT_00015023 - PA-ABT_00015043
U.S.	2017/0150480	July 17, 2015	May 25, 2017	Kim et al.	PA-ABT_00013192 - PA-ABT_00013332
U.S.	2017/0207843	January 13, 2017	July 20, 2017	Jung et al.	PA-ABT_00016976 - PA-ABT_00017060
U.S.	2017/0215170	June 26, 2016	July 27, 2017	Islam et al.	PA-ABT_00002913 - PA-ABT_00002932
U.S.	2017/0230994	February 3, 2017	August 10, 2017	You et al.	PA-ABT_00014344 - PA-ABT_00014390
U.S.	2017/0237478	February 9, 2017	August 17, 2017	Kwak et al.	PA-ABT_00013745 - PA-ABT_00013777
U.S.	2017/0288743	March 28, 2017	October 5, 2017	Nam et al.	PA-ABT_00013778 - PA-ABT_00013816
U.S.	2017/0331670	May 13, 2016	November 16, 2017	Parkvall et al.	PA-ABT_00002385 - PA-ABT_00002654
U.S.	2017/0339667	December 28, 2015	November 23, 2017	Shen et al.	PA-ABT_00018998 - PA-ABT_00019013
U.S.	2017/0373743	December 18, 2015	December 28, 2017	Park et al.	PA-ABT_00010196 - PA-ABT_00010245
WO	2017/023352	December 16, 2015	February 9, 2017	Xiong et al.	PA-ABT_00014504 - PA-ABT_00014566
WO	2017/024516	August 11, 2015	February 16, 2017	Lu et al.	PA-ABT_00012633 - PA-ABT_00012667
WO	2017/026983	December 26, 2015	February 16, 2017	Khoryaev et al.	PA-ABT_00014950 - PA-ABT_00015002
WO	2017/052199	September 21, 2016	March 30, 2017	You et al.	PA-ABT_00003965 - PA-ABT_00004038
WO	2017/079530	November 4, 2016	May 11, 2017	Pelletier	PA-ABT_00002655 - PA-ABT_00002709

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
WO	2017/079574	November 4, 2016	May 11, 2017	Lee et al.	PA-ABT_00014567 - PA-ABT_00014643
WO	2017/083489	November 10, 2016	May 18, 2017	Lee et al.	PA-ABT_00004110 - PA-ABT_00004207
WO	2017/083514	November 10, 2016	May 18, 2017	Deenoo et al.	PA-ABT_00010865 - PA-ABT_00010966
WO	2017/084235	April 5, 2016	May 26, 2017	Zhang et al.	PA-ABT_00010647 - PA-ABT_00010681
WO	2017/171398	March 29, 2017	October 5, 2017	Yi et al.	PA-ABT_00015319 - PA-ABT_00015373
WO	2017/174469	March 31, 2017	October 12, 2017	Wong et al.	PA-ABT_00015048 - PA-ABT_00015105
U.S.	2018/0007574	January 28, 2016	January 4, 2018	Park et al.	PA-ABT_00013389 - PA-ABT_00013440
U.S.	2018/0007673	August 11, 2015	January 4, 2018	Fwu et al.	PA-ABT_00015003 - PA-ABT_00015022
U.S.	2018/0034525	February 3, 2016	February 1, 2018	Park et al.	PA-ABT_00013540 - PA-ABT_00013583
U.S.	2018/0054290	September 2, 2016	February 22, 2018	Park et al.	PA-ABT_00017750 - PA-ABT_00017825
U.S.	2018/0054348	July 25, 2017	February 22, 2018	Luo et al.	PA-ABT_00013087 - PA-ABT_00013184
U.S.	2018/0054790	March 17, 2017	February 22, 2018	Islam et al.	PA-ABT_00012864 - PA-ABT_00012906
U.S.	2018/0054800	August 22, 2017	February 22, 2018	Yeo et al.	PA-ABT_00014706 - PA-ABT_00014790
U.S.	2018/0083680	September 15, 2017	March 22, 2018	Guo et al.	PA-ABT_00017482 - PA-ABT_00017528
U.S.	2018/0092139	February 28, 2017	March 29, 2018	Novlan et al.	PA-ABT_00012603 - PA-ABT_00012632
U.S.	2018/0098234	October 3, 2016	April 5, 2018	Kim et al.	PA-ABT_00010515 - PA-ABT_00010552
U.S.	2018/0110074	June 14, 2017	April 19, 2018	Akkarakaran et al.	PA-ABT_00012131 - PA-ABT_00012150
U.S.	2018/0192443	January 5, 2017	July 5, 2018	Novlan et al.	PA-ABT_00012796 - PA-ABT_00012819

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	2018/0227156	February 1, 2018	August 9, 2018	Papasakellariou	PA-ABT_00016543 - PA-ABT_00016601
U.S.	2018/0241454	August 12, 2016	August 23, 2018	Lee et al.	PA-ABT_00009475 - PA-ABT_00009502
U.S.	2018/0254867	September 7, 2016	September 6, 2018	Kim et al.	PA-ABT_00009937 - PA-ABT_00009970
U.S.	2018/0294859	December 21, 2015	October 11, 2018	Niu et al.	PA-ABT_00011197 - PA-ABT_00011217
U.S.	2018/0310283	November 10, 2016	October 25, 2018	Deenoo et al.	PA-ABT_00021602 - PA-ABT_00021660
U.S.	2018/0310322	June 28, 2018	October 25, 2018	Zhang et al.	PA-ABT_00011440 - PA-ABT_00011454
U.S.	2018/0323842	May 4, 2017	November 8, 2018	Majmundar et al.	PA-ABT_00012907 - PA-ABT_00012928
U.S.	2018/0324780	May 4, 2017	November 8, 2018	Novlan et al.	PA-ABT_00011618 - PA-ABT_00011641
U.S.	2018/0324843	May 3, 2018	November 8, 2018	Lee et al.	PA-ABT_00010682 - PA-ABT_00010729
U.S.	2018/0324865	May 4, 2018	November 8, 2018	Hui et al.	PA-ABT_00012066 - PA-ABT_00012099
U.S.	2018/0332605	November 4, 2016	November 15, 2018	Pelletier	PA-ABT_00014644 - PA-ABT_00014668
U.S.	2018/0367203	June 15, 2017	December 20, 2018	Nilsson et al.	PA-ABT_00011677 - PA-ABT_00011689
U.S.	2018/0367374	November 16, 2017	December 20, 2018	Liu et al.	PA-ABT_00009230 - PA-ABT_00009248
U.S.	2018/0368009	September 18, 2017	December 20, 2018	Xia et al.	PA-ABT_00013046 - PA-ABT_00013063
U.S.	2018/0375556	June 26, 2017	December 27, 2018	Wang et al.	PA-ABT_00013064 - PA-ABT_00013086
WO	2018/081913	November 3, 2016	May 11, 2018	Liu et al.	PA-ABT_00001717 - PA-ABT_00001760
WO	2018/126401	January 5, 2017	July 12, 2018	Liu et al.	PA-ABT_00002208 - PA-ABT_00002244
WO	2018/175809	March 22, 2018	September 27, 2018	Dinan et al.	PA-ABT_00012151 - PA-ABT_00012329

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
WO	2018/201861	April 10, 2018	November 8, 2018	Chen et al.	PA-ABT_00024105 - PA-ABT_00024158 PA-ABT_00004928 - PA-ABT_00004975 PA-ABT_00024045 - PA-ABT_00024093
WO	2018/202178	May 4, 2018	November 8, 2018	Guan et al.	PA-ABT_00024159 - PA-ABT_00024214
WO	2018/227464	June 15, 2017	December 20, 2018	Wu et al.	PA-ABT_00008998 - PA-ABT_00009029
U.S.	2019/0028162	February 3, 2017	January 24, 2019	Lee et al.	PA-ABT_00014315 - PA-ABT_00014343
U.S.	2019/0052337	October 17, 2017	February 14, 2019	Kwon et al.	PA-ABT_00012836 - PA-ABT_00012863
U.S.	2019/0053294	November 15, 2017	February 14, 2019	Xia et al.	PA-ABT_00009142 - PA-ABT_00009163
U.S.	2019/0075582	August 5, 2017	March 7, 2019	Kim et al.	PA-ABT_00015186 - PA-ABT_00015243
U.S.	2019/0081688	March 2, 2017	March 14, 2019	Deenoo et al.	PA-ABT_00011642 - PA-ABT_00011676
U.S.	2019/0081832	March 9, 2017	March 14, 2019	Marinier et al.	PA-ABT_00014872 - PA-ABT_00014900
U.S.	2019/0116611	April 3, 2017	April 18, 2019	Lee et al.	PA-ABT_00015249 - PA-ABT_00015275
U.S.	2019/0182821	August 10, 2017	June 13, 2019	You et al.	PA-ABT_00016681 - PA-ABT_00016710
U.S.	2019/0182856	April 13, 2017	June 13, 2019	Moroga et al.	PA-ABT_00015276 - PA-ABT_00015318
U.S.	2019/0229777	April 3, 2019	July 25, 2019	Guan et al.	PA-ABT_00009164 - PA-ABT_00009199
U.S.	2019/0281639	December 26, 2016	September 12, 2019	Yang et al.	PA-ABT_00017061 - PA-ABT_00017074
U.S.	2019/0319686	July 20, 2017	October 17, 2019	Chen et al.	PA-ABT_00023169 - PA-ABT_00023304
U.S.	2019/0349915	January 2, 2018	November 14, 2019	Ahn et al.	PA-ABT_00004077 - PA-ABT_00004109

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	2019/0387501	October 4, 2016	December 19, 2019	Park et al.	PA-ABT_00001457 - PA-ABT_00001497
U.S.	2020/0014453	March 23, 2017	January 9, 2020	Takeda et al.	PA-ABT_00012975 - PA-ABT_00013004
U.S.	2020/0022119	September 24, 2019	January 16, 2020	Wang et al.	PA-ABT_00001761 - PA-ABT_00001805
U.S.	2020/0028609	July 26, 2017	January 23, 2020	Ahn et al.	PA-ABT_00012100 - PA-ABT_00012130
U.S.	2020/0059958	April 10, 2018	February 20, 2020	Chen et al.	PA-ABT_00005057 - PA-ABT_00005080
U.S.	2020/0076492	May 5, 2017	March 5, 2020	Wu et al.	PA-ABT_00012929 - PA-ABT_00012941
U.S.	2020/0099437	March 23, 2017	March 26, 2020	Harada et al.	PA-ABT_00012668 - PA-ABT_00012709
U.S.	2020/0099499	November 25, 2019	March 26, 2020	Yeo et al.	PA-ABT_00021206 - PA-ABT_00021290
U.S.	2020/0186218	June 15, 2017	June 11, 2020	Wu et al.	PA-ABT_00012588 - PA-ABT_00012602
U.S.	2020/0374960	August 9, 2018	November 26, 2020	Deenoo et al.	PA-ABT_00023378 - PA-ABT_00023421
U.S.	2020/0389220	August 21, 2017	December 10, 2020	Kang et al.	PA-ABT_00013010 - PA-ABT_00013039
U.S.	2021/0204346	April 30, 2018	July 1, 2021	Ye et al.	PA-ABT_00012942 - PA-ABT_00012974
U.S.	2021/0235479	July 12, 2016	July 29, 2021	Tang	PA-ABT_00014480 - PA-ABT_00014496
U.S.	2022/0061025	November 1, 2021	February 24, 2022	Deng et al.	PA-ABT_00017449 - PA-ABT_00017481
U.S.	62/114,733	February 11, 2015		Fwu et al.	PA-ABT_00014910 - PA-ABT_00014947
U.S.	62/253,473	November 10, 2015		Lee et al.	PA-ABT_00004729 - PA-ABT_00004848
U.S.	62/455,155	February 6, 2017		Papasakellariou	PA-ABT_00016500 - PA-ABT_00016542
U.S.	62/479,604	March 31, 2017		Papasakellariou	PA-ABT_00016633 - PA-ABT_00016680

Country	Patent/ Application/ Publication No.	Date of Filing	Date of Issue/ Publication	Inventor(s)	Bates Range
U.S.	62/480,556	April 3, 2017		Kim et al.	PA-ABT_00017268 - PA-ABT_00017302
U.S.	62/521,170	June 16, 2017		Liu et al.	PA-ABT_00009250 - PA-ABT_00009314
U.S.	62/543,765	August 10, 2017		Xia et al.	PA-ABT_00009030 - PA-ABT_00009088

Table 2: Non-Patent Publications

Title	Publication Date	Author(s)	Publisher	Bates Range
3G Evolution: HSPA and LTE for Mobile Broadband	2007	Erik Dahlman, Stefan Parkvall, Johan Skold, Per Beming	Academic Press	PA-ABT_00016725 - PA-ABT_00016726
3GPP TR 25.892 version 6.0.0 release 6	June 28, 2004	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00004976 - PA-ABT_00005056
3GPP TR 36.873 version 12.2.0 release 12	July 3, 2015	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00009435 - PA-ABT_00009474
3GPP TR 36.897 version 13.0.0 release 13	July 3, 2015	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00009570 - PA-ABT_00009625
3GPP TR 37.840 version 12.1.0 release 12	January 6, 2014	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00009832 - PA-ABT_00009910
3GPP TR 38.802 version 1.2.0 release 14	March 1, 2017	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00012714 - PA-ABT_00012792
3GPP TR 38.802 version 14.0.0 release 14	March 25, 2017	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00003466 - PA-ABT_00003605

Title	Publication Date	Author(s)	Publisher	Bates Range
3GPP TS 36.133 version 12.8.0 release 12	September 9, 2015	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00019575 - PA-ABT_00020970
3GPP TS 36.133 version 13.2.0 release 13	January 8, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00007155 - PA-ABT_00008671
3GPP TS 36.211 version 12.3.0 release 12	October 2, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00019025 - PA-ABT_00019150
3GPP TS 36.211 version 12.5.0 release 12	March 16, 2015	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00004208 - PA-ABT_00004343
3GPP TS 36.211 version 12.8.0 release 12	January 26, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00009626 - PA-ABT_00009763
3GPP TS 36.211 version 12.8.0 release 12	January 6, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00017950 - PA-ABT_00018067
3GPP TS 36.211 version 13.2.0 release 13	August 24, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00001160 - PA-ABT_00001329
3GPP TS 36.211 version 14.2.0 release 14	April 18, 2017	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00015637 - PA-ABT_00015832
3GPP TS 36.211 version 8.9.0 release 8	December 9, 2009	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00001625 - PA-ABT_00001689
3GPP TS 36.211 version 11.3.0 release 11	June 26, 2013	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00002710 - PA-ABT_00002817
3GPP TS 36.211 version 12.5.0 release 12	March 16, 2015	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00004208 - PA-ABT_00004343

Title	Publication Date	Author(s)	Publisher	Bates Range
3GPP TS 36.211 version 13.0.0 release 13	January 5, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00006779 - PA-ABT_00006919
3GPP TS 36.212 version 12.2.0 release 12	September 23, 2014	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00000083 - PA-ABT_00000171
3GPP TS 36.212 version 12.2.0 release 12	October 2, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00021291 - PA-ABT_00021381
3GPP TS 36.212 version 12.4.0 release 12	March 18, 2015	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00004635 - PA-ABT_00004728
3GPP TS 36.212 version 12.8.0 release 12	March 27, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00002818 - PA-ABT_00002912
3GPP TS 36.212 version 12.8.0 release 12	March 27, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00018079 - PA-ABT_00018165
3GPP TS 36.212 version 12.8.0 release 12	April 22, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00021661 - PA-ABT_00021757
3GPP TS 36.212 version 13.0.0 release 13	January 5, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00006951 - PA-ABT_00007071
3GPP TS 36.212 version 13.3.0 release 13	September 29, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00001330 - PA-ABT_00001456
3GPP TS 36.212 version 14.2.0 release 14	April 11, 2017	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00016727 - PA-ABT_00016932
3GPP TS 36.213 version 12.11.0 release 12	September 29, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00004344 - PA-ABT_00004586

Title	Publication Date	Author(s)	Publisher	Bates Range
3GPP TS 36.213 version 12.3.0 release 12	October 2, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00022955 - PA-ABT_00023168
3GPP TS 36.213 version 12.8.0 release 12	May 3, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00022195 - PA-ABT_00022437
3GPP TS 36.213 version 12.8.0 release 12 Annex A	January 6, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00018068 - PA-ABT_00018075
3GPP TS 36.213 version 12.8.0 release 12, Cover	January 6, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00018076 - PA-ABT_00018078
3GPP TS 36.213 version 12.8.0 release 12, Section 14	January 6, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00018321 - PA-ABT_00018334
3GPP TS 36.213 version 12.8.0 release 12, Sections 0-9	January 6, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00018166 - PA-ABT_00018320
3GPP TS 36.213 version 12.8.0 release 12, Sections 10-13	January 6, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00018335 - PA-ABT_00018388
3GPP TS 36.213 version 13.0.0 release 13	January 5, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00005081 - PA-ABT_00005406
3GPP TS 36.213 version 13.2.0 release 13	August 5, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00000777 - PA-ABT_00001159
3GPP TS 36.214 version 12.0.0 release 12	October 2, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00022894 - PA-ABT_00022909

Title	Publication Date	Author(s)	Publisher	Bates Range
3GPP TS 36.214 version 12.2.0 release 12	April 24, 2015	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00022075 - PA-ABT_00022092
3GPP TS 36.214 version 13.0.0 release 13	December 15, 2015	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00006920 - PA-ABT_00006937
3GPP TS 36.300 version 12.3.0 release 12	September 29, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00020971 - PA-ABT_00021200
3GPP TS 36.300 version 12.8.0 release 12	January 4, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00003606 - PA-ABT_00003859
3GPP TS 36.300 version 12.8.0 release 12	January 18, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00021814 - PA-ABT_00022074
3GPP TS 36.300 version 14.3.0 release 14	July 27, 2017	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00011690 - PA-ABT_00012036
3GPP TS 36.302 version 12.1.0 release 12	September 29, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00023308 - PA-ABT_00023330
3GPP TS 36.302 version 12.6.0 release 12	January 18, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00019151 - PA-ABT_00019177
3GPP TS 36.304 version 12.2.0 release 12	September 29, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00022787 - PA-ABT_00022825
3GPP TS 36.304 version 12.8.0 release 12	August 25, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00022915 - PA-ABT_00022954

Title	Publication Date	Author(s)	Publisher	Bates Range
3GPP TS 36.304 version 12.8.0 release 12	July 1, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00002323 - PA-ABT_00002360
3GPP TS 36.304 version 14.0.0 release 14	October 3, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00003919 - PA-ABT_00003964
3GPP TS 36.304 version 9.1.0 Release 9	February 9, 2010	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00002933 - PA-ABT_00002965
3GPP TS 36.306 version 14.2.0 release 14	April 11, 2017	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00015559 - PA-ABT_00015636
3GPP TS 36.321 version 12.3.0 release 12	October 28, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00022606 - PA-ABT_00022664
3GPP TS 36.321 version 12.6.0 release 12	June 30, 2015	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00004849 - PA-ABT_00004927
3GPP TS 36.321 version 12.8.0 release 12	January 4, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00017882 - PA-ABT_00017949
3GPP TS 36.321 version 12.8.0 release 12	January 18, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00021452 - PA-ABT_00021530
3GPP TS 36.321 version 14.3.0 release 14	July 27, 2017	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00012472 - PA-ABT_00012580
3GPP TS 36.331 version 12.3.0 release 12	September 29, 2014	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00019178 - PA-ABT_00019560

Title	Publication Date	Author(s)	Publisher	Bates Range
3GPP TS 36.331 version 12.8.0 release 12	January 18, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00018389 - PA-ABT_00018981
3GPP TS 36.331 version 13.0.0 release 13	January 6, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00006272 - PA-ABT_00006778
3GPP TS 36.331 version 13.3.0 release 13	October 3, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00000172 - PA-ABT_00000776
3GPP TS 36.331 version 13.5.0 release 13	April 11, 2017	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00015851 - PA-ABT_00016495
3GPP TS 38.212 version 15.2.0 release 15	June 29, 2018	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00011047 - PA-ABT_00011143
3GPP TS 38.214 version 15.2.0 release 15	June 29, 2018	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00011501 - PA-ABT_00011592
3GPP TS 38.306 version 15.5.0 release 15	April 11, 2019	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00011148 - PA-ABT_00011196
3GPP TS 36.304 version 13.0.0 release 13	February 2, 2016	3rd Generation Partnership Project (3GPP)	ETSI publication of 3rd Generation Partnership Project (3GPP)	PA-ABT_00003422 - PA-ABT_00003465
3GPP TS 36.331 version 12.8.0 release 12	January 4, 2016	3rd Generation Partnership Project (3GPP)	3rd Generation Partnership Project (3GPP)	PA-ABT_00002966 - PA-ABT_00003421
4G LTE/LTE-Advanced for Mobile Broadband	2011	Erik Dahlman, Stefan Parkvall, Johan Skold	Academic Press	PA-ABT_00001806 - PA-ABT_00002096
4G: LTE/LTE-Advanced for Mobile Broadband	2014	Erik Dahlman, Stefan Parkvall, Johan Skold	Elsevier Ltd.	PA-ABT_00016720 - PA-ABT_00016724

Title	Publication Date	Author(s)	Publisher	Bates Range
1st 5G Algorithm Innovation Competition - Filtered-OFDM	2015	Altera InnovateAsia FPGA Design Contest - 5G Algorithm Innovation Competition	Terasic Inc.	PA-ABT_00002361 - PA-ABT_00002384
A Comparison of Symbol-wise and Self-contained Frame Structure for 5G Services	2016	Mohamed Ibrahim, Wen Xu	IEEE	PA-ABT_00014474 - PA-ABT_00014479
Accurate Determination of Transport Block Size for 5G New Radio	April 30, 2020	Hao Wu	Electronics Lettters, Vol. 56, No. 9 pp 459-462	PA-ABT_00011348 - PA-ABT_00011350
An Enhanced Multi-antenna Solution through Beamforming to 3G Long-term Evolution	2009	Ken Long, Wei-ling WU	IEEE	PA-ABT_00010626 - PA-ABT_00010629
Antenna Grouping based Feedback Compression for FDD-based Massive MIMO Systems	July 21, 2015	Byungju Lee, Junil Choi, Ji-Yun Seol, David Love, Byonghyo Shim	IEEE Transactions on Communications	PA-ABT_00010394 - PA-ABT_00010406
Antenna Grouping Techniques for MIMO Beamforming Systems	2008	Kyungchul Kim, Jungwoo Lee	IEEE	PA-ABT_00010098 - PA-ABT_00010102

Title	Publication Date	Author(s)	Publisher	Bates Range
Beam Selection Strategies for Orthogonal Random Beamforming in Sparse Networks	September 2008	Jose Lopez Vicario, Roberto Bosisio, Carles Anton-Haro, Umberto Spagnolini	IEEE Transactions on Wireless Communications, Vol. 7, No. 9	PA-ABT_00013926 - PA-ABT_00013937
Comparison Between Bit Error Rate And S ignal To Noise Ratio in OFDM Using LSE Al gorithm	2013	Raghav Pandey, Ashwani Awasthi, Vikas Srivastava	Atlantis Press	PA-ABT_00009209 - PA-ABT_00009212
Delay-Prioritized Scheduling (DPS) for Real Time Traffic in 3GPP LTE System	April 2010	Kumbesan Sandrasegaran, Huda Adibah Mohd Ramli, Riyaj Basukala	IEEE	PA-ABT_00011040 - PA-ABT_00011046
Dynamic TDD in LTE Small Cells	2016	Jussi Kerttula, Aleksi Marttinen, Kalle Ruttik, Riku Jantti, Mirza Nazrul Alam	EURASIP Journal on Wireless Communications and Networking	PA-ABT_00009396 - PA-ABT_00009405
Enabling Massive IoT in 5G and Beyond Systems: PHY Radio Frame Design Considerations	June 24, 2016	Ayesha Ijaz, Lei Zhang, Maxime Grau, Abdelrahim Mohamed, Serdar Vural, Atta Quddus, Muhammad Ali Imran, Chuan Heng Foh, Rahim Tafazolli	IEEE Access	PA-ABT_00015112 - PA-ABT_00015129
Enhanced Beam Selection for Multi-user MM-Wave massissive MIMO Systems	July 7, 2016	Jiaxuan Chen, Peiyao Zhao, Zhaocheng Wang, Jinguo Quan	Electronics Lettters, Vol. 52, No. 14 pp 1268-70	PA-ABT_00013185 - PA-ABT_00013191

Title	Publication Date	Author(s)	Publisher	Bates Range
Filtered-OFDM: Foundational Waveform for Self-adaptive Air Interface	2015	Altera InnovateAsia FPGA Design Contest - 5G Algorithm Innovation Competition	Terasic Inc.	PA-ABT_00004042 - PA-ABT_00004044
Joint Transmitter-Receiver Beamforming Over Space-Time Fading Channels	2007	T. Zhang, A. Manikas	IEEE	PA-ABT_00010103 - PA-ABT_00010108
LTE – The UMTS Long Term Evolution from Theory to Practice, Second Edition	2011	Stefania Sesia, Issam Toufik, Matthew Baker	John Wiley & Sons Ltd.	PA-ABT_00005449 - PA-ABT_00006242
Millimeter Wave Communications for Future Mobile Networks	May 17, 2017	Ming Xiao, Shahid Mumtaz, Yongming Huang, Linglong Dai, Yonghui Li, Michail Matthaiou, George K. Karagiannidis, Emil Björnson,Kai Yang, Chih-Lin I., Amitava Ghosh	IEEE	PA-ABT_00012037 - PA-ABT_00012061
MIMO Beamforming for High-Bit-Rate Transmission over Frequency-Selective Fading Channels	2004	Huy Hoang Pham,Tetsuki Taniguchi, Yoshio Karasawa	IEEE	PA-ABT_00010437 - PA-ABT_00010441

Title	Publication Date	Author(s)	Publisher	Bates Range
Multibeam Selection for Indoor MIMO Systems: Two Cases of Study	April 2007	Luis Gurrieri, Sima Noghanian	IEEE Transactions on Antennas and Propagation, Vol. 55, No. 4	PA-ABT_00013817 - PA-ABT_00013827
Overview of Full-Dimension MIMO in LTE-Advanced Pro	August 10, 2016	Hyoungju Ji,Younsun Kim, Juho Lee, Eko Onggosanusi,Younghan Nam, Jianzhong Zhang, Byungji Lee, Byongho Shim	IEEE Communications Magazine	PA-ABT_00010297 - PA-ABT_00010318
Overview of Narrowband IoT in LTE Rel-13	2016	Rapeepat Ratasuk, Nitin Mangalvedhe, Yanji Zhang, Michel Robert, Jussi-Pekka Koskinen	IEEE Conference on Standards for Communications and Networking	PA-ABT_00014497 - PA-ABT_00014503
Novel OFDM transmission scheme to overcome caused by multipath delay longer than cyclic prefix	2005	Chiwoo Lim, Youngbin Chang, Jaeweon Cho, Panyuh Joo and Hyeonwoo Lee	2005 IEEE 61st Vehicular Technology Conference, Stockholm, Sweden, 2005, pp. 1763-1767 Vol. 3, doi: 10.1109/VETECS.2005.1543624	PA-ABT_00024100 - PA-ABT_00024104
R1-130140	January 28-February 1, 2013 (Meeting dates) January 19, 2013 (Publication)	ZTE	3rd Generation Partnership Project (3GPP)	PA-ABT_00010553 - PA-ABT_00010555

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-130269	January 28-February 1, 2013 (Meeting dates) January 18, 2013 (Publication)	LG Electronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00009432 - PA-ABT_00009434
R1-144047	October 6-10, 2014 (Meeting dates) September 27, 2014 (Publication)	LG Electronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00009971 - PA-ABT_00009975
R1-150779	February 9-13, 2015 (Meeting dates) February 19, 2015 (Publication)	LG Electronics, ETRI, InterDigital, Qualcomm, Sony Coorperation	3rd Generation Partnership Project (3GPP)	PA-ABT_00014149 - PA-ABT_00014150
R1-151365	April 20-24, 2015 (Meeting dates) April 11, 2015 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00013894 - PA-ABT_00013898
R1-151535	April 20-24, 2015 (Meeting date) April 11, 2015 (Publication)	LG Electronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00021531 - PA-ABT_00021534
R1-153175	May 25-29, 2015 (Meeting date) May 16, 2015 (Publication)	Ericsson	3rd Generation Partnership Project (3GPP)	PA-ABT_00019022 - PA-ABT_00019024

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-154127	August 24-28, 2015 (Meeting date) August 14, 2015 (Publication)	Samsung	3rd Generation Partnership Project (3GPP)	PA-ABT_00018990 - PA-ABT_00018997
R1-1608671	October 10-14, 2016 (Meeting dates) October 1, 2016 (Publication)	ZTE, ZTE Microelectronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00014090 - PA-ABT_00014096
R1-1609080	October 10-14, 2016 (Meeting dates) September 30, 2016 (Publication)	Samsung	3rd Generation Partnership Project (3GPP)	PA-ABT_00017529 - PA-ABT_00017533
R1-1609414	October 10-14, 2016 (Meeting dates) October 1, 2016 (Publication)	Huawei, HiSilicon	3rd Generation Partnership Project (3GPP)	PA-ABT_00013695 - PA-ABT_00013699
R1-1609525	October 10-14, 2016 (Meeting date) October 1, 2016 (Publication)	Intel Corporation	3rd Generation Partnership Project (3GPP)	PA-ABT_00022458 - PA-ABT_00022461
R1-1609662	October 10-14, 2016 (Meeting date) September 30, 2016 (Publication)	Nokia, Alcatel-Lucent Shanghai Bell	3rd Generation Partnership Project (3GPP)	PA-ABT_00022690 - PA-ABT_00022692

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1609739	October 10-14, 2016 (Meeting dates) October 1, 2016 (Publication)	Nokia, Alcatel-Lucent Shanghai Bell	3rd Generation Partnership Project (3GPP)	PA-ABT_00015044 - PA-ABT_00015047
R1-1610145	October 10-14, 2016 (Meeting date) October 1, 2016 (Publication)	Qualcomm	3rd Generation Partnership Project (3GPP)	PA-ABT_00021201 - PA-ABT_00021205
R1-1610239	October 10-14, 2016 (Meeting date) September 30, 2016 (Publication)	Nokia, Alcatel-Lucent Shanghai Bell	3rd Generation Partnership Project (3GPP)	PA-ABT_00019018 - PA-ABT_00019021
R1-1611385	November 14-18, 2016 (Meeting date) November 5, 2016 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00022442 - PA-ABT_00022445
R1-1611387	November 14-18, 2016 (Meeting dates) November 5, 2016 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00010967 - PA-ABT_00010969
R1-1611415	November 14-18, 2016 (Meeting date) November 5, 2016 (Publication)	ZTE, ZTE Microelectronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00022446 - PA-ABT_00022452

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1611417	November 14-18, 2016 (Meeting date) November 5, 2016 (Publication)	ZTE, ZTE Microelectronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00019561 - PA-ABT_00019566
R1-1611421	November 14-18, 2016 (Meeting dates) November 5, 2016 (Publication)	ZTE, ZTE Microelectronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00017742 - PA-ABT_00017746
R1-1612015	November 14-18, 2016 (Meeting dates) November 6, 2016 (Publication)	Qualcomm	3rd Generation Partnership Project (3GPP)	PA-ABT_00011398 - PA-ABT_00011402
R1-1612056	November 14-18, 2016 (Meeting date) November 5, 2016 (Publication)	Qualcomm	3rd Generation Partnership Project (3GPP)	PA-ABT_00019014 - PA-ABT_00019017
R1-1612190	November 14-18, 2016 (Meeting date) November 5, 2016 (Publication)	CMCC	3rd Generation Partnership Project (3GPP)	PA-ABT_00004039 - PA-ABT_00004041
R1-1612493	November 14-18, 2016 (Meeting date) November 4, 2016 (Publication)	Samsung	3rd Generation Partnership Project (3GPP)	PA-ABT_00023305 - PA-ABT_00023307

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1612717	November 14-18, 2016 (Meeting date) November 5, 2016 (Publication)	NTT DOCOMO	3rd Generation Partnership Project (3GPP)	PA-ABT_00002320 - PA-ABT_00002322
R1-1612862	November 14-18, 2016 (Meeting date) November 4, 2016 (Publication)	Nokia, Alcatel-Lucent Shanghai Bell	3rd Generation Partnership Project (3GPP)	PA-ABT_00018985 - PA-ABT_00018989
R1-1613589	November 14-18, 2016 (Meeting dates) November 19, 2016 (Publication)	Samsung, Ericsson, NTT DOCOMO, Intel, Verizon, KT	3rd Generation Partnership Project (3GPP)	PA-ABT_00017737 - PA-ABT_00017741
R1-1613716	November 14-18, 2016 (Meeting date) November 19, 2016 (Publication)	ZTE, ZTE Microelectronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00023331 - PA-ABT_00023334
R1-164147	May 23-27, 2016 (Meeting dates) May 14, 2016 (Publication)	Intel Corporation	3rd Generation Partnership Project (3GPP)	PA-ABT_00013903 - PA-ABT_00013906
R1-166881	August 22-26, 2016 (Meeting dates) August 13, 2016 (Publication)	LG Electronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00019567 - PA-ABT_00019574

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-167028	August 22-26, 2016 (Meeting dates) August 12, 2016 (Publication)	KT Corp.	3rd Generation Partnership Project (3GPP)	PA-ABT_00011437 - PA-ABT_00011439
R1-167287	August 22-26, 2016 (Meeting dates) August 12, 2016 (Publication)	Nokia, Alcatel-Lucent Shanghai Bell	3rd Generation Partnership Project (3GPP)	PA-ABT_00013899 - PA-ABT_00013902
R1-167520	August 22-26, 2016 (Meeting dates) August 12, 2016 (Publication)	Lenovo	3rd Generation Partnership Project (3GPP)	PA-ABT_00013907 - PA-ABT_00013911
R1-1700192	January 16-20, 2017 (Meeting dates) January 10, 2017 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00011144 - PA-ABT_00011147
R1-1700539	January 16-20, 2017 (Meeting dates) January 10, 2017 (Publication)	Panasonic	3rd Generation Partnership Project (3GPP)	PA-ABT_00016496 - PA-ABT_00016499
R1-1700563	January 16-20, 2017 (Meeting dates) January 9, 2017 (Publication)	Guangdong OPPO Mobile Telecom	3rd Generation Partnership Project (3GPP)	PA-ABT_00010730 - PA-ABT_00010734

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1700703	January 16-20, 2017 (Meeting dates) January 10, 2017 (Publication)	InterDigital Communications	3rd Generation Partnership Project (3GPP)	PA-ABT_00012823 - PA-ABT_00012826
R1-1700771	January 16-20, 2017 (Meeting dates) January 10, 2017 (Publication)	Ericsson	3rd Generation Partnership Project (3GPP)	PA-ABT_00012832 - PA-ABT_00012835
R1-1701581	January 13-17, 2017 (Meeting dates) February 7, 2017 (Publication)	ZTE, ZTE Microelectronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00017095 - PA-ABT_00017108
R1-1701979	February 13-17, 2017 (Meeting date) February 4, 2017 (Publication)	NEC	3rd Generation Partnership Project (3GPP)	PA-ABT_00017446 - PA-ABT_00017448
R1-1702676	February 13-17, 2017 (Meeting dates) February 7, 2017 (Publication)	Ericsson	3rd Generation Partnership Project (3GPP)	PA-ABT_00022464 - PA-ABT_00022467
R1-1704342	April 3-7, 2017 (Meeting dates) March 25, 2017 (Publication)	AT&T	3rd Generation Partnership Project (3GPP)	PA-ABT_00012469 - PA-ABT_00012471

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1704456	April 3-7, 2017 (Meeting dates) March 25, 2017 (Publication)	MediaTek Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00022454 - PA-ABT_00022457
R1-1704465	April 3-7, 2017 (Meeting dates) March 25, 2017 (Publication)	MediaTek Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00013005 - PA-ABT_00013009
R1-1704551	April 3-7, 2017 (Meeting date) March 25, 2017 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00022886 - PA-ABT_00022893
R1-1704553	April 3-7, 2017 (Meeting dates) March 25, 2017 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00012062 - PA-ABT_00012065
R1-1704618	April 3-7, 2017 (Meeting dates) March 25, 2017 (Publication)	Guangdong OPPO Mobile Telecom	3rd Generation Partnership Project (3GPP)	PA-ABT_00015489 - PA-ABT_00015494
R1-1704867	April 3-7, 2017 (Meeting date) March 25, 2017 (Publication)	LG Electronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00022438 - PA-ABT_00022441

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1705961	April 3-7, 2017 (Meeting dates) March 24, 2017 (Publication)	Nokia, Alcatel-Lucent Shanghai Bell	3rd Generation Partnership Project (3GPP)	PA-ABT_00017075 - PA-ABT_00017080
R1-1707475	May 15-19, 2017 (Meeting date) May 6, 2017 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00004587 - PA-ABT_00004595
R1-1707782	May 15-19, 2017 (Meeting dates) May 5, 2017 (Publication)	Spreadtrum Communications	3rd Generation Partnership Project (3GPP)	PA-ABT_00017109 - PA-ABT_00017113
R1-1707830	May 15-19, 2017 (Meeting dates) May 7, 2017 (Publication)	MediaTek Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00016626 - PA-ABT_00016632
R1-1707832	May 15-19, 2017 (Meeting date) May 7, 2015 (Publication)	MediaTek Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00012581 - PA-ABT_00012587
R1-1707954	May 15-19, 2017 (Meeting date) May 6, 2017 (Publication)	Samsung	3rd Generation Partnership Project (3GPP)	PA-ABT_00022910 - PA-ABT_00022914
R1-1708135	May 15-19, 2017 (Meeting dates) May 6, 2017 (Publication)	Huawei, HiSilicon	3rd Generation Partnership Project (3GPP)	PA-ABT_00017086 - PA-ABT_00017094

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1708334	May 15-19, 2017 (Meeting dates) May 6, 2017 (Publication)	InterDigital, Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00015485 - PA-ABT_00015488
R1-1708336	May 15-19, 2017 (Meeting date) May 6, 2017 (Publication)	InterDigital, Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00012710 - PA-ABT_00012713
R1-1710078	June 27-30, 2017 (Meeting dates) June 17, 2017 (Publication)	CATT	3rd Generation Partnership Project (3GPP)	PA-ABT_00012820 - PA-ABT_00012822
R1-1710596	June 27-30, 2017 (Meeting dates) June 16, 2017 (Publication)	Lenovo, Motorola Mobility	3rd Generation Partnership Project (3GPP)	PA-ABT_00009315 - PA-ABT_00009319
R1-1710810	June 27-30, 2017 (Meeting dates) June 17, 2017 (Publication)	MediaTek Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00013040 - PA-ABT_00013045
R1-1710871	June 20-27, 2017 (Meeting date) June 16, 2017 (Publication)	InterDigital Inc.	3rd Generation Partnership Project (3GPP)	PA-ABT_00018982 - PA-ABT_00018984

Title	Publication Date	Author(s)	Publisher	Bates Range
R1-1711161	June 27-30, 2017 (Meeting dates) June 17, 2017 (Publication)	Qualcomm Incorporated	3rd Generation Partnership Project (3GPP)	PA-ABT_00012827 - PA-ABT_00012831
R2-1700902	February 13-17, 2017 (Meeting date) February 4, 2017 (Publication)	Ericsson	3rd Generation Partnership Project (3GPP)	PA-ABT_00015244 - PA-ABT_00015248
R2-1701727	February 13-17, 2017 (Meeting date) February 4, 2017 (Publication)	Intel Corporation	3rd Generation Partnership Project (3GPP)	PA-ABT_00002317 - PA-ABT_00002319
R2-1702662	April 3-7, 2017 (Meeting dates) March 25, 2017 (Publication)	Ericsson	3rd Generation Partnership Project (3GPP)	PA-ABT_00014948 - PA-ABT_00014949
R2-1703344	April 3-7, 2017 (Meeting date) March 24, 2017 (Publication)	LG Electronics	3rd Generation Partnership Project (3GPP)	PA-ABT_00022462 - PA-ABT_00022463
R2-1703561	April 3-7, 2017 (Meeting dates) March 25, 2017 (Publication)	Qualcomm Incorporated	3rd Generation Partnership Project (3GPP)	PA-ABT_00012330 - PA-ABT_00012333

Title	Publication Date	Author(s)	Publisher	Bates Range
R2-1706926	June 27-29, 2017 (Meeting dates) June 17, 2017 (Publication)	Qualcomm Incorporated	3rd Generation Partnership Project (3GPP)	PA-ABT_00012793 - PA-ABT_00012795
R4-161779	April 11-15, 2016 (Meeting date) April 26, 2016 (Publication)	Qualcomm Incorporated	3rd Generation Partnership Project (3GPP)	PA-ABT_00021382 - PA-ABT_00021387
SINR, RSRP, RSSI a nd RSRQ Measureme nts in Long Term Evolution Networks	August 2015	Farhana Afroz, Ramprasad Subramanian, Roshanak Heidary, Kumbesan Sandrasegaran, Solaiman Ahmed	International Journal of Wireless & Mobile Networks, Vol. 7, No. 4	PA-ABT_00008987 - PA-ABT_00008997
Subcarrier Spacing - How to Make Use of This Degree of Freedom	July 7, 2016	Frank Schaich, Thorsten Wild, Rana Ahmed	IEEE	PA-ABT_00014669 - PA-ABT_00014677
Subcarrier Spacing - How to Make Use of This Degree of Freedom	July 7, 2016	Frank Schaich, Thorsten Wild, Rana Ahmed	IEEE	PA-ABT_00015106 - PA-ABT_00015111
Waveform and Numerology to Support 5G Services and Requirements	November 1, 2016	Ali A. Zaidi, Robert Baldemair, Hugo Tullberg, Hakan Björkegren, Lars Sundström, Jonas Medbo, Caner Kilinc, Icaro Da Silva	IEEE Communications Magazine	PA-ABT_00014901 - PA-ABT_00014909

Title	Publication Date	Author(s)	Publisher	Bates Range
Weight Control Scheme for MIMO System with Multiple Transmit and Receive Beamforming	2003	Yoshitaka Hara, Akinori Taira, Takashi Sekiguchi	IEEE	PA-ABT_00009320 - PA-ABT_00009324

Defendants further incorporate by reference all "U.S. Patent Documents," "Foreign Patent Documents," and "Other Publications" cited on the face of the Patents-in-Suit. Any citation to one or more of the above prior art references, or other prior art references regarding any method or system, should be construed to constitute not only a citation to the prior art reference itself, but also a reference to the system itself. Discovery has only just begun in this case, and Defendants will supplement if and when more information becomes available from Plaintiff or third parties.

B. Prior Art Disclosures—Public Use/Sales/Offers for Sale/Available to the Public

Defendants believe that there were prior art disclosures in the form of sales, offers for sale, and/or uses by others of products that qualify as prior art under AIA 35 U.S.C. § 102(a)(1) against one or more of the Asserted Claims of the Patents-in-Suit. The below-identified prior art products include products Defendants are currently aware of through an on-going diligent and reasonable investigation at this early stage of discovery and/or based on public available information. Details regarding such offers for sale and public uses may be within the possession of third parties. As discovery progresses, Defendants intend and reserve the right to promptly supplement and/or amend the lists below to include additional prior art products that anticipate and/or render the Asserted Claims obvious.

Table 3: Prior Art Products

System	Sale or Use Date
Qualcomm Snapdragon X12 LTE Modem	At least by September 2015
Qualcomm Snapdragon X16 LTE Modem	At least by February 2016
Qualcomm Snapdragon 820 Platform / MSM8896	At least by November 2015
Qualcomm Snapdragon 821 Platform / MSM8896 Pro	At least by July 2016
Qualcomm Snapdragon 835 Platform / MSM8998	At least by, November 2016
Le Max Pro	At least by January 2016
Asus Zenfone 3 Deluxe	At least by July 2016
Samsung Galaxy S7	At least by February 2016
Samsung Galaxy S7 EDGE	At least by February 2016
Samsung Galaxy S8	At least by March 2017
Samsung Galaxy S8+	At least by March 2017
ZTE Axon 7	At least by June 2016
ZTE Axon 7S	At least by June 2017
5G Algorithm Innovation Competition - Filtered-OFDM	At least by December 2015

For the public uses identified herein, Defendants are investigating the identities of the individuals who knew about and/or were involved in the making, first public use, offer for sale and/or sale of these products and systems. Defendants are also investigating the exact date that these products and systems were first made, first publicly used, offered for sale and/or sold. In addition, Defendants are currently investigating the dates of conception and reduction to practice of these products and systems and when these products and systems were first known or used by others.

In the course of their investigation, Defendants may identify additional prior art documents describing these products, systems, and/or disclosures that may also anticipate and/or render obvious as invalidating printed publications. Any citation to one or more of prior art references regarding these products, systems, and/or disclosures should be construed to constitute not only a

citation to the prior art reference itself, but also a reference to the associated products, systems, and/or disclosures.

C. Prior art under 35 U.S.C. §§ 101 and/or 116

Discovery has only just recently begun, and inventor discovery is forthcoming. Based on limited discovery received to date, Defendants contend that the Asserted Claims are invalid under 35 U.S.C. § 101 and/or for failing to satisfy § 116 on the grounds that the named inventor of the Patents-in-Suit did not invent the subject matter claimed therein and/or improperly omitted an inventor. A patent is invalid if more or fewer than the true inventors are named. Should Defendants obtain additional evidence, they will provide the name of the person(s) from whom and the circumstances under which the alleged invention or any part of it was derived.

For example, Defendants believe that one or more other people may have invented or contributed to the subject matter claimed in the Patents-in-Suit. Defendants may identify additional information describing additional persons, facts, and circumstances that may also demonstrate that the named inventor is not entitled to the Patents-in-Suit under 35 U.S.C. § 101 and/or failed to satisfy the requirements under § 116 such that the Asserted Claims of the Patents-in-Suit are invalid.

Additionally, Plaintiff may have in its possession, custody, or control information related to or pertaining to information concerning the failure to satisfy §§ 101 and/or 116. Defendants will supplement these Invalidity Contentions if and when Plaintiff produces such information and Defendants have had the opportunity to obtain and analyze that information. Defendants contend that the Patents-in-Suit are invalid under 35 U.S.C. §§ 101 and/or 116 in the event Defendants obtain evidence that the named inventor of any of the Patents-in-Suit did not invent (either together

or in conjunction with other parties) the subject matter claimed therein and/or omitted a true inventor.

D. Invalidity by Anticipation or Obviousness

Subject to the Defendants' reservation of rights stated in these Invalidity Contentions and based on Defendants' present understanding of the Asserted Claims and the apparent interpretations that Plaintiff is asserting based on Plaintiff's Complaint and its Infringement Contentions, Defendants provide below exemplary references and combinations of references that anticipate and/or render the Asserted Claims of the '767 patent obvious in Table 4, exemplary references and combinations of references that anticipate and/or render the Asserted Claims of the '113 patent obvious in Table 5, exemplary references and combinations of references that anticipate and/or render the Asserted Claims of the '081 patent obvious in Table 6, exemplary references and combinations of references that anticipate and/or render the Asserted Claims of the '527 patent obvious in Table 7, and exemplary references and combinations of references that anticipate and/or render the Asserted Claims of the '271 patent obvious in Table 8.

Aspects of these Invalidity Contentions are based, in whole or in part, on Defendants' present understanding of Plaintiff's apparent interpretations of the Asserted Claims based on Plaintiff's Complaint and its Infringement Contentions. Given Plaintiff's apparent interpretations of the Asserted Claims, Defendants have attempted to apply those interpretations, but this application of Plaintiff's interpretations is not an agreement or admission that any of Plaintiff's interpretations are correct. To be clear, Defendants do not agree with Plaintiff's Infringement Contentions but are merely offering Invalidity Contentions based on those interpretations.

The references identified in the exhibits attached to these Invalidity Contentions may disclose the elements of the Asserted Claims explicitly and/or inherently, and/or they may be relied

upon to show how the state of the art in the relevant time frame invalidates the asserted patent claims. In some instances, multiple prior art publications discuss the same underlying system, software, or other project. For example, some patents and published patent applications may reflect commercial products or services offered in the market. It would have been obvious to consider and combine the teachings of a patent or patent application that relate to a certain product or service with the features of that product or service as provided commercially. Similarly, where multiple publications discuss the same underlying product, service, project, or system, it would have been obvious to combine the discussions and disclosures of the publications as they would have been understood to describe features or potential features of the underlying subject matter. Likewise, where one publication discusses another publication, it would have been obvious to consider and combine the teachings of each publication in combination with each other.

Defendants' contentions that the references in this section, in various combinations, render the Asserted Claims of the Patents-in-Suit obvious under 35 U.S.C. § 103 are in no way an admission or suggestion that each reference does not independently anticipate the Asserted Claims under 35 U.S.C. § 102. Any of these references may be combined with other disclosed references, the disclosed products and systems, and/or with the knowledge of one of ordinary skill in the art during the relevant time period to render obvious, and, therefore, invalidate, the Asserted Claims of the Patents-in-Suit.

Although Defendants have identified at least one disclosure of a limitation for each prior art reference, each and every disclosure of the same limitation in the same reference is not necessarily identified. To focus the issues, Defendants cite only exemplary and representative portions of an identified reference, even where a reference may contain additional support for a particular claim limitation. Persons of ordinary skill in the art read an item of prior art as a whole

and in the context of other publications and literature. Thus, to understand and interpret any specific statement or disclosure within a prior art reference that Defendants identify as exemplary and representative, such persons of ordinary skill in the art would rely on other information within the reference, along with other publications and their general scientific knowledge. As such, Defendants may rely upon uncited portions of the prior art references and on other publications and expert testimony to provide context, and as aids to understanding and interpreting the exemplary portions that are cited.

No showing of a specific motivation to combine prior art is required to combine the references disclosed above and in the attached charts, as each combination of art would have no unexpected results, and at most would simply represent a known alternative to one of ordinary skill in the art. *See KSR Int'l Co. v. Teleflex, Inc.*, 127 S. Ct. 1727, 1739-40 (2007) (rejecting the Federal Circuit's "rigid" application of the teaching, suggestion, or motivation to combine test, instead espousing an "expansive and flexible" approach). That said, the Supreme Court's rationale, that a person of ordinary skill in the art is "a person of ordinary creativity, not an automaton" and "in many cases a person of ordinary skill in the art will be able to fit the teachings of multiple patents together like pieces of a puzzle," applies equally here. *Id.* at 1742. Nevertheless, in addition to the information contained in the section(s) above and elsewhere in these contentions, Defendants hereby identify additional motivations and reasons to combine the cited art. Further motivations are provided in the attached charts.

One or more combinations of the prior art references identified herein would have been obvious because these references would have been combined using: known methods to yield predictable results; known techniques in the same way; a simple substitution of one known, equivalent element for another to obtain predictable results; and/or a teaching, suggestion, or

motivation in the prior art generally. In addition, it would have been obvious to try combining the prior art references identified above because there were only a finite number of predictable solutions and/or because known work in one field of endeavor prompts variations based on predictable design incentives and/or market forces either in the same field or a different one. In addition, the combinations of the prior art references identified above would have been obvious because the combinations represent the known potential options with a reasonable expectation of success.

Motivation to combine any two or more of the identified references, systems, and/or products comes from the fact that the references, systems, and/or products teach structural designs and use of multiple display devices, and one would have been motivated by considerations of efficiency, effectiveness, convenience, cost-savings, power savings, and accessibility, to combine the various teachings. Additional evidence that there would have been a motivation or reason to combine the prior art references identified above includes the interrelated teachings of multiple prior art references; the effects of demands known to the design community or present in the marketplace; the existence of a known problem for which there was an obvious solution; the existence of a known need or problem in the field of endeavor at the time of the invention; and the background knowledge that would have been possessed by a person having ordinary skill in the art. For example, the prior art references, systems, and/or products are generally directed to the same or similar problems. Some references expressly incorporate others by reference or are authored by the same inventor. Thus, a skilled artisan seeking to solve these problems would have looked to these cited references in combination.

Thus, the motivation or reason to combine the teachings of the prior art references disclosed herein is found in the references themselves and in: (1) the nature of the problem being solved;

(2) the express, implied, and inherent teachings of the prior art; (3) the knowledge of persons of ordinary skill in the art; (4) the fact that the prior art is generally directed towards the same problem; (5) the predictable results obtained in combining the different elements of the prior art; (6) the use of a known technique to improve similar devices, methods, or products in the same way; (7) the predictable results obtained in applying a known technique to a known device, method, or product ready for improvement; (8) the finite number of identified predictable solutions having a reasonable expectation of success; and/or (9) known work in various technological fields that could be applied to the same or different technological fields based on design incentives or other market forces.

1. '767 Patent

Table 4: Exemplary Anticipatory and Combinations for the Asserted Claims of the '767 Patent

Chart	Prior Art References
A1	R2-1701727 to Intel either alone or in combination with one or more of US 2015/0358848 A1 to Kim et al., R1-1701979 to NEC Corporation, US 2017/0339667 A1 to Shen et al., 3GPP TR 38.802 V14.0.0 to Radio Access Technology, WO2016025899A1 to Stern-Berkowitz et al., US 10,785,747 B2 to Kim et al., and R1-166881 to LG Electronics
A2	3GPP TR 38.802 V14.0.0 to Radio Access Tech (V14.0.0)
A3	US 2022/0061025 A1 to Deng et al.
A4	You either alone or in combination with one or more of Liu (WO2018/126401), Mallick, Liu (WO 2018/081913), Hu, Luo, and Vitthaladevuni
A5	Wang either alone or in combination with one or more of Dahlman, Chen, Weng, Islam, You, and 3GPP TS 36.304 V12.8.0
A6	4G Device(s) either alone or in combination with one or more of Liu (WO2018/126401), Islam, You, Hu, Luo, and Vitthaladevuni, 3GPP TS 36.304 V14.0.0, and 3GPP TR 38.802 V14.0.0

The prior art identified above, and in the attached ’767 charts, individually anticipate and/or can properly be combined in multiple ways to demonstrate the obviousness of the Asserted Claims of the ’767 patent. Various combinations of the references would have naturally been considered as part of the exercise of ordinary skill by one skilled in the art. The references disclosed in the attached charts and herein are also directed to the same or similar features as the purported invention claimed in the Asserted Claims of the ’767 patent. To the extent Apex contends that any of these features solved a problem in the art, the references cited herein show that that problem was known to those of ordinary skill and had already been solved using obvious solutions.

To that end, the Asserted Claims of the ’767 patent simply combine elements already combined and well known in the art and yield no more than what one skilled in the art would have expected from such a combination. For example, with respect to the ’767 patent, when confronted with the alleged problems described in the ’767 patent, one of ordinary skill in the art at the time of the alleged inventions would have been motivated to consider the techniques taught by the prior art cited in these Invalidity Contentions. Consideration of the teachings of this prior art, both individually and in combination, would necessarily lead to the alleged invention claimed in the ’767 patent. This is demonstrated by the cited prior art, which disclose all of the elements of the Asserted Claims of the ’767 patent, as well as motivations to modify or combine their individual teachings. One of skill in the art would have been motivated to either modify the prior art identified in the claim charts or to combine that prior art in the manner indicated, by, for example, their background knowledge, design incentives, effects of demands known to the design community, or other market forces. Moreover, the cited prior art share commonalities. To the extent it is argued that any cited prior art does not expressly disclose a particular claim or element, it would have

been inherent in the disclosure and/or obvious to a person of ordinary skill in the art to include the claimed element to perform the invention as claimed in the ’767 patent.

As described in the attached charts, all the elements of the Asserted Claims of the ’767 patent were commonplace before the alleged date of inventions. For each element, there exists evidence from the cited prior art that it was well known in the art prior to the date of invention. To the extent it is argued any of the cited prior art references, systems, and/or products do not anticipate the Asserted Claims, it would have been obvious to a person of ordinary skill in the art that the Asserted Claims are merely combinations of well-known methods and systems resulting in expected results.

Additionally, Defendants hereby incorporate by reference the motivations to combine references set forth during the prosecution of the Asserted Claims of the ’767 patent, including the statements and reasoning set forth by the examiner, as to why it would have been obvious to modify or combine references to achieve the limitations of the Asserted Claims of the ’767 patent.

2. ’113 Patent

Table 5: Exemplary Anticipatory and Combinations for the Asserted Claims of the ’113 Patent

Chart	Prior Art References
B1	R1-1701581 to ZTE Corporation et al. either alone or in combination with one or more of R1-1708135 to Huawei Technologies Co. Ltd. et al., R1-1704465 to MediaTek Inc., and US 2017/0207843 A1 to Jung et al.
B2	Yang Pub (639) either alone or in combination with US 2017/0207843 A1 to Jung et al.
B3	R1-1707782 to Spreadtrum
B4	R1-1705961 to Nokia
B5	Xia either alone or in combination with Jover, Vembu, and Deenoo.

Chart	Prior Art References
B6	Liu either alone or in combination with one or more of Wu, Jover, Vembu, and Deenoo
B7	Wu either alone or in combination with one or more of Jover, Vembu, Deenoo, and Liu
B8	Guan (US or WO publication) either alone or in combination with one or more of Jover, Vembu, Deenoo, and R1-1710596
B9	R1-170596 either alone or in combination with one or more of Jover, Vembu, Deenoo, and Guan
B10	4G Device(s) either alone or in combination with one or more of Jung, Yang, and ZTE

The prior art identified above, and in the attached ’113 charts, individually anticipate and/or can properly be combined in multiple ways to demonstrate the obviousness of the Asserted Claims of the ’113 patent. Various combinations of the references would have naturally been considered as part of the exercise of ordinary skill by one skilled in the art. The references disclosed in the attached charts and herein are also directed to the same or similar features as the purported invention claimed in the Asserted Claims of the ’113 patent. To the extent Apex contends that any of these features solved a problem in the art, the references cited herein show that that problem was known to those of ordinary skill and had already been solved using obvious solutions.

To that end, the Asserted Claims of the ’113 patent simply combine elements already combined and well known in the art and yield no more than what one skilled in the art would have expected from such a combination. For example, with respect to the ’113 patent, when confronted with the alleged problems described in the ’113 patent, one of ordinary skill in the art at the time of the alleged inventions would have been motivated to consider the techniques taught by the prior art cited in these Invalidity Contentions. Consideration of the teachings of this prior art, both individually and in combination, would necessarily lead to the alleged invention claimed in the

’113 patent. This is demonstrated by the cited prior art, which disclose all of the elements of the Asserted Claims of the ’113 patent, as well as motivations to modify or combine their individual teachings. One of skill in the art would have been motivated to either modify the prior art identified in the claim charts or to combine that prior art in the manner indicated, by, for example, their background knowledge, design incentives, effects of demands known to the design community, or other market forces. Moreover, the cited prior art share commonalities. To the extent it is argued that any cited prior art does not expressly disclose a particular claim or element, it would have been inherent in the disclosure and/or obvious to a person of ordinary skill in the art to include the claimed element to perform the invention as claimed in the ’113 patent.

As described in the attached charts, all the elements of the Asserted Claims of the ’113 patent were commonplace before the alleged date of inventions. For each element, there exists evidence from the cited prior art that it was well known in the art prior to the date of invention. To the extent it is argued any of the cited prior art references, systems, and/or products do not anticipate the Asserted Claims, it would have been obvious to a person of ordinary skill in the art that the Asserted Claims are merely combinations of well-known methods and systems resulting in expected results.

Additionally, Defendants hereby incorporate by reference the motivations to combine references set forth during the prosecution of the Asserted Claims of the ’113 patent, including the statements and reasoning set forth by the examiner, as to why it would have been obvious to modify or combine references to achieve the limitations of the Asserted Claims of the ’113 patent.

3. ’081 Patent

Table 6: Exemplary Anticipatory and Combinations for the Asserted Claims of the ’081 Patent

Chart	Prior Art References
C1	US 2015/0009968 A1 to Yu et al.
C2	US 2016/0323028 to Cheng et al.
C3	R1-1707475 to CATT
C4	One or more of the references disclosed in Charts C1, C2, and C3 alone or in combination with one or more of 3GPP TS 36.306 version 14.2.0 Release 14, R1-1700539 to Panasonic, R1-1704618 to Guangdong OPPO Mobile Telecom, US 2010/0039970 A1 to Cho et al., US 2012/0314711 A1 to Trachewsky, R1-1707830 to MediaTek Inc., R1-1708334 to InterDigital, Inc., US 2019/0182821 A1 to You et al., US 2018/0227156 A1 to Papasakellariou, US 2011/0096856 A1 to Sadowsky et al., 3GPP TS 36.211 version 14.2.0 Release 14, 3GPP TS 36.212 version 14.2.0 Release 14, 3GPP TS 36.331 version 13.5.0 Release 13, 3G Evolution: HSPA and LTE for Mobile Broadband, and 4G: LTE / LTE-Advanced for Mobile Broadband
C5	Lee either alone or in combination with one or more of TS-36.212, TS-36.211, Islam, and Ahn
C6	Chen (US or WO publication) either alone or in combination with one or more of Lee, TS-36.212, TS-36.211, Islam, and Ahn
C7	R1-1707475 either alone or in combination with one or more of Lee, TS-36.212, TS-36.211, Chen, Islam, and Ahn
C8	4G Device(s) either alone or in combination with one or more of Lee, Chen, R1-1707475, Ahn, and Islam

The prior art identified above, and in the attached ’081 charts, individually anticipate and/or can properly be combined in multiple ways to demonstrate the obviousness of the Asserted Claims of the ’081 patent. Various combinations of the references would have naturally been considered as part of the exercise of ordinary skill by one skilled in the art. The references disclosed in the attached charts and herein are also directed to the same or similar features as the purported

invention claimed in the Asserted Claims of the ’081 patent. To the extent Apex contends that any of these features solved a problem in the art, the references cited herein show that that problem was known to those of ordinary skill and had already been solved using obvious solutions.

To that end, the Asserted Claims of the ’081 patent simply combine elements already combined and well known in the art and yield no more than what one skilled in the art would have expected from such a combination. For example, with respect to the ’081 patent, when confronted with the alleged problems described in the ’081 patent, one of ordinary skill in the art at the time of the alleged inventions would have been motivated to consider the techniques taught by the prior art cited in these Invalidity Contentions. Consideration of the teachings of this prior art, both individually and in combination, would necessarily lead to the alleged invention claimed in the ’081 patent. This is demonstrated by the cited prior art, which disclose all of the elements of the Asserted Claims of the ’081 patent, as well as motivations to modify or combine their individual teachings. One of skill in the art would have been motivated to either modify the prior art identified in the claim charts or to combine that prior art in the manner indicated, by, for example, their background knowledge, design incentives, effects of demands known to the design community, or other market forces. Moreover, the cited prior art share commonalities. To the extent it is argued that any cited prior art does not expressly disclose a particular claim or element, it would have been inherent in the disclosure and/or obvious to a person of ordinary skill in the art to include the claimed element to perform the invention as claimed in the ’081 patent.

As described in the attached charts, all the elements of the Asserted Claims of the ’081 patent were commonplace before the alleged date of inventions. For each element, there exists evidence from the cited prior art that it was well known in the art prior to the date of invention. To the extent it is argued any of the cited prior art references, systems, and/or products do not

anticipate the Asserted Claims, it would have been obvious to a person of ordinary skill in the art that the Asserted Claims are merely combinations of well-known methods and systems resulting in expected results.

Additionally, Defendants hereby incorporate by reference the motivations to combine references set forth during the prosecution of the Asserted Claims of the ’081 patent, including the statements and reasoning set forth by the examiner, as to why it would have been obvious to modify or combine references to achieve the limitations of the Asserted Claims of the ’081 patent.

4. ’527 Patent

Table 7: Exemplary Anticipatory and Combinations for the Asserted Claims of the ’527 Patent

Chart	Prior Art References
D1	US 10,425,139 B2 to Guo et al. either alone or in combination with one or more of US 10,299,267 to Wang and R1-1611421 to ZTE et al.
D2	US 2018/0054290 A1 to Park et al. either alone or in combination with R1-1613589 to Samsung et al.
D3	US 2013/0286960 to Li et al. either alone or in combination with R1-1612190 to China Mobile Communications Corporation (CMCC)
D4	Kim either alone or in combination with one or more of Zhang, Kang, Park-902, Park, TS 36.212 v12.2.0, Hu, Luo, and Vitthaladevuni
D5	Lee either alone or in combination with one or more of Zhang, Kang, Park-902, Park, TS 36.212 v12.2.0, Hu, Luo, and Vitthaladevuni
D6	Park-902 either alone or in combination with one or more of Zhang, Kang, Park, TS 36.212 v12.2.0, Hu, Luo, and Vitthaladevuni
D7	4G Device(s) either alone or in combination with one or more of Zhang, Kang, Park-902, Hu, Luo, and Vitthaladevuni

The prior art identified above, and in the attached ’527 charts, individually anticipate and/or can properly be combined in multiple ways to demonstrate the obviousness of the Asserted Claims

of the ’527 patent. Various combinations of the references would have naturally been considered as part of the exercise of ordinary skill by one skilled in the art. The references disclosed in the attached charts and herein are also directed to the same or similar features as the purported invention claimed in the Asserted Claims of the ’527 patent. To the extent Apex contends that any of these features solved a problem in the art, the references cited herein show that that problem was known to those of ordinary skill and had already been solved using obvious solutions.

To that end, the Asserted Claims of the ’527 patent simply combine elements already combined and well known in the art and yield no more than what one skilled in the art would have expected from such a combination. For example, with respect to the ’527 patent, when confronted with the alleged problems described in the ’527 patent, one of ordinary skill in the art at the time of the alleged inventions would have been motivated to consider the techniques taught by the prior art cited in these Invalidity Contentions. Consideration of the teachings of this prior art, both individually and in combination, would necessarily lead to the alleged invention claimed in the ’527 patent. This is demonstrated by the cited prior art, which disclose all of the elements of the Asserted Claims of the ’527 patent, as well as motivations to modify or combine their individual teachings. One of skill in the art would have been motivated to either modify the prior art identified in the claim charts or to combine that prior art in the manner indicated, by, for example, their background knowledge, design incentives, effects of demands known to the design community, or other market forces. Moreover, the cited prior art share commonalities. To the extent it is argued that any cited prior art does not expressly disclose a particular claim or element, it would have been inherent in the disclosure and/or obvious to a person of ordinary skill in the art to include the claimed element to perform the invention as claimed in the ’527 patent.

As described in the attached charts, all the elements of the Asserted Claims of the ’527 patent were commonplace before the alleged date of inventions. For each element, there exists evidence from the cited prior art that it was well known in the art prior to the date of invention. To the extent it is argued any of the cited prior art references, systems, and/or products do not anticipate the Asserted Claims, it would have been obvious to a person of ordinary skill in the art that the Asserted Claims are merely combinations of well-known methods and systems resulting in expected results.

Additionally, Defendants hereby incorporate by reference the motivations to combine references set forth during the prosecution of the Asserted Claims of the ’527 patent, including the statements and reasoning set forth by the examiner, as to why it would have been obvious to modify or combine references to achieve the limitations of the Asserted Claims of the ’527 patent.

5. ’271 Patent

Table 8: Exemplary Anticipatory and Combinations for the Asserted Claims of the ’271 Patent

Chart	Prior Art References
E1	US 2017/0085303 A1 to Chen et al.
E2	US 2015/0063287 A1 to Mazzarese et al.
E3	US 2014/0192917 A1 to Nam et al.
E4	One or more of the references disclosed in Charts E1, E2, and E3 alone or in combination with one or more of US 2014/0192917 A1 to Nam et al., R1-1609080 to Samsung, US 2015/0358848 A1 to Kim et al., and US 2018/0083680 A1 to Guo et al.
E5	Liu either alone or in combination with one or more of Kim, Park, Chen, Sesia LTE, Hu, Luo, and Vitthaladevuni
E6	Kim either alone or in combination with one or more of Liu, Park, Chen, Sesia LTE, Hu, Luo, and Vitthaladevuni

Chart	Prior Art References
E7	Sesia LTE either alone or in combination with one or more of Liu, Kim, Park, Chen, Hu, Luo, and Vitthaladevuni
E8	4G Device(s) either alone or in combination with one or more of Liu, Kim, Park, Chen, Sesia LTE, Hu, Luo, and Vitthaladevuni
E9	Chen US/WO either alone or in combination with one or more of Liu, Kim, Park, Sesia LTE, Hu, Luo, and Vitthaladevuni

The prior art identified above, and in the attached ’271 charts, individually anticipate and/or can properly be combined in multiple ways to demonstrate the obviousness of the Asserted Claims of the ’271 patent. Various combinations of the references would have naturally been considered as part of the exercise of ordinary skill by one skilled in the art. The references disclosed in the attached charts and herein are also directed to the same or similar features as the purported invention claimed in the Asserted Claims of the ’271 patent. To the extent Apex contends that any of these features solved a problem in the art, the references cited herein show that that problem was known to those of ordinary skill and had already been solved using obvious solutions.

To that end, the Asserted Claims of the ’271 patent simply combine elements already combined and well known in the art and yield no more than what one skilled in the art would have expected from such a combination. For example, with respect to the ’271 patent, when confronted with the alleged problems described in the ’271 patent, one of ordinary skill in the art at the time of the alleged inventions would have been motivated to consider the techniques taught by the prior art cited in these Invalidity Contentions. Consideration of the teachings of this prior art, both individually and in combination, would necessarily lead to the alleged invention claimed in the ’271 patent. This is demonstrated by the cited prior art, which disclose all of the elements of the Asserted Claims of the ’271 patent, as well as motivations to modify or combine their individual

teachings. One of skill in the art would have been motivated to either modify the prior art identified in the claim charts or to combine that prior art in the manner indicated, by, for example, their background knowledge, design incentives, effects of demands known to the design community, or other market forces. Moreover, the cited prior art share commonalities. To the extent it is argued that any cited prior art does not expressly disclose a particular claim or element, it would have been inherent in the disclosure and/or obvious to a person of ordinary skill in the art to include the claimed element to perform the invention as claimed in the ’271 patent.

As described in the attached charts, all the elements of the Asserted Claims of the ’271 patent were commonplace before the alleged date of inventions. For each element, there exists evidence from the cited prior art that it was well known in the art prior to the date of invention. To the extent it is argued any of the cited prior art references, systems, and/or products do not anticipate the Asserted Claims, it would have been obvious to a person of ordinary skill in the art that the Asserted Claims are merely combinations of well-known methods and systems resulting in expected results.

Additionally, Defendants hereby incorporate by reference the motivations to combine references set forth during the prosecution of the Asserted Claims of the ’271 patent, including the statements and reasoning set forth by the examiner, as to why it would have been obvious to modify or combine references to achieve the limitations of the Asserted Claims of the ’271 patent.

III. Invalidity Under 35 U.S.C. § 112

Defendants contend that one or more of the Asserted Claims are invalid under 35 U.S.C. § 112. As explained below, these claims are indefinite and/or fail to satisfy the written description and/or enablement requirements.

For example, the patents do not provide sufficient written description support to establish

that the alleged inventor possessed the alleged inventions recited in the Asserted Claims. *See Ariad Pharm.*, 598 F.3d at 1351. As another example, the patents do not provide sufficient support—by themselves or through any disclosure incorporated by reference. Because the patents do not support these claim elements, the corresponding claims—and any claim(s) depending directly or indirectly therefrom—are invalid under 35 U.S.C. § 112(a).

One or more of the Asserted Claims are also invalid as indefinite under 35 U.S.C. § 112(b). These claims fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention. *Nautilus*, 572 U.S. at 901. Accordingly, these claims are invalid as indefinite. For example, an artisan of ordinary skill could not discern, with reasonable certainty, the scope of the claim terms identified below.

Asserted Patent	**Asserted Claim(s)**	**Claim Term(s)**	**Invalidity Under 35 U.S.C. § 112**
’767 Patent	Claims 1-5 and 11-15	The phrases “used for determining,” and “used for transmitting” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.
’767 Patent	Claims 2, 3, 12, and 13	The phrase “the X time intervals are X time intervals of the Y time intervals, Y being a positive integer not smaller than X” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’767 Patent	Claims 3 and 13	The term “configurable” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.
’767 Patent	Claim 11	The terms “occupied frequency domain resource” and “frequency domain” are invalid under 35 U.S.C. §§ 112(a) and (b).	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claim. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.
’113 Patent	Claims 1, 2, 5, 11, 12, and 15	The phrases: “used for triggering,” “used for determining,” and “used for transmitting” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’113 Patent	Claims 1 and 11	The phase “the second time window and the third time window have overlapped time domain resource(s)” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’113 Patent	Claims 3 and 13	The terms “first type” and “second type” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’113 Patent	Claim 11	“a measurement for the target radio signal obtains a target measurement value” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claim. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’113 Patent	Claim 11	There is no antecedent basis for “fourth receiver module.” The claim recites a “first receiver module,” but no “second receiver module” or “third receiver module”	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claim. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.
’113 Patent	Claim 11	There is no antecedent basis for “second transmitter module” or “third transmitter module.” There is no “first transmitter module.”	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claim. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.
’081 Patent	Claims 1 and 9	“the second radio signal is used for determining the multi-antenna related receiving” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claim. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’081 Patent	Claims 1 and 9	“a first bit block is used for generating the first radio signal,” “any one given multicarrier symbol of the G multicarrier symbols,” “the second radio signal is used for determining a time-domain resource,” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.
’081 Patent	Claims 1 and 9	“multi-antenna related receiving” and “relative position” lack antecedent basis	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’081 Patent	Claims 2 and 10	“the first information is/being used for determining the first time point,” and “the third information is/being used for determining a candidate scheme” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’081 Patent	Claims 3, 4, and 10	“the second information is/being used for determining the first time point” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’081 Patent	Claim 9	“used to determine” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claim. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitation fails to inform those skilled in the art about the scope of the invention with reasonable certainty.
’527 Patent	Claims 1 and 11	“available to the base station”	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’527 Patent	Claims 1 and 11	“available to the user equipment”	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’527 Patent	Claims 1, 2, 4, 11, 12, and 14	“used to determine” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’527 Patent	Claims 1 and 11	“associated with” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’527 Patent	Claims 11 and 12	“receiving” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’527 Patent	Claims 2 and 12	“operating” is invalid under 35 U.S.C. §§ 112(a) and (b).	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’527 Patent	Claims 3 and 13	“at most” and “block(s)” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’527 Patent	Claim 13	“further monitors” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’527 Patent	Claims 4 and 14	“group(s)” and “belong(s)” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’527 Patent	Claim 14	“further receives” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’527 Patent	Claims 5 and 15	“time domain” lacks an antecedent basis	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claim 1 and 11	“a Signal to Interference plus Noise Ratios (SINRs)” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 1-4, 5 and 11-14, 15	“a ratio(ratios)” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’271 Patent	Claims 1, 2, 4, 11, 12, and 14	“a first channel quality is a best channel quality value among the K1 channel quality values” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 1, 3, 11, and 13	“ratio(ratios) among the K1/K2 channel quality values” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 1, 4, 11, and 14	“worse channel quality value” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’271 Patent	Claims 1 and 11	“first information is used to determine the K1 antenna port groups and the first proportional sequence” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 1 and 11	“the first signaling is used to determine a target threshold” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’271 Patent	Claims 1 and 11	“the first signaling is used by the UE to determine the K antenna port groups” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 1 and 11	“K antenna port groups of the base station are used to transmit the first wireless signal” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 2 and 12	“at least one 1” and “quantized values” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’271 Patent	Claims 2 and 12	“the K channel quality values are broadband channel quality values” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claims are invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claims are invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claim 3	“receive signals” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claim 3	“second receive beamforming vector” lacks antecedent basis	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’271 Patent	Claims 3 and 13	“a first receiving beamforming vector is used to receive signals transmitted through the Kl antenna port groups” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 3 and 13	“a second receiving beamforming vector is used to receive signals transmitted through the K2 antenna port groups” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 3 and 13	“the first receiving beamforming vector and the second receive beamforming vector are different” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’271 Patent	Claims 3 and 13	“the first information is further used to determine the K2 antenna port groups and the second proportional sequence” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claim 4 and 14	“same carrier” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 4 and 14	“wherein any two antenna ports in the Kl antenna port groups are co-located or quasi-co-located (QCL), and any two antenna ports in the K2 antenna port groups are co-located or quasi-co-located (QCL)” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.

Asserted Patent	Asserted Claim(s)	Claim Term(s)	Invalidity Under 35 U.S.C. § 112
’271 Patent	Claims 4 and 14	“at least the last one of the K1, the K2 and the target threshold,” “the first signaling is further used to determine at least the last one of the K1, the K2 and the target threshold,” “the first information is further used to determine at least one of the first channel quality and the third channel quality,” and “on a same carrier” are invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 5 and 15	“a target antenna port group is used to transmit the second wireless signal” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty.
’271 Patent	Claims 5 and 15	“the target antenna port group is associated with the Kl antenna port groups and the first proportional sequence, or the target antenna port group is associated with the K2 antenna port groups and the second proportional sequence” is invalid under 35 U.S.C. §§ 112(a) and (b)	The claim is invalid under 35 U.S.C. § 112(a) because the specification fails to describe or enable the full breadth of the claims. The claim is invalid under 35 U.S.C. § 112(b) because the claim limitations fail to inform those skilled in the art about the scope of the invention with reasonable certainty

IV. P.R. 3-4: Document Production Accompanying Invalidity Contentions

Defendants have produced documents, including PA-ABT_00000001 through PA-ABT_00024214 and SAM-ABT_00000001 through SAM-ABT_00007790; SAM-ABT_00008142 through SAM-ABT_00013569; SAM-ABT_00016130 through SAM-ABT_00018554; SAM-ABT_00018555 through SAM-ABT_00041223, pursuant to P.R. 3-4(a) and P.R. 3-4(b).

Dated: March 2, 2023

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CERTIFICATE OF SERVICE

I hereby certify that on March 2, 2023, I caused to be served copies of the foregoing **DEFENDANTS' INVALIDITY CONTENTIONS** on the following counsel via email:

Dated: March 2, 2023

/s/ *Seth Katz*
Seth Katz