

UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.,
Petitioner

v.

ASUS TECHNOLOGY LICENSING INC.,
Patent Owner.

IPR2024-01217
Patent No. 10,104,658

**PETITION FOR *INTER PARTES* REVIEW OF
CLAIMS 11-24 OF U.S. PATENT 10,104,658**

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TABLE OF EXHIBITS

Exhibit	Description
1001	U.S. Patent No. 10,104,658 (the “’658 patent”)
1002	Prosecution history of U.S. Patent No. 10,104,658 (“658FH”)
1003	Declaration of Michael AM Davies (“Davies Decl.”)
1004	U.S. Patent App. Pub. 2012/0207099 (“Lindh”)
1005	Stefania Sesia, Issam Toufik, and Matthew Baker (eds.), LTE— The UMTS Long Term Evolution: from theory to practice, 2d ed., John Wiley & Sons Ltd. (2011) (“Sesia”) TK5103.4883.S47 2011 621.3845’6-dc22 2010039466 Print ISBN: 978040660256 (H/B) ePDF ISBN: 9780470978511 oBook ISBN: 9780470978504 epub ISBN: 9780470978641
1006	U.S. Patent App. Pub. 2014/0307560 (“Kim”)
1007	U.S. Patent App. Pub. 2017/0290008 (“Tooher”)
1008	U.S. Provisional App. 62/047,610 (“Tooher-Prov”)
1009	3GPP TS 36.300 v12.5.0 (2015-03) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 12) (March 24, 2015) (“3GPP-36.300”)
1010	R1-112517, 3GPP TSG-RAN1#66 meeting Athens, Greece, 22-26 August 2011 Agenda Item: 6.6.2.2 Sou[r]ce: Samsung Title: Discussion on EPDCCH Design Issues

Exhibit	Description
	Document for: Discussion
1011	3GPP TS 36.300 v8.11.0 (2009-12) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 8) (January 5, 2010) (“3GPP-36.300-8.11.0”)
1012	Declaration of Craig Bishop
1013	Appendices to the Declaration of Craig Bishop
1014	Samsung <i>Sotera</i> Stipulation letter regarding IPR grounds in District court litigation
1015	3GPP TS 36.300 10.2.0 (2010-12) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall description; Stage 2 (Release 10) (January 5, 2010) (“3GPP-36.300-10.2.0”)
1016	First Amended Complaint, <i>Asus Technology Licensing Inc. et al. v. Samsung Elecs. Co. Ltd. et al.</i> , Case No. 2:23-cv-00409 (E.D. Tex. Mar. 11, 2024) (Dkt. 027)
1017	Dahlman, Erik et al., “4G, LTE/LTE-Advanced for Mobile Broadband,” Elsevier, 2d Ed. (October 7, 2013) Electronic version available for purchase from https://shop.elsevier.com/books/4g-lte-lte-advanced-for-mobile-broadband/dahlman/978-0-12-419985-9

TABLE OF AUTHORITIES

Cases

<i>Arbutus Biopharma Corp. v. ModernaTX, Inc.</i> , 65 F.4th 656 (Fed. Cir. 2023).....	32
<i>Constant v. Advanced Micro-Devices, Inc.</i> , 848 F.2d 1560 (Fed. Cir. 1988)	24
<i>EVE Energy Co., Ltd. v. VARTA Microbattery GmbH</i> , IPR2022-01476, Paper 16 (Mar. 14, 2023)	7
<i>Hulu LLC v. SITO Mobile R&D, LLC</i> , IPR2021-00298, Paper 11 (May 19, 2021)	7
<i>Littlefuse, Inc. v. Mersen USA EP Corp.</i> , 29 F.4th 1376 (Fed. Cir. 2022)	16
<i>Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.</i> , 868 F.3d 1013 (Fed. Cir. 2017)	10
<i>Penumbra, Inc. v. RapidPulse, Inc.</i> , IPR2021-01466, Paper 34 (March 10, 2023)	21
<i>Qualcomm Inc. v. Apple Inc.</i> , 24 F.4th 1367 (Fed. Cir. 2022)	24
<i>Sotera Wireless, Inc. v. Masimo Corp.</i> , IPR2020-01019, Paper 12 (Dec. 1, 2020)	7
<i>Straight Path IP Grp., Inc. v. Sipnet EU S.R.O.</i> , 806 F.3d 1356 (Fed. Cir. 2015)	17

I. Introduction

Samsung Electronics Co., Ltd. (“Petitioner”) hereby seeks *inter partes* review of claims 11-24 (the “Challenged Claims”) of U.S. Patent No. 10,104,658 (Ex-1001, the “’658 patent”).

II. Mandatory Notices Under 37 C.F.R. §42.8

A. Real Party-in-Interest Under 37 C.F.R. §42.8(b)(1)

Petitioner certifies that the real parties-in-interest are Samsung Electronics Co., Ltd., Samsung Electronics America, Inc., and Samsung Research America.

B. Related Matters Under 37 C.F.R. §42.8(b)(2)

The ’658 patent is currently the subject of pending litigation involving Petitioner: *Asus Technology Licensing Inc. et al. v. Samsung Elecs. Co. Ltd. et al.*, Case No. 2:23-cv-00409 (E.D. Tex.) (the “Asus Litigation”).¹ Petitioner is not aware of any other matters involving the ’658 patent.

C. Lead and Back-up Counsel Under 37 C.F.R. §42.8(b)(3) and Service Information under 37 C.F.R. §42.8(b)(4)

Petitioner designates the following lead and back-up counsel:

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¹ Asus filed an amended complaint on March 11, 2024, at which time Asus first asserted the ’658 patent. (Ex-1016.)

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III. Word Count

Petitioner certifies this Petition is 13,612 words, as counted by the word-processing program (Microsoft Word for Office 365) used to generate this Petition (excluding the table of contents, table of authorities, mandatory notices, certificate

of service, and this certificate). This Petition complies with the 14,000 word limit (37 C.F.R. §42.24(a)(1)(i)).

IV. IPR Eligibility and Fees

Petitioner certifies under 37 C.F.R. §42.104(a) that the '658 patent is available for IPR and Petitioner is not barred or estopped from requesting cancellation of the Challenged Claims on the grounds identified below.

Ground	'658 Patent Claim	Basis
Ground 1	11-24	Rendered obvious by Lindh (Ex-1004) in view of Tooher (Ex-1007)
Ground 2	11-24	Rendered obvious by Kim (Ex-1006) in view of 3GPP-36.300 (Ex-1009) and Samsung R1-112517 Proposal (Ex-1010)

V. The '658 Patent

A. General Overview

The '658 patent is directed to common and user equipment (UE) specific control signaling in wireless communication systems. (Ex-1001 at Abstract, 1:14-19, 1:41-55.) As was well known, a “UE” is a wireless communication device or access terminal that communicates with a network node (commonly called a base station, eNB, and the like). (*Id.* at 3:35-42; Ex-1003-Davies at ¶25.)

The '658 patent includes 10 Applicant Admitted Prior Art (“AAPA”) figures with 11 columns of corresponding text. (Ex-1001 at FIGS. 5-14, 5:18-16:8.) The

alleged invention is described in the context of known wireless networks, including 3GPP LTE and LTE-Advanced, as described in the AAPA. (*Id.* at 2:38-67 (describing conventional networks, modulation techniques, and standards, and incorporating various standards and publications by reference); 5:18-16:8 (describing LTE standards and the related AAPA figures, as noted above).)

The '658 patent focuses on the downlink subframe structure:

“SUMMARY

A method and apparatus for delivery of control signaling in a wireless communication system are disclosed....The method also includes transmitting, in the cell, a UE specific signal in a first symbol of a downlink control region of a subframe of the multiple subframes, wherein the network node is not allowed to transmit a common signal in the first symbol.” (*Id.* at 1:41-55).²

“FIG. 15 is a diagram of a subframe 1500 in according with one exemplary embodiment. In general, the concept of the invention is that in downlink control region 1505 of a subframe, there is at least a first part of the downlink control region (e.g., consisting of at least one symbol) used to transmit UE specific downlink control signaling (e.g., type 2) 1510, and not used to transmit common downlink control signaling (e.g., type 1). Then, the network could flexibly use the first part of downlink control region to transmit signaling on

² The complete Summary (of the Invention) is only 3 sentences long.

beam(s) of certain UE(s), and is not limited by the beams for type 1 signaling.” (*Id.* at 16:9-19.)

The subframe 1500 is depicted in FIG. 15:

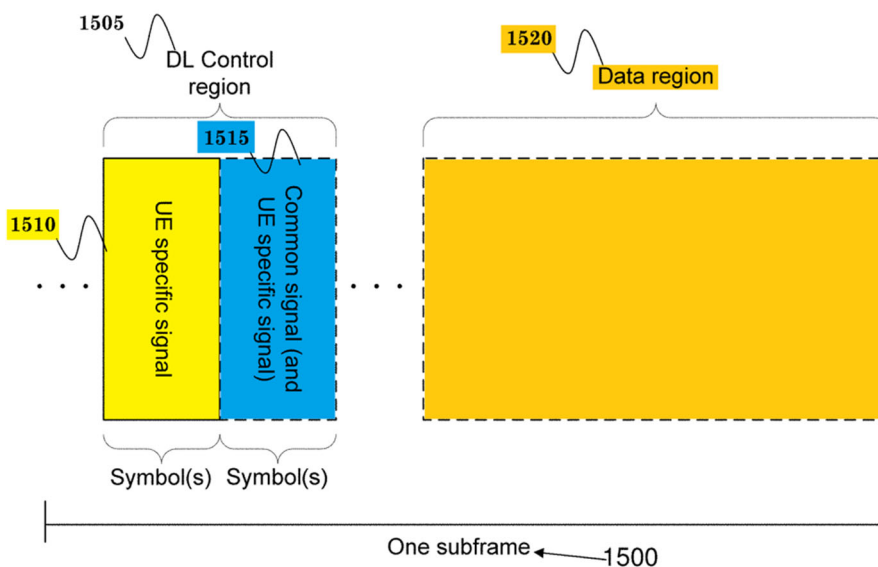


FIG. 15

(*Id.* at FIG. 15.)³ The subframe has distinct control (1505) and data (1520, orange) regions, with the control region having UE-specific (1510, yellow) and common (1515) control signal portions.

B. Effective Filing Date

The '658 patent was filed June 7, 2016 and claims priority to two provisional applications filed June 12, 2015 and June 23, 2015. (Ex-1001, (60).) The prior art

³ Highlighting, emphasis, and annotations in this this Petition are Petitioner's unless otherwise noted.

relied on herein is prior art with respect to all three dates. Mr. Davies further explains that his opinion regarding the level of ordinary skill in the art would be the same regardless of which date applies. (Ex-1003-Davies at ¶30.) Accordingly, to narrow the disputes at issue in this Petition, Petitioner assumes that the June 12, 2015 applies, while noting that there does not appear to be §112 support in either provisional for at least limitations 11.5 and 18.5.

C. Prosecution History

Prosecution of the '658 patent was minimal. The examiner issued a single non-final rejection rejecting claims over Takano (U.S. Patent App. Pub. 2014/0119349) alone and in view of Guey (US2016/0087707). (Ex-1002 at 373-78.)

In response, the applicant added limitations directed to monitoring a common signal in a second symbol of the DL control region, and required “the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe.” (*Id.* at 392-97.) The applicant also stated that “Takano fails to disclose control signals on different symbols would indicate data resources on different symbols, as recited in the claims.” (*Id.* at 399.) This argument, whether correct or not, does not distinguish the alleged invention from the prior art as shown herein.

A Notice of Allowance (“NOA”) issued thereafter. (*Id.* at 410-14.) The examiner did not provide any reasoning in support thereof.

After the NOA, the applicant filed an RCE and amended the challenged independent claims to recite “*at least one*” instead of “*a*” [first/second] symbol. (*Id.* at 452-61.) Another NOA without accompanying reasoning issued thereafter. (*Id.* at 469-73.)

D. The Challenged Claims

Petitioner challenges claims 11-24; claims 11 and 18 are independent.

VI. Discretionary Denial is Unwarranted

A. 35 U.S.C. §314(a) Does Not Favor Denial

The Board cannot discretionarily deny institution in view of the *Fintiv* factors when, as here, a petitioner presents a *Sotera* stipulation. (Ex-1014.) *EVE Energy Co., Ltd. v. VARTA Microbattery GmbH*, IPR2022-01476, Paper 16 at 9 (PTAB Mar. 14, 2023); *Sotera Wireless, Inc. v. Masimo Corp.*, IPR2020-01019, Paper 12 (Dec. 1, 2020) (precedential). For at least this reason, the Board should not discretionarily deny this petition.

The *Fintiv* factors also weigh against discretionary denial. Factor 1 (stay) is neutral because Samsung has not yet moved for a stay. *Hulu LLC v. SITO Mobile R&D, LLC*, IPR2021-00298, Paper 11 at 10-11 (May 19, 2021).

Factor 2 (proximity) favors institution. Petitioner is filing this Petition in August 2024, which suggests a final written decision around February 2026. The current Asus Litigation case schedule sets trial for September 2025. However, the equities show that any gap between trial and a final written decision is of Patentee’s

own making—the case schedule including the trial date was set in the ordinary course of a one-patent case Patentee originally filed in September 2023. The ’658 patent was first added to that case in March 2024 via Patentee’s Amended Complaint (Ex-1016).

Factor 3 (investment) heavily favors institution. Fact and expert discovery are in early stages and the Court has not issued any orders regarding the ’658 patent.

Factor 4 (overlap) heavily favors institution. Petitioner’s *Sotera* stipulation (Ex-1014) obviates the risk of overlap, as noted above.

Factor 5 (same parties) does not weigh against discretionary denial, because the parties in this IPR are the same as in the Asus Litigation. *See Fintiv*, IPR2020-00019, Paper 11 at 13-14.

Factor 6 (merits) heavily favors institution. The compelling merits of Petitioner’s arguments herein warrant institution because the Challenged Claims are unpatentable over references that were not considered by the Office during prosecution. Further, this is the only petition challenging the ’658 patent, so adjudicating invalidity in this proceeding would conserve resources.

B. 35 U.S.C. §325(d) Does Not Favor Denial

Non-institution under §325(d) would be improper in view of the *Advanced Bionics* framework and the *Becton Dickinson* factors. The prior art cited in

Petitioner’s Grounds were not before the examiner during prosecution and were not cited by the examiner in any Office Action. (Ex-1001 at 1-2.)

As shown above in §V.C, the examiner’s rejection related to Takano. The applicant alleged that Takano did not disclose the first and second symbol limitations of the challenged independent claims. Petitioner does not rely on Takano, and the prior art cited herein discloses the limitations that were allegedly missing in Takano. Furthermore, the examiner did not have the benefit of the Davies declaration, which explains what a POSITA would have understood from the prior art at the time of the ’658 patent. (Ex-1003-Davies at §§VII-X.) Accordingly, discretionary denial under 35 U.S.C. §325(d) would be improper.

VII. Person of Ordinary Skill in the Art (“POSITA”)

A POSITA in the field of the ’658 patent, as of its first provisional filing date⁴ of June 12, 2015, would have had at least a bachelor’s degree in electrical engineering, computer science, computer networking, or network engineering, and would have had familiarity with telecommunications. A POSITA also would have had familiarity with the relevant 3GPP standards as of this time, and two years of experience working in a field involving wireless communications. Additional

⁴ *But see* §V.B.

education may serve as a substitute for a lack of experience and vice versa. (Ex-1003-Davies, ¶¶33-42.)

VIII. Claim Construction

Petitioner does not believe any claim constructions are required and interprets the claims at issue in accordance with their ordinary and customary meanings to the extent possible. 37 C.F.R. §41.100(b). To be clear, Petitioner is not suggesting that there are no disputes regarding claim scope, including with respect to §112 issues. Rather, the invalidity Grounds raised herein render obvious the Challenged Claims under any reasonable interpretation of the claims, and thus the Board need not issue any formal constructions. *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Below, Petitioner addresses several potentially-ambiguous aspects of the Challenged Claims.

A. “signal”

The term “signal” is used nearly 300 times in the ’658 patent, often at a very general level. The term is also used in the Challenged Claims. For instance, the “common signal” and the “UE specific signal” of claims 11 and 18 cover control signals (e.g., “control signaling” or “signalings” such as a signal on PDCCH for allocating resources; Ex-1001 at 16:30-52) and reference signals (see, e.g., claims 15-16 and 21-22). (Ex-1003-Davies at ¶¶44-46.)

B. “symbol”

The term “symbol” is also used throughout the specification and claims. (*E.g.*, Ex-1001 at 3:59-4:6, 19:50-52.) The term often refers to a time duration (e.g., 1 OFDM symbol is often used to refer to the time it takes to transmit that symbol). (Ex-1003-Davies at ¶¶47-55.) The dependent claims of the ’658 patent indicate that the time duration interpretation is appropriate here because it refers to “a downlink control region” that “is two symbols,” i.e., is a region defined in terms of its time duration. (Ex-1001 at claims 17, 23.) AAPA FIG. 7 and FIG. 15 also suggest this interpretation. In AAPA FIG. 7, for example, a standard 0.5ms subframe slot⁵ has a time duration or length corresponding to 7 OFDM symbols; a full 1ms subframe would have 14 OFDM symbols:

⁵ See Ex-1001 [AAPA] at 5:36-40 “Each 10 ms radio frame consists of two half-frames of 5 ms each. Each half-frame consists of eight slots of length 0.5 ms and three special fields: DwPTS, GP and UpPTS.”

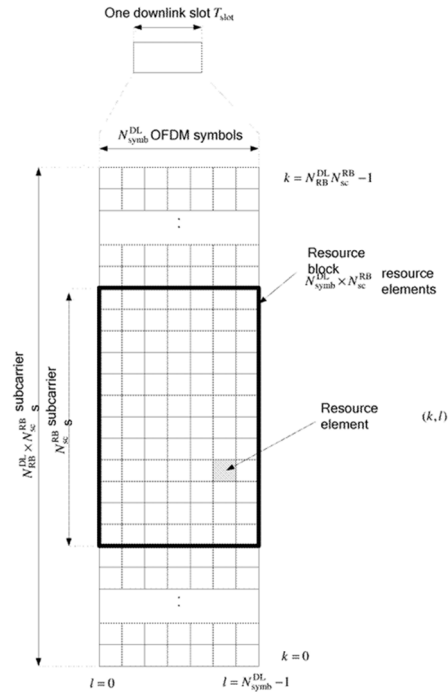


FIG. 7 (PRIOR ART)

(Ex-1001 at AAPA FIG. 7; Ex-1003-Davies at ¶49.)

FIG. 15, which illustrates “the concept of the [alleged] invention,”⁶ shows a subframe structure (1500) having a known duration (e.g., 1ms):

⁶ Ex-1001 at 16:10-16.

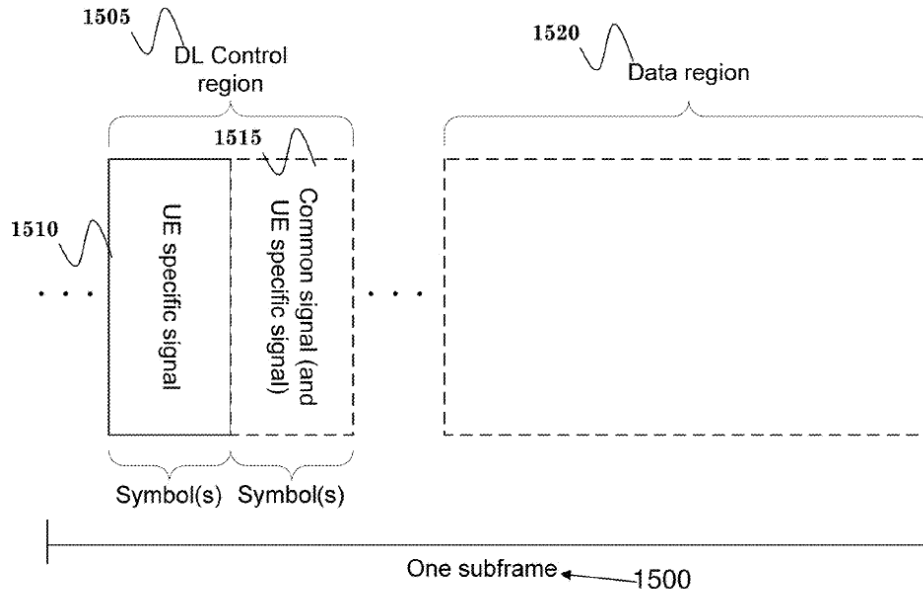


FIG. 15

The figure shows a subframe's duration is further divided into symbols for each portion of the subframe, which indicates that a “symbol” reflects a time length or duration. (Ex-1001 at FIG. 15; Ex-1003-Davies at ¶¶53-54 (noting that FIG. 15's horizontal axis relates to time, whereas the vertical axis relates to frequency).)

The prior art uses the term “symbol” in the same manner as the '658 patent. Indeed, a typical LTE subframe structure had a control region length of 3 OFDM symbols and a data region length of 11 OFDM symbols. (Ex-1003-Davies at ¶55.) This typical structure and variations thereof are discussed below.

C. “downlink control region of a subframe” and “data region of the subframe”

The Challenged Claims require a subframe that has two different downlink regions: a “control region” and a “data region.” An example is illustrated in FIG. 15:

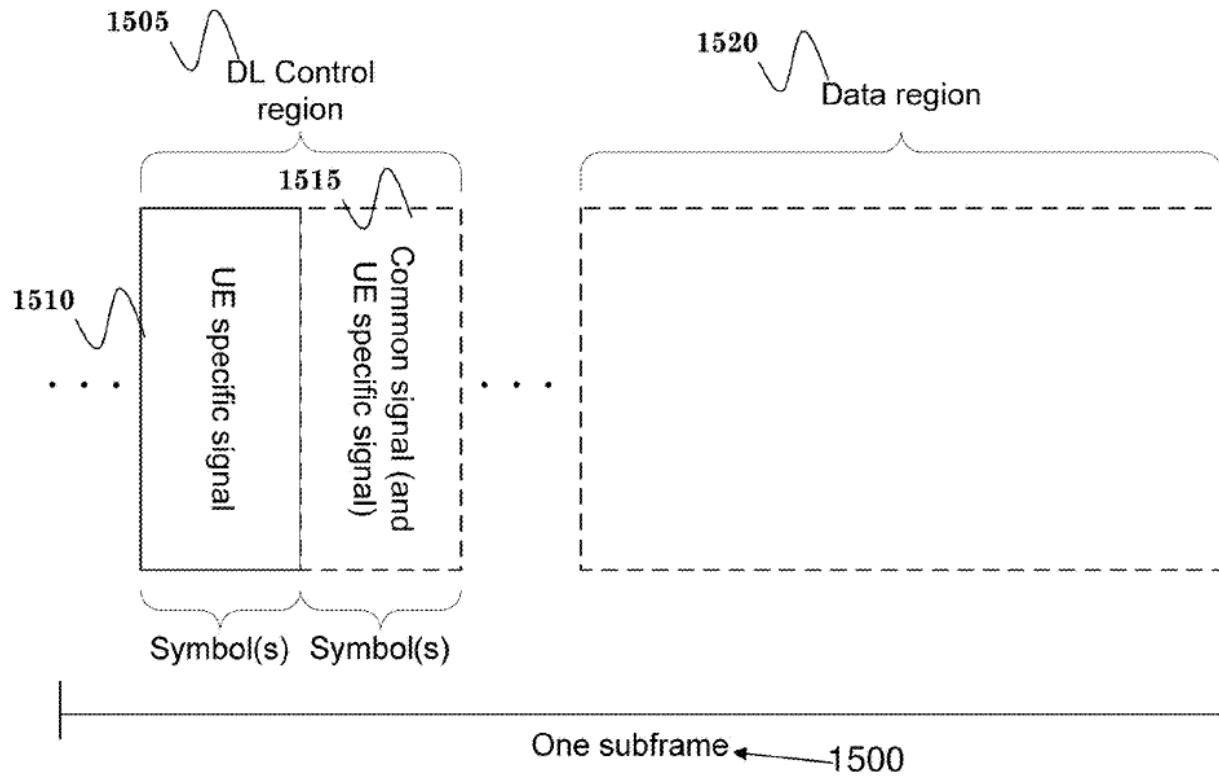
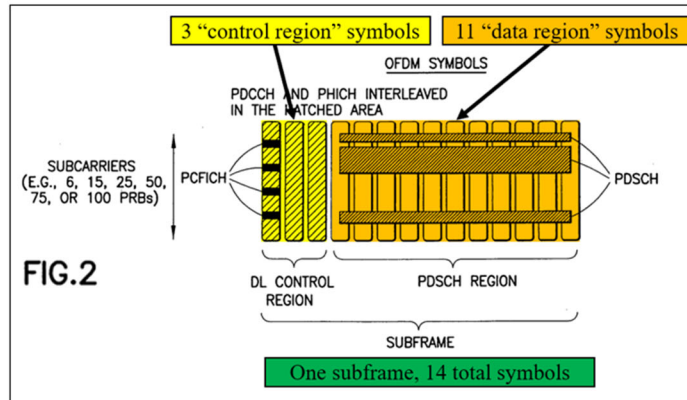
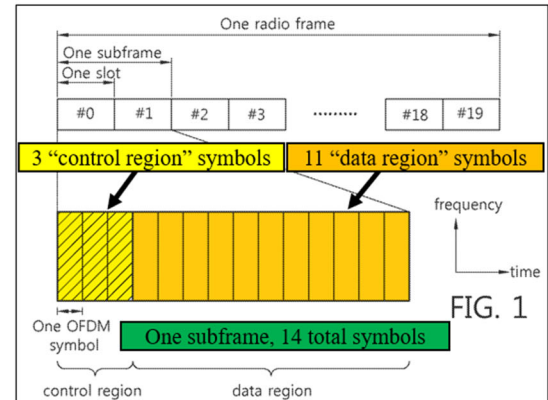


FIG. 15

(Ex-1001 at FIG. 15.) As shown, the two regions (1505, 1520) are defined separately (non-overlapping). Representations of typical LTE subframe structures in the prior art also reflect a similar separation between the two regions:

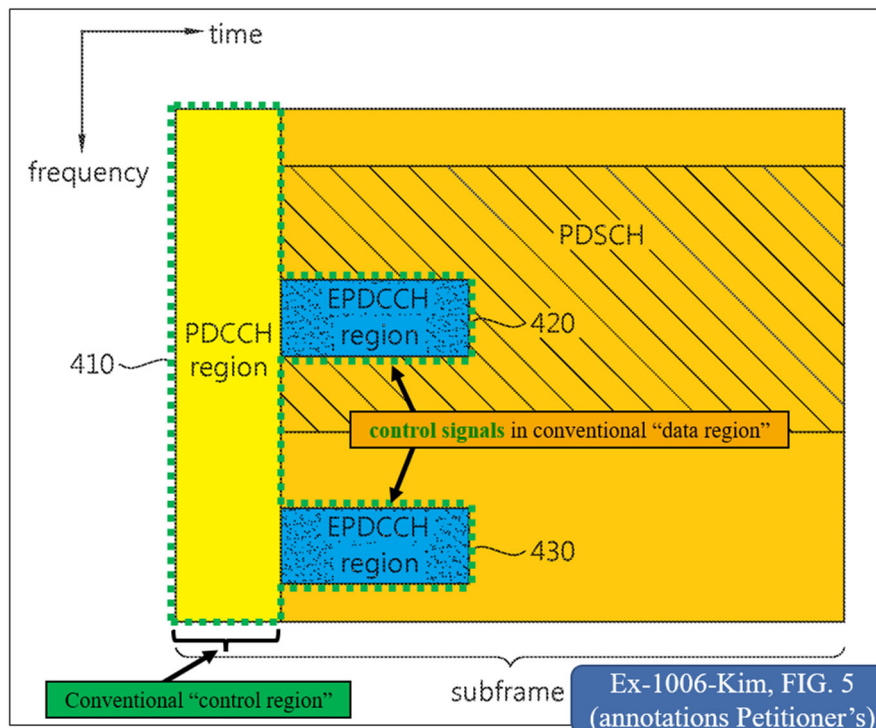


Ex-1004-Lindh, FIG. 2
 (label moved by Petitioner)



Ex-1006-Kim, FIG. 1
 (labels moved by Petitioner)

As shown herein, both Lindh and Kim disclose distinct downlink subframe control and data regions. However, as technology progressed, control information migrated into the data region. Kim (Ex-1006 (discussed in §IX and Ground 2)) provides an example:



Ex-1006-Kim, FIG. 5
 (annotations Petitioner's)

Kim explains that control information in the figure above is monitored in both the PDCCH region (yellow) and the EPDCCH regions (blue). (Ex-1006-Kim at 0087-98; Ex-1003-Davies at ¶¶56-59.) Thus, if the claims allow portions of the control region and data region to occupy the same symbol(s), as Patentee appears to interpret the claims, then Kim discloses such an arrangement as shown herein.⁷

D. “resources in different symbols of a data region of a subframe”

Limitations 11.5 and 18.5 require “wherein the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe.” The word “different” in this context could carry a variety of meanings, but appears to mean here that the symbols occupied by a UE-specific signal cannot be coextensive with the symbols for a common signal. (Ex-1003-Davies at ¶¶60-67.)

First, Petitioner notes that “different” cannot be limited to “completely different” because dependent claims (12, 19) cover symbols that are “completely different or partially different.” *E.g., Littlefuse, Inc. v. Mersen USA EP Corp.*, 29 F.4th 1376, 1380 (Fed. Cir. 2022) (explaining independent claim must cover dependent claim embodiments).

⁷ In the Asus Litigation, Patentee appears to rely on a frame structure that does not define a control region and data region or restrict such regions to certain symbols. (Ex-1016-Complaint at ¶92.)

Second, the specification suggests that “different” means that the “indicate[d] resources” cannot be coextensive in terms of symbols:

“[A] signaling transmitted in the first part of the downlink control region of the subframe could be associated with resources in first symbol(s) of the data region in the subframe; and a signaling transmitted in the second part of the downlink control region of the subframe could be associated with resources in second symbol(s) of the data region in the subframe. The first symbol(s) and the second symbol(s) are completely or partially different.” (Ex-1001 at 17:15-22.)

The language in the specification is slightly different than in the claims (e.g., a signal is “associated with resources” rather than “indicate[s] resources,”), but conveys the same concept: a difference exists unless two indicated resources are coextensive (occupying exactly the same symbols). (Ex-1003-Davies at ¶¶60-67.) The prior art relied on herein discloses indicated resources in different symbols of a data region under any reasonable construction. (*Id.*)

E. “a length of the downlink control region is two symbols”

Dependent claims 17 and 23 require that the “length of the downlink control region is two symbols.” As shown, the word “is” defines how many symbols are allowed and is equivalent to “equals” in this context. *Straight Path IP Grp., Inc. v. Sipnet EU S.R.O.*, 806 F.3d 1356, 1360 (Fed. Cir. 2015). Thus, dependent claims 17 and 23 require a control region length of exactly two symbols. This construction is

confirmed by the language of the corresponding independent claims which, by contrast, recite “at least one” [first/second] symbol. By changing from “at least one” in the independent claims to the word “is” in dependent claims 17 and 23, Patentee appears to limit the control region to exactly two symbols. (Ex-1003-Davies at ¶68.)

IX. Prior Art Overview

A. Lindh (Ex-1004)

Lindh is U.S. Patent App. Pub. 2012/0207099, filed February 11, 2011 and published August 16, 2012. Lindh is prior art under at least AIA §102(a)(2).

Lindh discloses UEs that communicate with a network node (eNB) over a network using downlinks and uplinks. (Ex-1004-Lindh at FIGS. 1-2, 0050-0062, 0080-0082.) Lindh further discloses downlink control channel structures corresponding to those of the Challenged Claims. For example, Lindh’s FIG. 4 discloses a subframe (470) having two portions of a control region (410, 420), one for legacy control signals [420, highlighted yellow] and the other for enhanced control signals [410, blue], a data region (orange), and resources (green and purple) located in the data region:

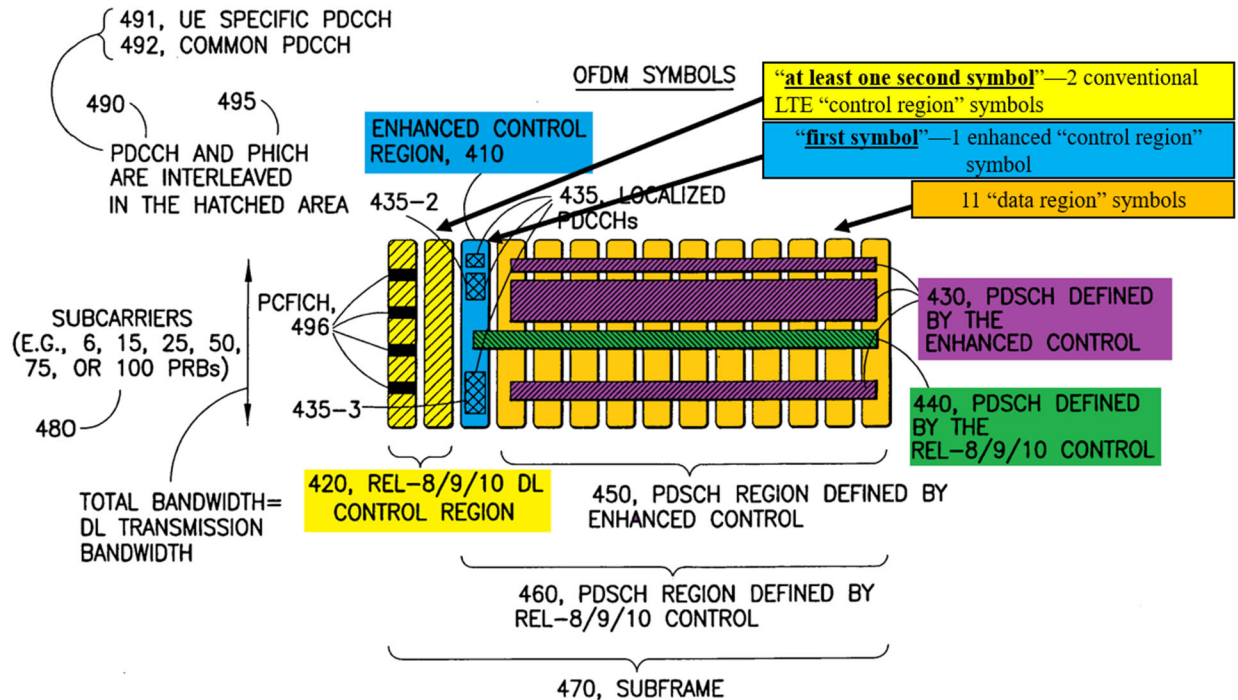


FIG. 4

(Ex-1004-Lindh at FIG. 4; *see id.* at 0067, 0095-112 (describing FIG. 4 and related FIG. 5).)

B. Sesia (Ex-1005)

Sesia is a 2011 book entitled "LTE: The UMTS Long Term Evolution—From Theory to Practice."⁸ Sesia is prior art under at least AIA §102(a)(1). As the Foreword states, Sesia "provides a thorough, authoritative and complete tutorial of the LTE

⁸ Sesia states it was first published in and bears a copyright date of 2011, and recites ISBN Nos. 9780470660256 (hardback) and 9780470978511 (ePDF), among other indicators, showing it was published and publicly accessible in 2011. (Ex-1005-Sesia at 6.)

system” inclusive of LTE-Advanced. (Ex-1005-Sesia at 29.) In relevant part, Sesia provides express details regarding how “special purpose” information was conventionally transmitted in LTE.

C. Kim (Ex-1006)

Kim is U.S. Patent Application Publication No. 2014/0307560, which published on October 16, 2014. Kim is prior art under at least AIA §102(a)(2).⁹

Kim discloses UEs communicating with a network node (eNB) over a network using downlinks and uplinks. (Ex-1006-Kim at 0024-27.) Kim further discloses downlink control channel structures corresponding to those of the Challenged Claims under at least Patentee’s apparent interpretation of the claim language. (*See* §VIII.) For example, FIG. 1 discloses a conventional frame having 10 subframes with 2 slots and 14 OFDM symbols per subframe (the symbols in one subframe being separated into 3 control region symbols and 11 data region symbols). (Ex-1006-Kim at FIG. 1.) Kim further discloses an enhancement to the conventional subframe structure that comprises “enhanced” control regions called “EPDCCH”

⁹ Kim also published in Korean as WO2013/066083 on May 10, 2013 (“Kim-PCT”). Kim-PCT is also prior art to the ’658 patent. Petitioner uses US2014/0307560 herein for convenience.

regions. (Ex-1006-Kim at FIG. 5, 0020; *see id.* at 0087-0101 (generally describing FIG. 5).)

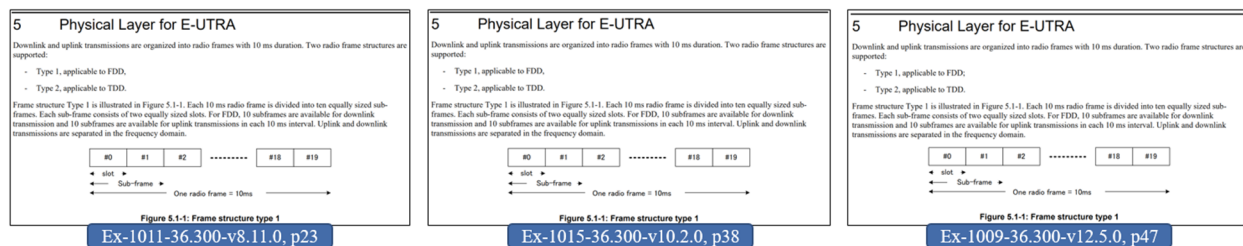
D. Tooher (Ex-1007)

Tooher is U.S. Patent App. Pub. 2017/0290008, filed September 8, 2015 and claiming priority to two provisionals, including U.S. Provisional App. No. 62/047,610, filed September 8, 2014 (Ex-1008-Tooher-Prov, “Tooher-Prov”). Tooher is prior art as of the Tooher-Prov’s September 8, 2014 filing date. Both Tooher and Tooher-Prov describe the subject matter relied upon in Ground 1, as Petitioner’s parallel citations herein demonstrate. Thus, Tooher is prior art under at least §102(a)(2) as of the Tooher-Prov filing date. *Penumbra, Inc. v. RapidPulse, Inc.*, IPR2021-01466, Paper 34 at 29-32 (March 10, 2023) (precedential).

Tooher discloses variable durations/locations for control signals and resources, including signals and resources found in a Physical Downlink Control Channel (“PDCCH”), Enhanced PDDCH (“EPDCCH”), and Physical Downlink Shared Channel (“PDSCH”). Tooher’s FIG. 5 discloses that signals in a subframe’s EPDCCH regions may indicate corresponding data resources in PDSCH channels that are in different symbols; in FIG. 5 one EPDCCH indicates a PDSCH resource allocation in symbols of time slot 1, while another EPDCCH indicates resource allocation in symbols of time slot 2. (*E.g.*, Ex-1007-Tooher at FIG. 5, 0143; Ex-1008-Tooher-Prov at FIG. 4, 0093; Ex-1003-Davies at ¶¶76-78.)

E. 3GPP-36.300 (Ex-1009)

3GPP-36.300 is prior art; as Mr. Bishop confirms, v12.5.0 was published and publicly accessible by March 24, 2015. (Ex-1012-Bishop at ¶¶47-52, 58-59.) Ex-1009 is from 3GPP LTE Release 12; as discussed in §IX.G, v12.5.0 is referenced in the '658 patent and constitutes AAPA. Earlier versions from Release 8 (v8.11.0) and Release 10 (v10.2.0) are also filed herewith. (Ex-1011-36.300-8.11.0; Ex-1015-36.300-v10.2.0.) As relevant here, each Release (8, 10 and 12) discloses the same information about LTE frame structure, e.g., that downlink and uplink transmissions in LTE were organized in frames, with each frame having ten 1ms subframes and each subframe having two .5ms slots:



Each .5ms slot was (normally) 7 symbols in duration—OFDM symbols in the downlink direction,¹⁰ and SC-FDMA symbols in the uplink direction.¹¹

¹⁰ Ex-1009-36.300-12.5.0 at §5.1.1, p49; Ex-1011-36.300-8.11.0 at §5.1.1, p25; Ex-1015-36.300-10.2.0 at §5.1.1, p40.

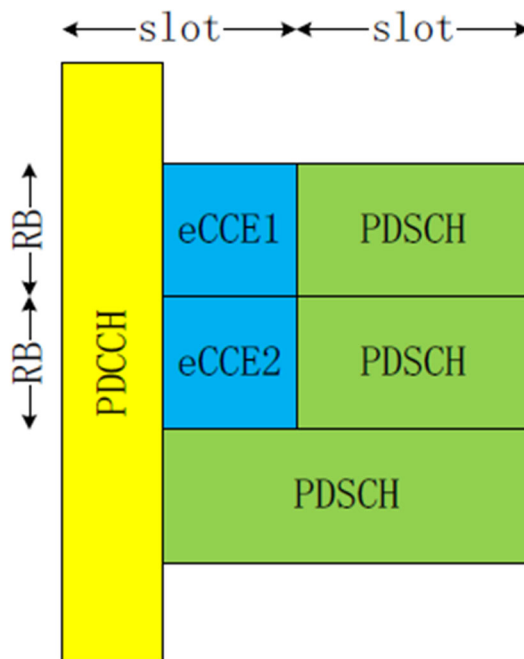
¹¹ Ex-1009-36.300-12.5.0 at §5.2.1, p52; Ex-1011-36.300-8.11.0 at §5.2.1, p28; Ex-1015-36.300-10.2.0 at §5.2.1, p43.

Petitioner cites to Release 12 (Ex-1009) in the Grounds below to simplify review (unless otherwise noted). (Ex-1003-Davies at ¶¶79-82.)

F. R1-112517 (Ex-1010)

R1-112517 is a 3GPP discussion document titled “Discussion on ePDCCH Design Issues.” It was submitted by Samsung for discussion at the 3GPP TSG-Ran #66 meeting held in Athens, Greece, in August 2011. R1-112517 is prior art, having been published and publicly accessible by August 16, 2011. (Ex-1012-Bishop at ¶¶53-59.)

R1-112517 discusses improvements for downlink control channel capacity and accounts for related design concerns, including resource allocation. R1-112517 teaches transmitting a PDCCH in a conventional control region, and a corresponding PDSCH that occupies all data region symbols, while also transmitting eCCEs in the first slot of a subframe and corresponding PDSCHs in the second slot, including as shown in Fig.1(b):



(b) partial FDM
RB based

(Ex-1010 at 2).

G. Applicant-Admitted Prior Art (“AAPA”)

Patentee labeled FIGS. 5-14 “PRIOR ART.” These figures and their corresponding descriptions show that many aspects of the Challenged Claims are AAPA, including the conventional LTE frame structure.¹² (*See, e.g.*, Ex-1001 at

¹² *Qualcomm Inc. v. Apple Inc.*, 24 F.4th 1367, 1375 (Fed. Cir. 2022) (“[I]t is appropriate to rely on admissions in a patent’s specification when assessing whether that patent’s claims would have been obvious in an inter partes review proceeding.”); *Constant v. Advanced Micro-Devices, Inc.*, 848 F.2d 1560, 1570 (Fed. Cir. 1988)

AAPA-FIG. 5 (10ms radio frame organized into 10 subframes, each subframe having 2 slots), AAPA-FIGS. 7-8 (slot having [normal] 7-symbol duration), AAPA-FIGS. 12-13 (UE and base station [eNB] communicate via uplink and downlink transmissions), AAPA-FIG. 14 (subframe structure separated into control and data regions).)

The '658 patent also identifies conventional communications systems, including 3GPP LTE and LTE-A (Ex-1001 at 2:40-49) and incorporates-by-reference 3GPP technical specifications, including 3GPP-36.300 (Ex-1009). (Ex-1001 at 2:50-67.)¹³

X. GROUND 1: Lindh in view of Tooher renders obvious claims 11-24

A. Scope, Content, and Rationale for Combining Prior Art

Ground 1 relies on Lindh and Tooher. Lindh expressly discloses most elements of the Challenged Claims, including the downlink, uplink, radio frame, subframe, and symbol requirements of the claims. As it relates to the downlink, Lindh discloses a frame structure in which multiple data resources allocated by

(“A statement in the patent that something is in the prior art is binding on the applicant and patentee for determinations of anticipation and obviousness.”)

¹³ 3GPP-36.300 also constitutes AAPA since AAPA FIGS. 5-6 and 12-13 are admitted reproductions from 3GPP-36.300. (Ex-1001 at 2:1-20.)

common and enhanced control signals are located in symbols corresponding to a data region, as shown in FIG. 4:

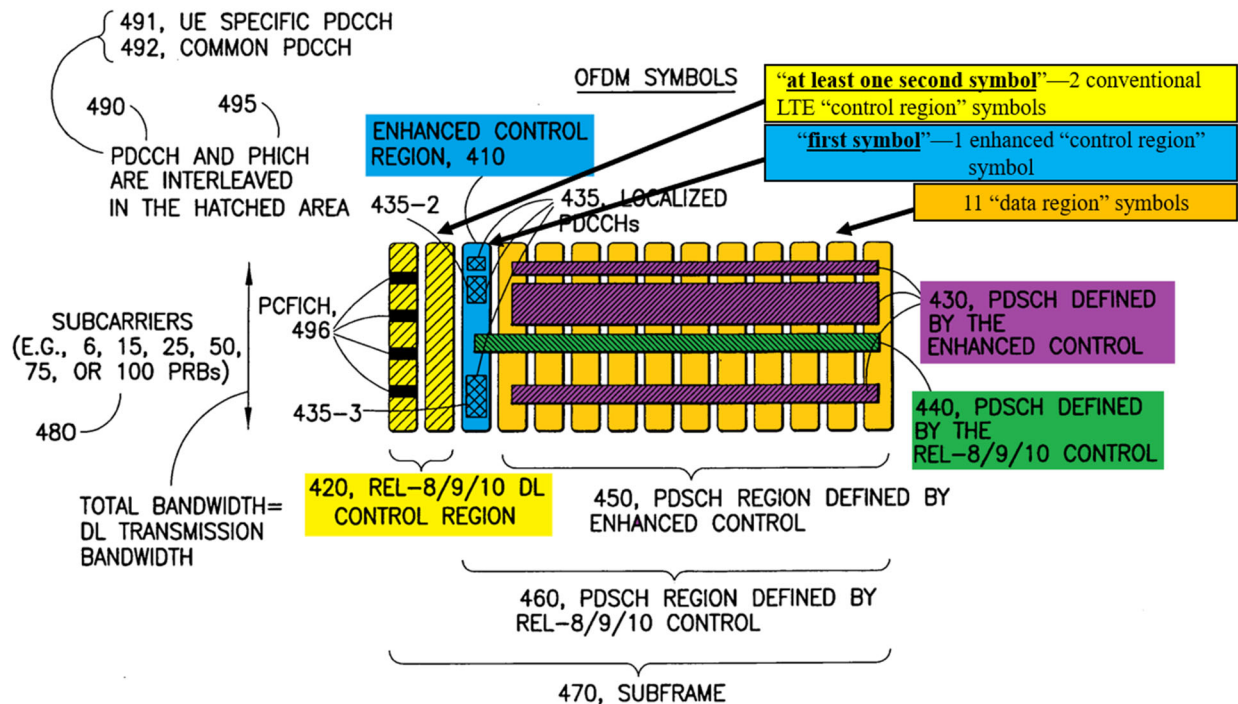


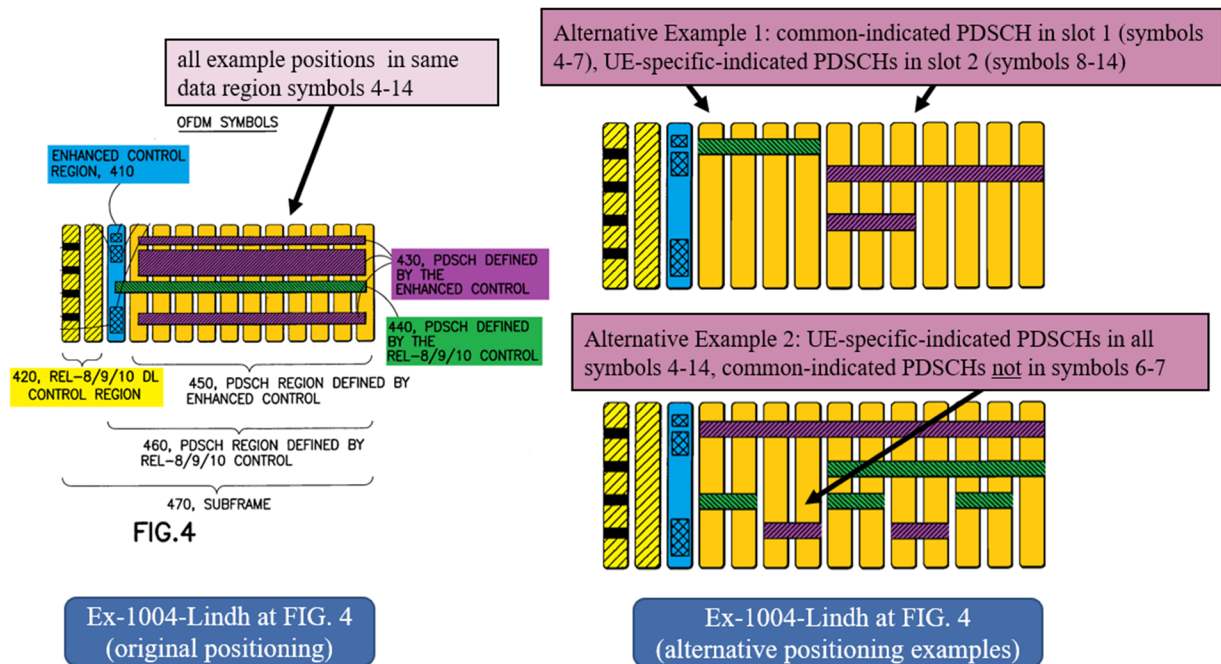
FIG. 4

Limitations 11.5 and 18.5 require “wherein the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe.” As explained herein, “common signal[s]” are found in the yellow downlink control region (“DLCR”) and “UE specific signal[s]” are found in the blue enhanced downlink control region (“**ECR**”). While FIG. 4 does not expressly show a common signal and UE specific signal indicating resources in different symbols in

Lindh’s data region,¹⁴ a POSITA would reasonably expect this to be the case. (Ex-1003-Davies at ¶¶88-91.) A POSITA would have had this expectation because there were typically at least 11 data region symbols, and it was inefficient to reserve all 11 for a given data resource if fewer symbols were sufficient. (*Id.*) Indeed, Lindh teaches and suggests as much, providing that “the locations of the exemplary PDSCH 430 and 440 positions are merely illustrative and are not limiting.” (Ex-1004-Lindh at 0100.) A POSITA would have reasonably understood the preceding disclosure in Lindh to mean that the PDSCHs in Lindh may vary with respect to position both in both axes—both in terms of frequency bandwidth (vertical) and symbol duration (horizontal). Petitioner illustrates how a POSITA would have understood this disclosure below:

¹⁴ As noted in §VIII, Lindh expressly discloses resources in “different” symbols under Patentee’s apparent interpretation because data indicated by common signals (data found in green PDSCH 440) and data indicated by UE-specific signals (purple PDSCH 430) are not coextensive.

“It is noted that the locations of the exemplary PDSCH 430 and 440 positions are merely illustrative and are not limiting.” (Ex-1004-Lindh at 0100)



(Ex-1003-Davies at ¶¶91-92.)

Tooher confirms the above understanding. Specifically, Tooher discloses that data resources may (a) be allocated in a single symbol or may be as long as an entire subframe, (b) start in different symbols, and (c) be specified by legacy PDCCH or enhanced EPDCCH control signals. (Ex-1003-Davies at ¶93 (citing Ex-1007-Tooher at FIG. 5, 0078-81, 0088-97, 0102-104, 0143, 0146-152, 0155-157; Ex-1008-Tooher at FIG. 4, 0061-76, 0093-0103).)

A POSITA would have been motivated and found it obvious to combine Lindh and Tooher. (Ex-1003-Davies at ¶¶94-97.) In particular, both Lindh and Tooher relate to LTE/LTE-A network configurations. (Ex-1004-Lindh at 0090; Ex-1007-

Tooher at 0029; Ex-1008-Tooher-Prov at 0021.)¹⁵ Tooher facilitates improvement in transmission efficiency, latency, channel capacity, and scheduling flexibility by varying transmission time interval (“TTI”) durations based on factors including the amount and type of data to be transmitted. (Ex-1007-Tooher at 0003-05, 0078-80; Ex-1008-Tooher-Prov at 0002, 0061-63, 0073, 0076, 0104.) A POSITA would have found such improvements beneficial to Lindh. Indeed, the two references are described in the context of LTE networks, such that Tooher’s disclosures for improving transmission efficiency, latency, channel capacity, and scheduling flexibility would be expected to offer the same predictable improvements for Lindh’s UEs. (Ex-1003-Davies at ¶¶94-96.) Tooher’s ability to vary the starting location and symbol duration of a given data resource in a subframe would allow the network to more fully utilize available resources in a way that would improve Lindh in the ways described by Tooher. (*Id.*)

A POSITA also would have expected to succeed in making this combination. Lindh and Tooher disclose closely related teachings, are in the same field as the ’658 patent, and relate to enhancements in 3GPP LTE networks. (*Id.* at ¶¶95-97.) A POSITA would have had no difficulty utilizing Tooher’s teachings with Lindh’s

¹⁵ Lindh and Tooher are analogous art to the ’658 patent being within the same field of endeavor. (Ex-1003-Davies at ¶95.)

network because doing so would merely require implementing routine software and/or hardware enhancements that would allow the Lindh's eNBs/UE to more efficiently communicate, as disclosed in Tooher (e.g., variable TTI duration and related channel signaling information). (*Id.*)

B. Challenged Claims

Ground 1 addresses claims 11-24.

[11.0] A method for a User Equipment (UE), comprising:

Lindh teaches the preamble. Specifically, Lindh discloses “[e]xemplary UE behavior when reading the DL control channel structure.” (Ex-1004-Lindh at 0103; *see id.* at 0068 (FIG. 5 “is a flowchart of an exemplary method performed by a user equipment in accordance with an exemplary embodiment”).)

Thus, Lindh teaches the preamble.

[11.1] communicating with a network node in a cell via downlink and uplink transmissions, wherein the downlink and uplink transmissions are organized into radio frames, each radio frame includes multiple subframes, and each subframe includes multiple symbols;

Lindh teaches this limitation. Specifically, Lindh discloses:

“In a cellular radio system like 3GPP LTE, the base station (BS) (also known as eNode-B or eNB) signals the time-frequency resources allocated to a terminal (UE). In LTE, the downlink and uplink resources are allocated in terms of resource blocks (RB).” (Ex-1004-Lindh at 0082.)

As shown, Lindh's UEs communicate with a network node (BS, eNB) via downlink and uplink transmissions, which meets the first part of limitation 11.1. (*See id.* at 0090.)

As for the uplink and downlink transmission structure, the AAPA admits that the claimed radio frame/subframe/symbol structure was conventional in LTE. (*See §IX.G.*) Lindh uses the same basic organizational scheme (frames, subframes, and symbols):

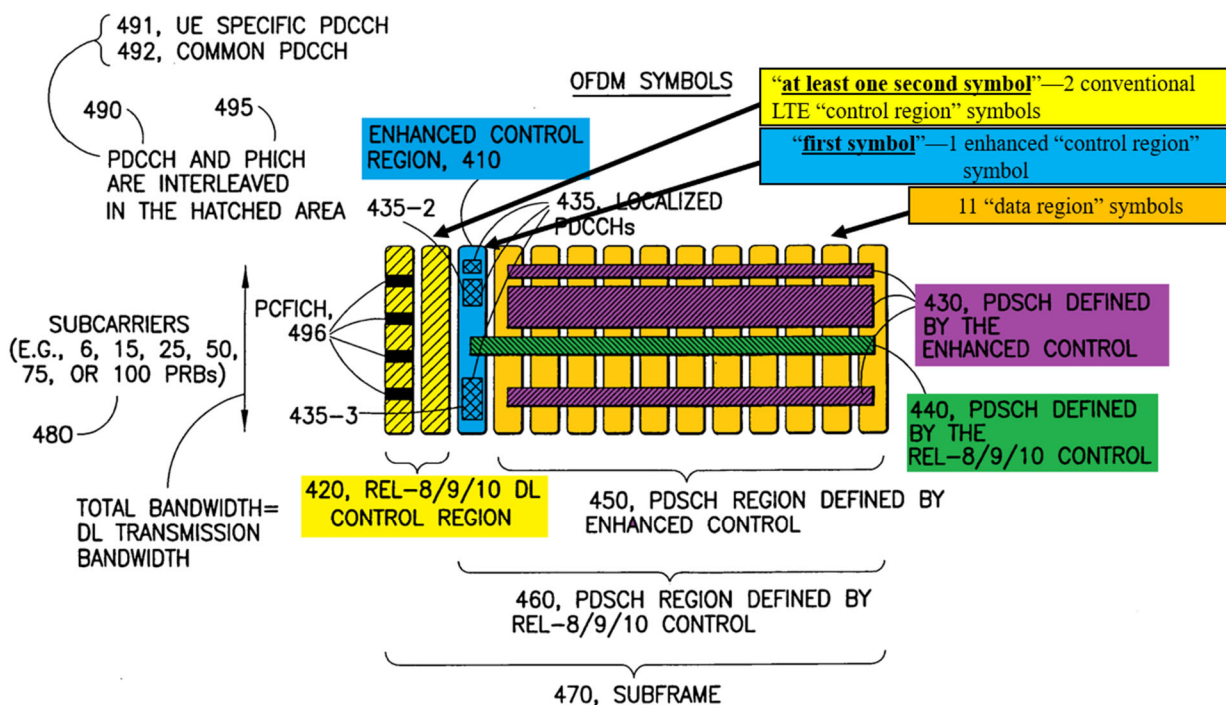


FIG.4

(Ex-1004-Lindh at FIG. 4, 0102 (“[T]he DL subframe 470 occupies in the time domain several OFDM symbols (of which there are 14 in this example). Thus, the DL subframe 470 has a time duration equivalent to the duration of 14 OFDM

symbols in this example.”); *see generally id.* at 0099-0129.) Lindh does not illustrate an example of an uplink frame, but Lindh discloses that its network may be LTE/LTE-A (*id.* at 0090) and also incorporates-by-reference LTE/LTE-A specifications, including 3GPP TS 36.300 v8.11.0 (Ex-1004-Lindh at 0051).¹⁶ As explained previously, 3GPP 36.300 discloses that uplink/downlink frames are organized by subframes, slots, and symbols. (Ex-1011-3GPP-36.300-8.11.0 at §5 [p23] (disclosing one 10ms frame organized into ten 1ms subframes, each subframe having one 0.5ms slot), §5.1 [p25] (disclosing 7 OFDM symbols per slot when using normal cyclic prefix), §5.2 [pp27-28] (disclosing 7 SC-FDMA symbols per slot when using normal cyclic prefix).) Given Lindh’s network may be LTE/LTE-A, a POSITA would have understood Lindh’s uplink frames would follow the same conventional organizational scheme. (Ex-1003-Davies at ¶¶101-10.) Thus, Lindh discloses that its “downlink and uplink transmissions are organized into radio frames, each radio frame includes multiple subframes.”

Accordingly, Lindh teaches this limitation.

¹⁶ *Arbutus Biopharma Corp. v. ModernaTX, Inc.*, 65 F.4th 656, 662-63 (Fed. Cir. 2023) “When a reference or material from various documents is incorporated, they are ‘effectively part of the host document as if [they] were explicitly contained therein.’”))

[11.2] monitoring, in the cell, a UE specific signal in at least one first symbol of a downlink control region of a subframe,

Lindh teaches this limitation.¹⁷ Specifically, FIG. 4 illustrates an **ECR** [410, blue]:

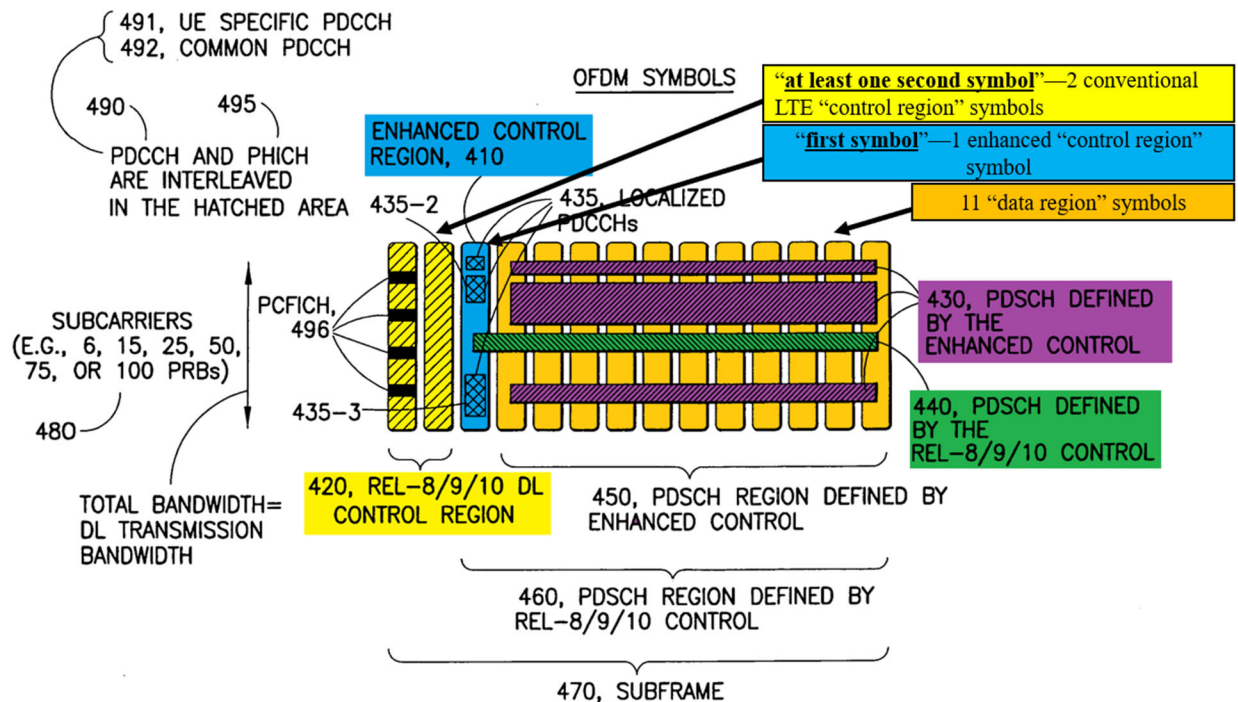


FIG. 4

The claimed “first symbol of a downlink control region” corresponds to the symbol associated with the **ECR** (410).

¹⁷ As the specification confirms, the “first” symbol is not required to be the chronologically first symbol in the subframe: “the first symbol could be in front of the second symbol in the subframe. Alternatively, the second symbol could be in front of the first symbol in the subframe.” (Ex-1001 at 19:45-47.)

Lindh further discloses a “flowchart of an exemplary method performed by a [UE]” in FIG. 5, which shows that Lindh’s UEs use the **ECR** (step 5D) to “monitor enhanced control region to find PDCCH message corresponding to the UE” (step 5G, blue):

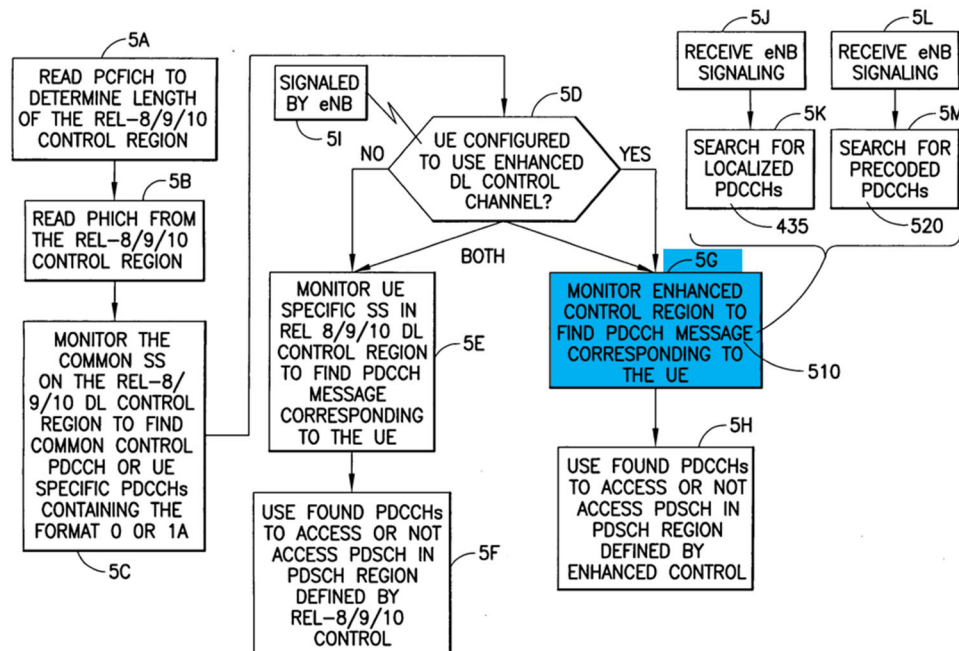


FIG.5

(Ex-1004-Lindh at FIG. 5.) Monitoring the **ECR** to find PDCCH signals corresponding to the UE discloses “monitoring, in the cell, a UE-specific signal in at least one first symbol of a downlink control region of a subframe.” (Ex-1003-Davies at ¶¶111-16.) Indeed, the ’658 patent considers “a UE specific signal” to be a “Type 2” signal such as any of “PDCCH, PHICH, DMRS, etc.” which may be used “to allocate resources for a DL or UL transmission.” (Ex-1001 at 15:59:60; 16:33-

34), and Lindh's UEs monitor for PDCCHs in the same manner and for the same purpose:

“In block 5G, if the UE is configured to use the enhanced DL control channel (i.e., the accompanying enhanced control region 410) (block 5D=YES), the UE monitors the enhanced control region 410 to find the PDCCHs 510 (and their messages) corresponding to the UE (e.g., PDCCHs 510 masked with its own C-RNTI or SPS-RNTI). In one example, the PDCCHs 510 are the localized PDCCHs 435 found at a specific PRBs corresponding to the UE in the enhanced control region 410. Each localized PDCCH 430 contains a PDCCH message corresponding to a certain UE. In principle, the UE has to search for the localized PDCCH 435 in block 5K. However, the search can be restricted to a pre-determined search space (e.g., as signaled by the eNB in block 5J). In another example, the UE would find the PDCCHs 510 in the enhanced control region 410 that are precoded (e.g., beamformed) PDCCHs 520 and that correspond to the UE. In an example, the UE searches the UE-specific SS to find the precoded PDCCHs 520 (block 5M). The precoding information can be signaled (block 5L) to the UE either explicitly or by using precoded reference symbols. Alternatively, the UE may perform blind decoding or blind estimation of the precoder. The precoding may be precoding for transmit diversity, spatial multiplexing, beamforming, antenna selection, and any other suitable precoding.” (Ex-1004-Lindh at 0108.)

“Here it is assumed that there is a user specific SS defined in the enhanced control region 410 in a similar way as for the Rel-8/9/10 in

order to let the UE know where to look for PDCCH candidates. In an exemplary embodiment, the SS is defined in UE specific way and would be designed to give a choice of starting points for PDCCH in different locations spread over the channel in order to select the best, or at least a reasonably good, channel state.” (*Id.* at 0112; *see also id.* at 0113-29.)

Accordingly, Lindh teaches this limitation. (Ex-1003-Davies at ¶¶111-16.)

[11.3] and not monitoring a common signal in the at least one first symbol; and [11.4] monitoring, in the cell, the common signal in at least one second symbol of the downlink control region,

Petitioner addresses these two limitations together because they relate to the symbol(s) in the downlink control region in which common signals are and are not monitored.

Lindh teaches these limitations. Specifically, FIG. 4 illustrates a control region portion [420, yellow] in which “a common signal” is monitored while that same control signal is not monitored in the “first symbol” (blue):

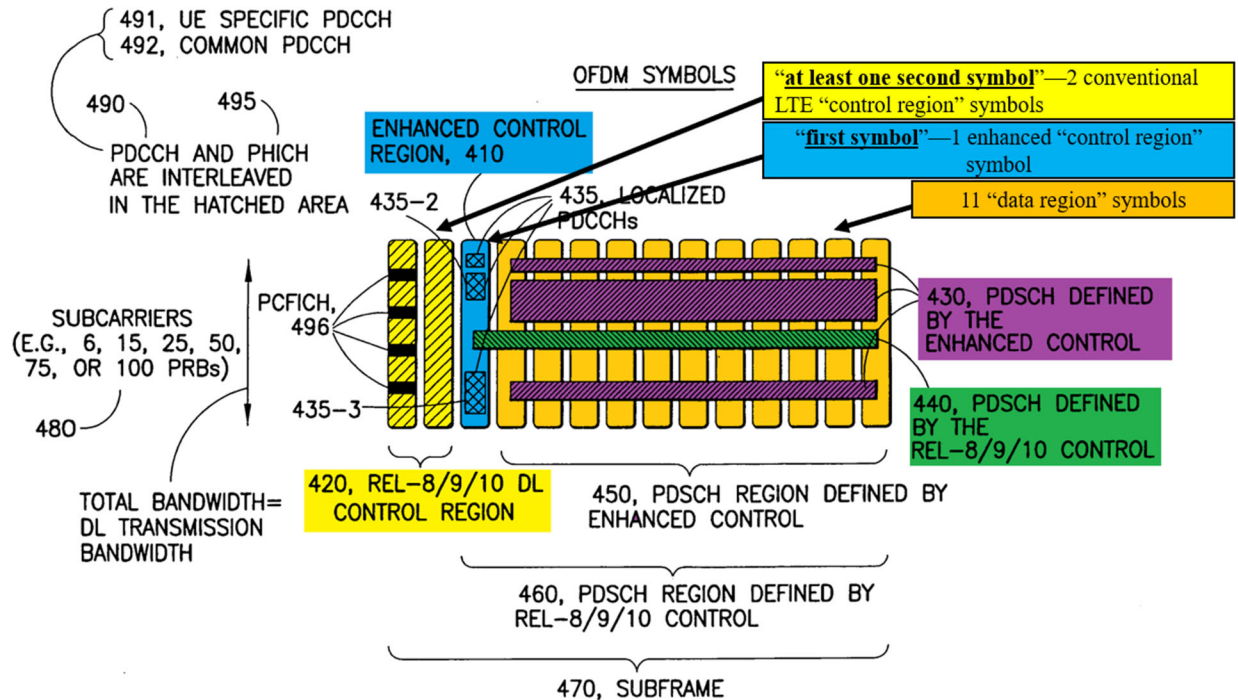
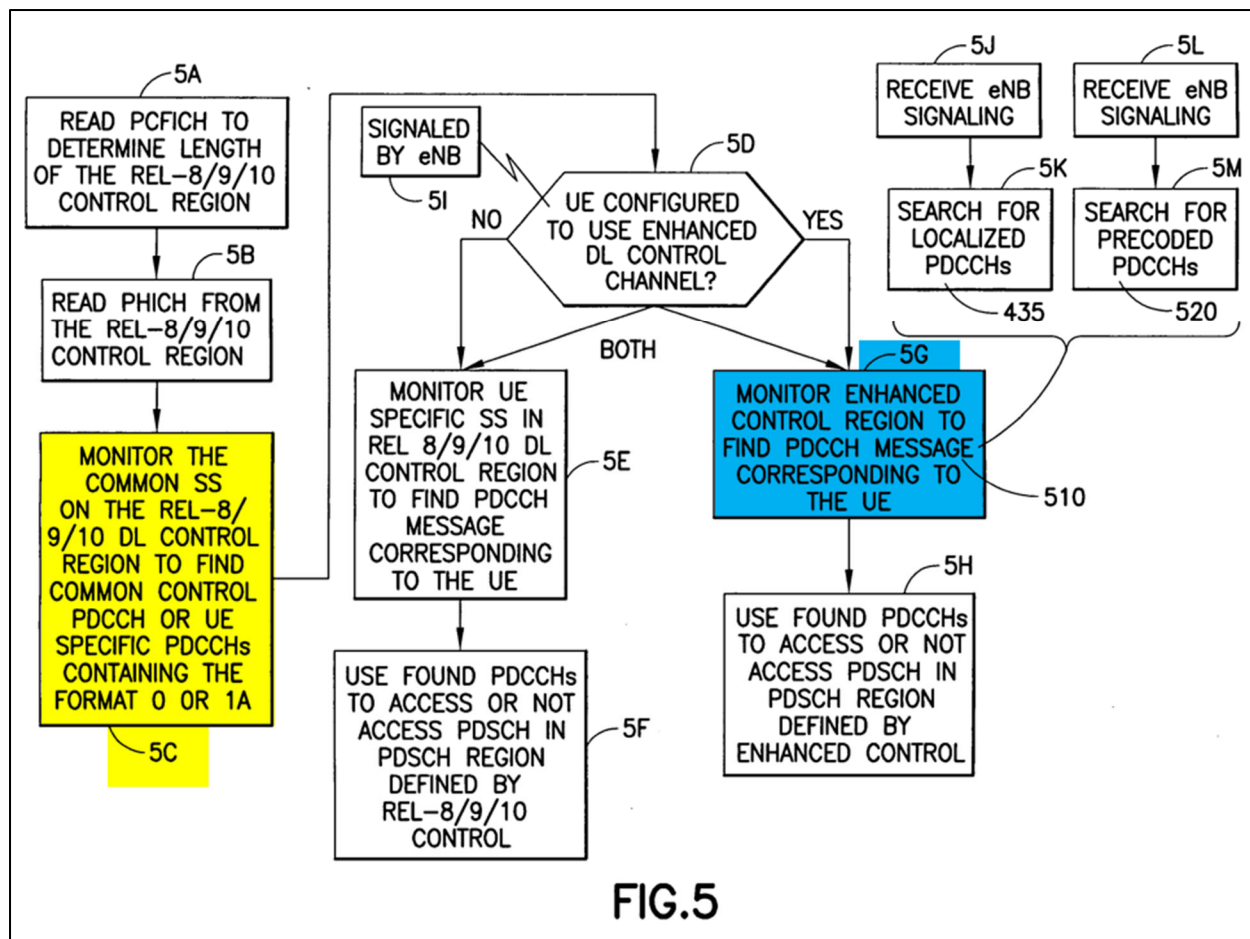


FIG. 4

(Ex-1004-Lindh at FIG. 4.) FIG. 5, block 5C discloses that UEs monitor “the common SS...DL control region to find common control PDCCH” signals in the yellow control region 420:



Lindh teaches monitoring common signals only in region 420:

“In block 5C, *the UE monitors the common SS on the Rel-8/9/10 type **DL control region 420** in order to find the common PDCCH 492*, which is recognized by having a CRC masked with SI-RNTI, RA-RNTI or P-RNTI or UE specific PDCCHs containing the format 0 or 1A as explained in 3GPP TS 36.213 Table 7.1-5.” (Ex-1004-Lindh at 0105.)

Again, this is the same common signal monitoring scheme described by the ’658 patent:

“Type 1—Common signaling (transmitted periodically) intended for all or plurality of UEs in the cell or UEs connecting to the TP or TRP (e.g., system information, PSS/SSS, CRS, control signaling for broadcast message, etc.)... In addition, the common downlink control signaling (e.g., for multiple UEs) could include ... [a] signaling (*e.g., on PDCCH*) [to] allocate resource for a broadcast message (e.g., system information, paging, random access response) for UE(s) in the cell or for UE(s) connecting to the TP or TRP.” (Ex-1001 at 15:53-58, 16:39-52.)

Lindh further notes a benefit of maintaining the same total downlink control region length—i.e., the UE-specific signals are “moved” to the **ECR** 410 and the legacy portion of the control region shrinks:

“The techniques of enhancing the control channel have at least one or more of the following non-limiting benefits.... No increase of the total DL control because the UE specific SS is moved to the enhanced channel for the Rel-11/12 UEs the Rel-8/9/10 control channel can be correspondingly decreased.” (Ex-1004-Lindh at 0120, 0124.)

Accordingly, a POSITA would reasonably understand and interpret Lindh as disclosing that Lindh’s UEs only monitor common signals in the “second” (yellow) symbols and do not monitor common signals in the “first” (blue) symbol. (Ex-1003-Davies at ¶¶117-19.) Further, FIG. 4 states “PDCCH AND PHICH ARE INTERLEAVED *IN THE HATCHED AREAS*,” which Lindh explains as being only applicable to the first two OFDM symbols:

“The hatched portions (*in this example two OFDM symbols*) of the subframe 400 denote the Rel-8/9/10 DL control region 420 and include the Rel. 8/9/10 PDCCH 490 (including UE specific Rel. 8/9/10 PDCCH 491 and common PDCCH 492), the PCFICH 496 and the PHICH 495.” (Ex-1004-Lindh at 0102.)

A POSITA would therefore know and expect that “common” signals (e.g., “common PDCCH 492) would only be monitored in control region (420) and not in the enhanced control region of (410) of Lindh (where EPDCCH signals are monitored). (Ex-1003-Davies at ¶¶120-28.)

Thus, Lindh teaches these limitations.

[11.5] wherein the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe.

As explained in §VIII.D, this limitation at least encompasses resources in a data region that are not in coextensive symbols.

Lindh alone and in view of Tooher teaches this limitation. Lindh’s FIG. 4 shows a data region of a subframe (470), having eleven OFDM symbols (orange):

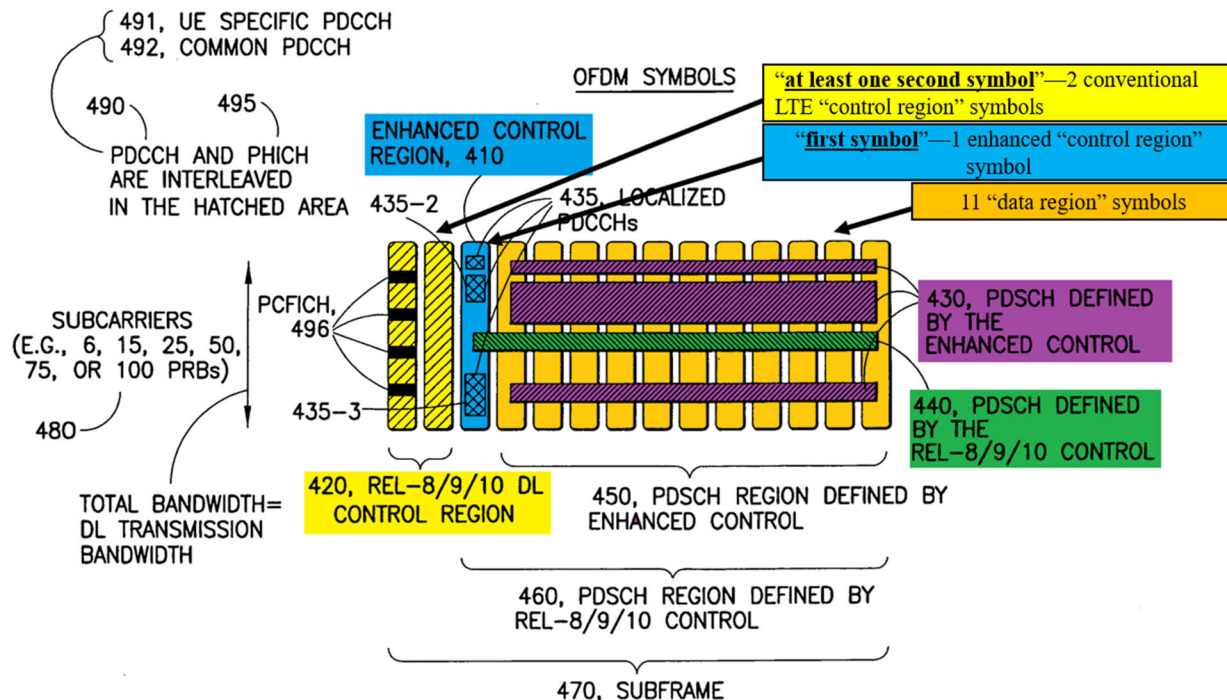


FIG. 4

The orange-highlighted symbols are a “data region” in which data channel (“PDSCH”) resources are transmitted. (Ex-1003-Davies at ¶¶129-33 (citing Ex-1004-Lindh at 0084 (“...the data channel (PDSCH)”), 0089).) The ’658 patent confirms that data is transmitted on PDSCH and carried by symbols corresponding to the data region:

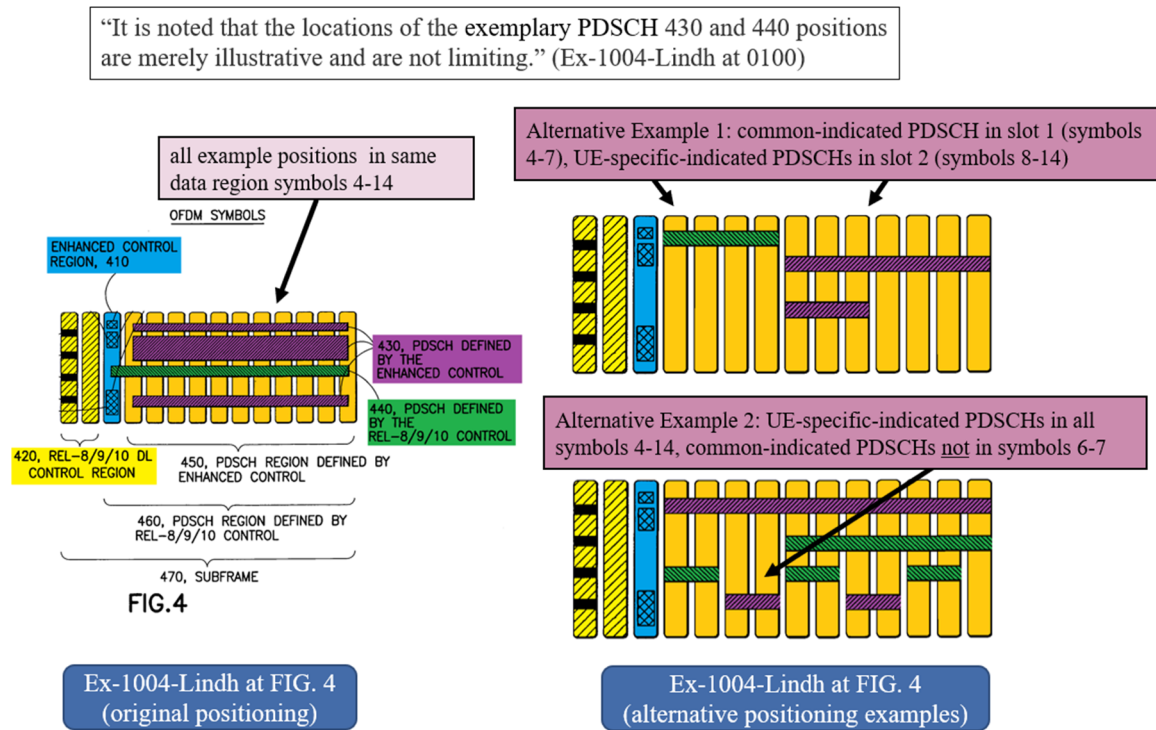
“As for downlink data in LTE, it is transmitted on PDSCH and carried by symbols excluding the first or first several symbols of a subframe, i.e. excluding the symbols which are (maybe) occupied by the physical control channels....” (Ex-1001 at 12:33-36.)

Thus, a POSITA would have understood that the orange-highlighted symbols in FIG. 4 are the symbols corresponding to the “data region.” (Ex-1003-Davies at ¶¶129-33.)

Second, with respect to “indicat[ing] resources in different symbols of a data region of the subframe,” Lindh discloses that both types of signals (UE-specific and common) may indicate resources in the data region. The examples in FIG. 4 show PDSCH resources that span all of the data region symbols (the 4th through 14th symbols in FIG. 4 above). The green-highlighted horizontal bar of FIG. 4 (labeled 440) is associated with the common signals of the control region 420 while the purple-highlighted horizontal bars of FIG. 4 (labeled 430) are associated with the UE specific signals of **ECR** 410. (Ex-1004-Lindh at FIGS. 4-5, 0084, 0100-06, 0110-12; Ex-1003-Davies at ¶¶134-35.) The purple and green resources are also illustrated as having different symbol durations. Under Patentee’s apparent interpretation of the claims, Lindh discloses this limitation based on the green PDSCH extending into the control region because the green PDSCH would be considered part of the data region. (Ex-1004-Lindh at FIG. 4; §VIII.)

Lindh further discloses that the positioning of those resources in the figure is merely an example: “the locations of the exemplary PDSCH 430 and 440 positions are merely illustrative and are not limiting.” (Ex-1004-Lindh at 0100; Ex-1003-Davies at ¶¶136-51.) Accordingly, a POSITA would have understood Lindh as

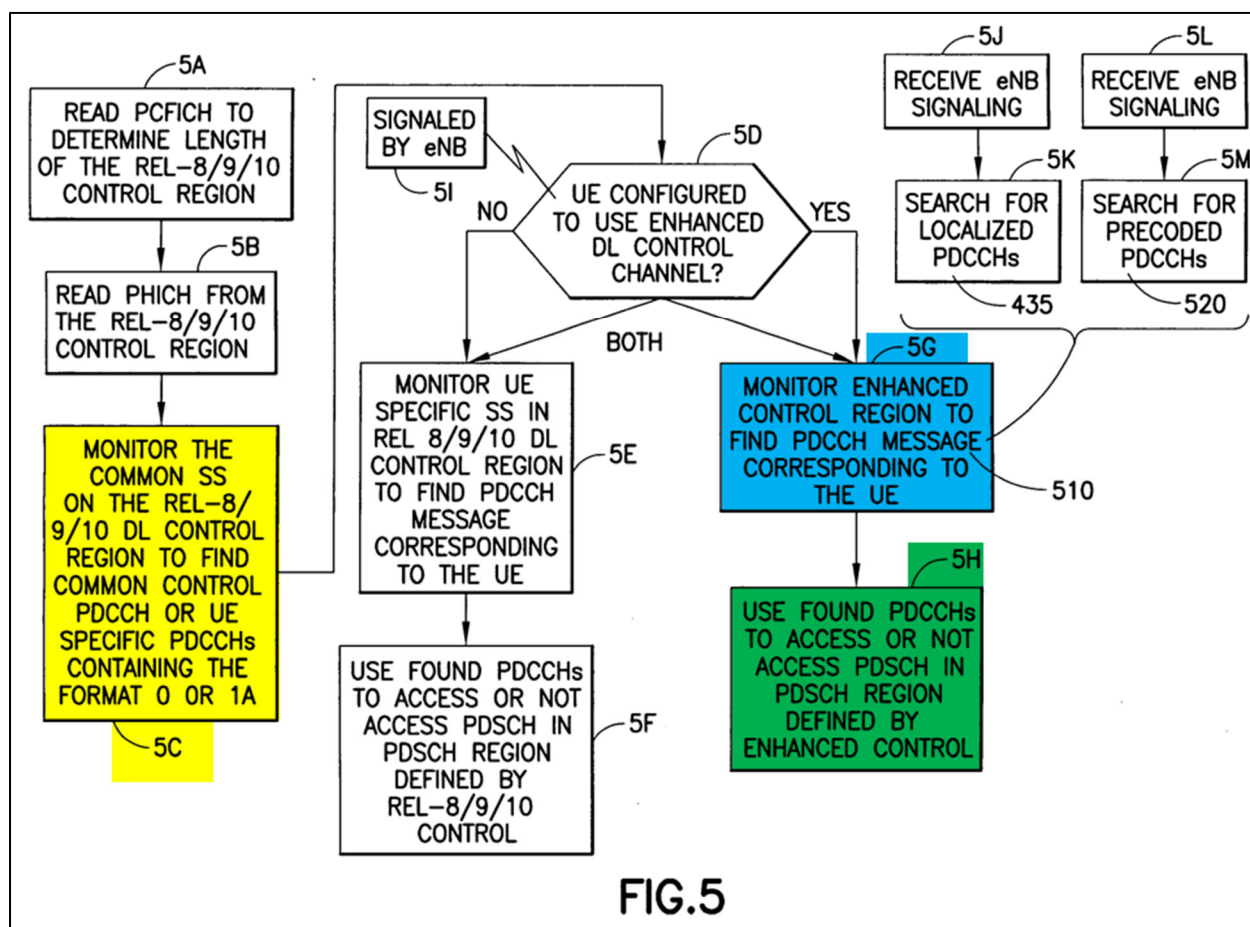
teaching common and UE-specific resources that may be of any length and across different frequencies. That is, resources indicated by UE-specific signals and common signals may indicate resources in one data region symbol, eleven data region symbols, and all options in between, with varying degrees of symbol overlap for the UE-specific signaled and common-signaled resources in any given transmission. (Ex-1003-Davies at ¶¶136-37.) Two non-limiting examples illustrate this teaching below:



In the figure above, Lindh teaches and suggests resources in “completely different” symbols in Alternative Example 1 (because UE-specific resource symbols do not overlap with common resource symbols at all), and *at least* “partially different” symbols in Alternative Example 2 (because there are no common resources in

symbols 6-7). (Ex-1003-Davies at ¶138.) Under Patentee’s interpretation, Lindh’s FIG. 4 itself discloses “partially different” symbols, because data may be found in the green PDSCH region, which extends into symbol 3 where there would not be UE-specific data resources. (*Id.*)

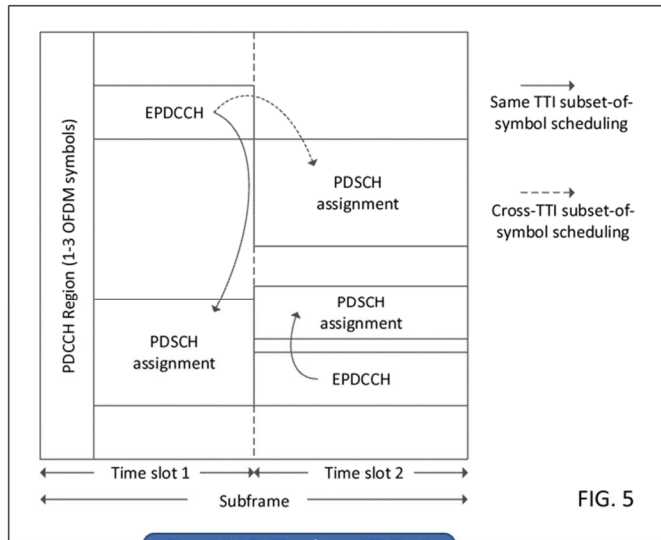
The flowchart in Lindh’s FIG. 5 also confirms that Lindh’s common and UE-specific signals indicate resources in different symbols. For example, Lindh’s UE uses information from step 5G (green) to find resources in the data region (“PDSCH”) defined by enhanced control:



“In block 5H, the UE uses information from the found PDCCHs 510 to access or not access the PDSCH 430 in PDSCH region 450 defined by enhanced control. In block 5H, the UE therefore determines portions of the PDSCH region 450 that correspond to the UE and contain at least some UE-specific information. Based on the information from the found UE specific PDCCH messages UE also may not access the PDSCH region 450. That is, only if the PDCCH message contains a downlink assignment does the UE access the PDSCH region 450.” (Ex-1004-Lindh at 0110.)

Thus, Lindh’s UEs find and access appropriate resources wherever they are located in the data region symbols. By referring to “portions” of that region in the above excerpt, Lindh confirms that different symbols may be used for different data resources. (Ex-1003-Davies at ¶¶138-40.)

Limitation 11.5 is also obvious over Lindh in view of Tooher. As detailed in §X.A, both Lindh and Tooher disclose LTE/LTE-A network configurations, and Tooher shows how to vary TTI durations in order to improve latency and enhance channel utilization. Tooher discloses that control signals may indicate resources having variable lengths and starting positions. For instance, Tooher illustrates one EPDCCH control signal indicating a resource (“PDSCH assignment”) in time slot 1, while a second EPDCCH control signal indicates a resource in slot 2:



Ex-1007-Tooher, FIG. 5
(annotations Petitioner's)

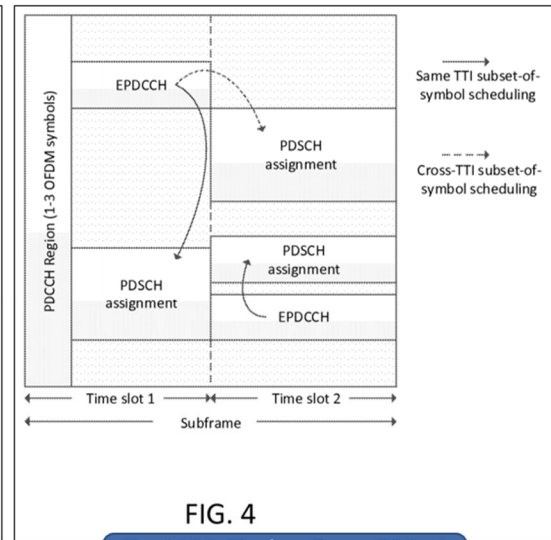


FIG. 4
Ex-1008-Tooher-Prov, FIG. 4
(annotations Petitioner's)

In the figures above, the lower arrow from the EPDCCH in Time Slot 1 indicates a resource allocation in symbols within Time Slot 1, while the arrow from the EPDCCH in Time Slot 2 indicates a resource allocation in symbols within Time Slot 2. (Ex-1003-Davies at ¶¶141-44.) The time slots do not overlap, and thus neither do the respective sets of symbols in each slot. (*Id.* at ¶145 (citing Ex-1001 at AAPA FIGS. 5-7 (illustrating that a subframe consists of two slots, each slot having 7 symbols in a typical configuration); Ex-1011 at §§5, 5.1.1 [pages 23, 25] (disclosing the same).) Thus, Tooher discloses control signals indicating data resources in different symbols of a data region within the same subframe. (Ex-1003-Davies at ¶¶141-46.)

Tooher also discloses a PDCCH control signal that indicates a resource in a corresponding PDSCH having a duration from as little as one symbol up to an entire

subframe. The same is true for an EPDCCH control signal, and the respective PDSCH durations may be the same or different (i.e., PDSCHs corresponding to an EPDCCH control signal need not be the same length as PDSCHs corresponding to a PDCCH control signal):

“The shortened TTI may be applicable to a subset of channels (e.g., only to the subset), for example PDSCH. In such scenarios, among others, the control region (e.g., PDCCH, PCFICH, and/or PHICH) may use legacy TTI timing. The first shortened TTI’s PDSCH region may include the last X-C symbols of the TTI (e.g., where X may be the duration in symbols of the first shortened TTI and C may be the duration in symbols of the control region). The second TTI’s PDSCH region may be composed of one or more, or all, Y symbols (e.g., where Y may be the second shortened TTI’s duration).” (Ex-1007-Tooher at 0112; see Ex-1008-Tooher-Prov at 0063-64.)

“Scheduling of PDSCH assignments...using EPDCCH may require using the reuse of the same TTI duration for one or more, or each, channel, e.g., described by example with reference to FIG. 5. An EPDCCH located in a subset of symbols may assign...PDSCH...resources in the same subset of symbols, e.g., with a fixed time offset. Short TTI duration for EPDCCH may lead to short TTI duration for PDSCH.... The size and/or location of a TTI used for EPDCCH may be reused for PDSCH.... The TTI duration and/or location of the PDSCH...might not be tied to the TTI duration and/or location of the EPDCCH. For example, the EPDCCH may be located in a subset of symbols (e.g., a first time-slot); the

assigned...PDSCH...resources may be for the entire subframe (e.g., full subframe TTI). The EPDCCH and/or PDSCH...may use reduced TTI duration. The EPDCCH may be located in (e.g., only in) a first subset of symbols. The EPDCCH in a first subset of symbols may assign...PDSCH...resources in a second subset of symbols. For example, an EPDCCH in a first time slot may assign...PDSCH...resources in a first time-slot and/or a second time-slot, e.g., in a cross-TTI scheduling manner.” (Ex-1007-Tooher at 0143 (references to UL transmissions and the corresponding PUSCH omitted); Ex-1008-Tooher-Prov at 0093; *see also* Ex-1007-Tooher at 0146-152, 0155-157; Ex-1008-Tooher-Prov at 0094-103.)

Tooher further explains that transmissions in a subframe of different channels may vary in length from a single symbol to subframe duration, and that common signals may indicate resources having different durations than UE-specific signals. (Ex-1007-Tooher at 0078-81 (e.g., 0081 (“[A] TTI duration may be defined as an entire subframe or a pair of resource blocks (PRB or Physical Resource Blocks) (e.g., 14 OFDM symbols for normal cyclic prefix and 12 OFDM symbols for extended cyclic prefix). The TTI may be as short as a single OFDM symbol. The TTI duration may be defined as one or more time slots (e.g., 7 OFDM symbols for normal cyclic prefix and 6 OFDM symbols for extended cyclic prefix). A combination of the above TTI durations can be used.”)), 0088, 0092-93, 0102-103; Ex-1008-Tooher-Prov at 0061-65 (describing the use of variable TTI durations from 1-symbol to subframe duration for various channels including EPDCCH, PDDCH, PUCCH, and PDSCH, e.g. 0064

("[A] TTI duration may be defined as an entire subframe or a pair of [RBs] (e.g., 14 OFDM symbols....). The TTI may be as short as a single OFDM symbol. The TTI duration may be defined as a time slot (e.g., 7 OFDM symbols....). A combination of the above TTI durations may be used.")), 0069-70 (explaining that different channels may have different TTI durations, inclusive of the scenario where an "(E)PDCCH"¹⁸ is a different duration from its corresponding PDSCH), 0074-76 (disclosing that a signal in a common search space may indicate a transmission of a first duration while a signal in a UE-specific search space may indicate a transmission of a second duration).) Thus, Tooher discloses that common and UE-specific signals in PDCCHs and EPDCCHs may indicate resources in different symbols, which reads on the "different" requirement of limitation 11.5 under any reasonable interpretation—the resources in a corresponding PDSCH may be of any duration and located throughout the data region of a subframe. (Ex-1003-Davies at ¶¶147-48.)

As explained in §X.A, a POSITA would have been motivated and found it obvious to combine Lindh and Tooher. This would have improved transmission efficiency, latency, channel capacity, and scheduling flexibility in Lindh's network.

¹⁸ Tooher uses "(E)PDCCH" to indicate attributes that could apply to EPDCCH and PDCCH (i.e., "E" is optional). (Ex-1003-Davies at ¶148, n16.)

(Ex-1003-Davies at ¶¶149-51.) A POSITA would have expected to succeed in making this combination given the closely related teachings of Lindh and Tooher, which both relate to improved scheduling flexibility in 3GPP networks. (Ex-1003-Davies at ¶¶150-512.) More specifically, a POSITA would have found it straightforward to apply Tooher's teachings to Lindh because doing so would merely require applying routine software and/or hardware updates to Lindh's UEs/eNBs to implement Tooher's downlink frame teachings. (Ex-1003-Davies at ¶150; §X.A.)

Thus, Lindh in view of Tooher teaches this limitation, and Lindh in view of Tooher renders obvious claim 11.

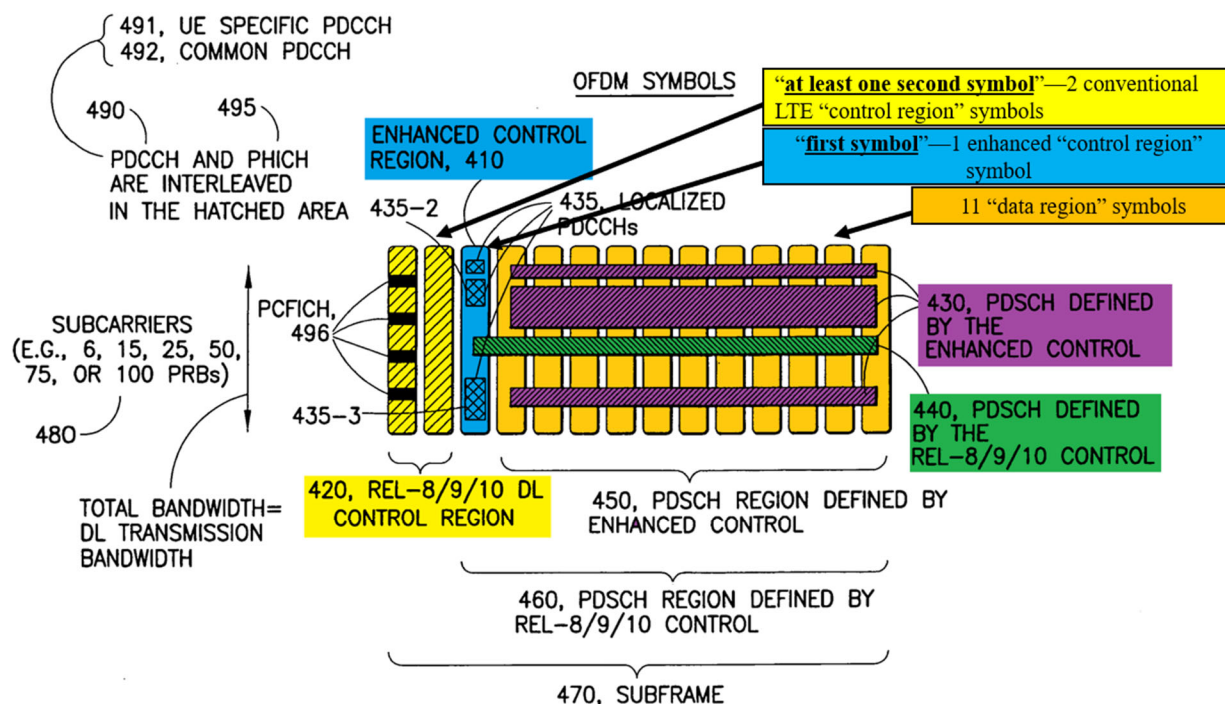
[Claim 12] The method of claim 11, wherein the common signal and the UE specific signal indicate resources in completely different or partially different symbols of the data region of the subframe.

As explained above, Lindh in view of Tooher discloses resources in symbols that are different; indeed, both partial differences and complete differences are taught as shown above in limitation 11.5. (Ex-1003-Davies at ¶152.) Thus, Lindh in view of Tooher renders obvious claim 12 for the reasons discussed above relative to claim 11.

[Claim 13] The method of claim 11, wherein the UE monitors the UE specific signal in the second symbol.

Lindh teaches this limitation. Specifically, Lindh's UEs monitor UE-specific signals in *both* the first (ECR; blue) and second (DLCR; yellow) symbols:

“In addition, as described above, advanced schemes could be envisioned, where the UE monitors the UE specific SSs on both the Rel-8/9/10 type control channel (e.g., Rel-8/9/10 DL control region 420) as well as on the enhanced DL control channel (e.g., enhanced control region 410). That is, the UE could perform the blocks of 5G and 5H and also blocks 5E and 5F (block 5D=BOTH).” (Ex-1004-Lindh at 0111; *see id.* at 0112.)

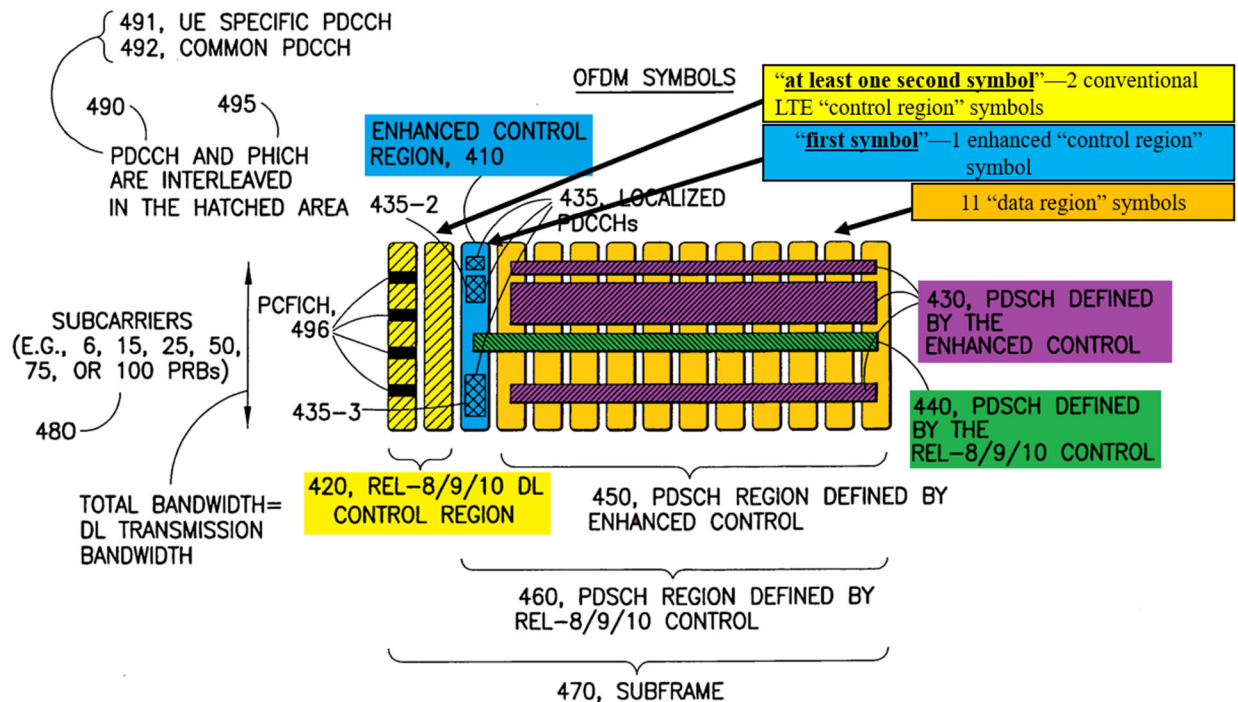


(Ex-1003-Davies at ¶¶153-55.)

Thus, Lindh teaches this limitation and Lindh in view of Tooher renders obvious claim 13.

[Claim 14] The method of claim 11, wherein the UE does not monitor the UE specific signal in the at least one second symbol.

Lindh discloses this limitation. As discussed above regarding claim 13, Lindh’s disclosure of a UE that monitors the UE-specific signal in both the first and (limitation 11.2) and second (claim 13) symbols is an “advanced scheme.” (Ex-1004-Lindh at 0111; *see id.* at 0112, 0129.) Accordingly, a POSITA would have understood that Lindh’s default operation for Lindh’s UEs was to monitor UE-specific signals in only the **ECR** of the “first symbol” without also monitoring the yellow-highlighted control region of the “second symbols:” (Ex-1003-Davies at ¶¶156-58.)



Thus, Lindh teaches this limitation, and Lindh in view of Tooher renders obvious claim 14.

[Claim 15] The method of claim 11, wherein the UE specific signal is a signaling indicating resource allocation, a signaling indicating HARQ (Hybrid Automatic Repeat reQuest) feedback, and/or a reference signal for demodulation.

Lindh teaches this limitation. Specifically, Lindh discloses:

“In block 5H, the UE uses information from the found PDCCHs 510 to access or not access the PDSCH 430 in PDSCH region 450 defined by enhanced control. In block 5H, the UE therefore determines portions of the PDSCH region 450 that correspond to the UE and contain at least some UE-specific information. Based on the information from the found UE specific PDCCH messages UE also may not access the PDSCH region 450. That is, only if the PDCCH message contains a downlink assignment does the UE access the PDSCH region 450.” (Ex-1004-Lindh at 0110.)

Stated differently, Lindh’s UE-specific signaling indicates at least “resource allocation,” as recited by the claim, because Lindh’s UE determines from the UE-specific control signaling which resources were allocated to it, then accesses the allocated resource in the indicated part of the data region (PDSCH region 450). (Ex-1003-Davies at ¶¶159-61.)

Thus, Lindh teaches this limitation and Lindh in view of Tooher renders obvious claim 15.

[Claim 16] The method of claim 11, wherein the common signal is a signaling indicating a system frame number (SFN), a signaling indicating resource allocation for a broadcast message, a synchronization signal, or a reference signal for DL radio condition measurement.

Lindh discloses this limitation as evidenced by Sesia. Specifically, Lindh discloses:

“In block 5C, the UE monitors the common SS on the Rel-8/9/10 type DL control region 420 in order to find the common PDCCH 492, *which is recognized by having a CRC masked with SI-RNTI, RA-RNTI or P-RNTI or UE specific PDCCHs containing the format 0 or 1A as explained in 3GPP TS 36.213 Table 7.1-5.*” (Ex-1005-Lindh at 0105.)

A POSITA would know Lindh’s use of SI-RNTI in this context discloses “a signaling indicating resource allocation for a broadcast message” to a POSITA.¹⁹ (Ex-1003-Davies at ¶¶162-66.)

Specifically, Sesia is an LTE reference book that “provides a thorough, authoritative and complete tutorial of the LTE system” inclusive of LTE-Advanced. (Ex-1005-Sesia at 29.) Sesia provides express details regarding how “special

¹⁹ The ’658 patent treats system information, paging, and random access responses as broadcast messages. (Ex-1001 at 16:39-46.)

purpose” information was conventionally transmitted in LTE. (Ex-1005-Sesia at p238 [§9.2.2.2 Special Uses of the PDSCH].) Sesia explains:

“One such use is for the **broadcast system information** (i.e. SIBs) that is not carried on the PBCH. The RBs used for broadcast data of this sort are indicated by signalling messages on the PDCCH in the same way as for other PDSCH data, except that the identity indicated on the PDCCH is not the identity of a specific UE but is, rather, a designated **broadcast identity known as the System Information Radio Network Temporary Identifier (SI-RNTI)**, which is fixed in the specifications (see Section 7.1 of [1]) and therefore known a priori to all UEs.” (Ex-1005-Sesia at p238.)

As shown, Sesia shows the meaning of SI-RNTI as used in Lindh to a POSITA (a common broadcast identifier), that it was used in broadcasting system information, that it was fixed (required) in the specifications, and “therefore known a priori to all UEs.” Sesia further discloses monitoring common signal in the conventional downlink control region (PDCCH), with such common signals indicating PDSCH resource allocations “in the same way as for other PDSCH data.” (Ex-1003-Davies at ¶¶164-65.) A POSITA would have thus understood that Lindh’s SI-RNTI disclosures read on “signaling indicating resource allocation for a broadcast message.” (Ex-1003-Davies at ¶¶165-66.)

Thus, Lindh teaches this limitation, and Lindh in view of Tooher renders obvious claim 16.

[Claim 17] The method of claim 11, wherein a length of the downlink control region is two symbols and the UE does not monitor the UE specific signal in the at least one second symbol.

This claim requires a control region having exactly two symbols as discussed in §VIII.E.

Lindh teaches a control region that is exactly two symbols and in which the UE-specific signal is not monitored in the “second symbol.” Specifically, Lindh discloses that the length of the downlink control region in LTE is indicated by the PCFICH channel, and is 1-4 symbols in length:

“1) PCFICH, which indicates the number of OFDM symbols for the DL control region (1-3 or 2-4 symbols for the smallest bandwidth)....” (Ex-1004-Lindh at 0084-85; *see id.* at FIG. 5, Steps 5A (reading PCFICH to determine “REL-8/9/10 control region”).)

As shown above, FIG. 4 of Lindh illustrates an example of a control region that is 3 symbols long, two of which are the indicated 2-symbol control region and the third of which is the enhanced control region. (Ex-1004-Lindh at 0103-04.) Since Lindh expressly discloses that a downlink control region may have a shorter duration (e.g., 1 or 2 total symbols) and Lindh requires an enhanced control region, it was obvious to a POSITA to have a first symbol relating to the enhanced control region and a second symbol relating to the normal (legacy) control region. (Ex-1003-Davies at ¶¶167-72.)

The remainder of the claim is taught by Lindh for the reasons stated above relative to claim 14, and Lindh in view Tooher renders obvious claim 17.

[18.0] A User Equipment (UE) for communication with a network node, comprising:

Lindh teaches this preamble for the reasons provided above regarding 11.0.

[18.0.1] a control circuit;

[18.0.2] a processor installed in the control circuit; and

[18.0.3] a memory installed in the control circuit and operatively coupled to the processor;

[18.0.4] wherein the processor is configured to execute a program code stored in the memory to:

Lindh teaches these limitations. For example, Lindh discloses that its enhanced techniques may be implemented on a UE:

“Each UE 10 includes a controller, such as a computer or a data processor (DP) 10A, a computer-readable memory medium embodied as a memory (MEM) 10B that stores a program of computer instructions (PROG) 10C, and at least one suitable radio frequency (RF) transceiver 10D for bidirectional wireless communications with the eNB 12 via one or more antennas 10E. ...

The techniques herein may be considered as being implemented...as a combination of computer program code (executed by one or more processors) and various hardware, including memory locations, data processors, buffers, interfaces and the like, or entirely in hardware (such as in a very large scale integrated circuit). Additionally, the transceivers 10D and 12D may also be implemented using any type of wireless communications interface suitable to the local technical environment, for example, they may be implemented using

individual transmitters, receivers, transceivers or a combination of such components.” (Ex-1004-Lindh at 0092; *see id.* at Abstract.)

Thus, Lindh discloses a processor and memory, operatively coupled together and installed in control circuitry to execute program code in the memory to implement limitations 18.1-18.5 and claims 19-24. (Ex-1003-Davies at ¶¶174-76.)

Thus, Lindh teaches these limitations.

[18.1] communicate with the network node in a cell via downlink and uplink transmissions, wherein the downlink and uplink transmissions are organized into radio frames, each radio frame includes multiple subframes, and each subframe includes multiple symbols;

Lindh teaches this limitation for the reasons provided above regarding limitation 11.1.

[18.2] monitor, in the cell, a UE specific signal in at least one first symbol of a downlink control region of a subframe,

Lindh teaches this limitation for the reasons provided above regarding limitation 11.2.

[18.3] and not monitoring a common signal in the at least one first symbol; and

Lindh teaches this limitation for the reasons provided above regarding limitation 11.3.

[18.4] monitor, in the cell, the common signal in at least one second symbol of the downlink control region,

Lindh teaches this limitation for the reasons provided above regarding limitation 11.4.

[18.5] wherein the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe.

Lindh in view of Tooher teaches this limitation for the reasons provided above regarding limitation 11.5, and Lindh in view of Sesia and Tooher renders obvious claim 18.

Claims 19-24

Claims 19-24 include the same limitations as claims 12-13, 15-17, and 14, respectively, and thus are obvious for the same reasons provided above relative to those claims.

XI. GROUND 2: Kim in view of 3GPP-36.300 and R1-112517 renders obvious claims 11-24

A. Scope and Content of the Prior Art

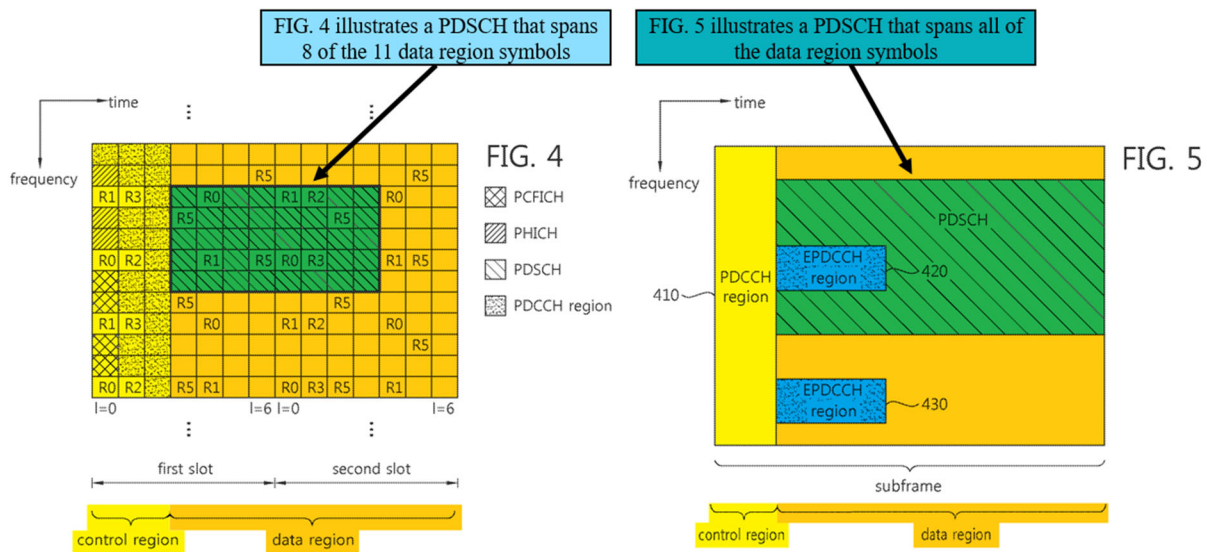
Ground 2 relies on Kim in view of 3GPP-36.300 (Ex-1009) and R1-112517. Kim discloses a communications system “applied according to [3GPP]” LTE or LTE-A technical specifications (TS), releases 8 and 10, respectively, with a particular focus on methods “for monitoring a downlink control channel.” (Ex-1006-Kim at 0026, 0008.) Kim focuses on downlink, and thus unsurprisingly does not illustrate its uplink frame structure. A POSITA would have reasonably expected Kim to use conventional 3GPP uplink frame organization. (*Id.* at 0027 (describing use of downlink and uplink carrier components), 0039-41 (describing general use of uplink); Ex-1003-Davies at ¶¶183-87.) 3GPP-36.300 discloses that LTE (including Release 8, Release 10, and Release 12) uplink frames are organized into 10

subframes, 2 slots per subframe, and 7 SC-FDMA per “normal” slot. (Ex-1009-3GPP-36.300 at §5.2; §194.) A POSITA would have recognized that this was the obvious frame structure to use with Kim. (Ex-1003-Davies at ¶¶183-89.) Indeed, Kim’s FIG. 1 illustrates an LTE-A radio frame structure, and Kim generally defines a radio frame as having 10 subframes, with each having two slots. (Ex-1006-Kim at 0030-31.) Kim also references LTE’s organization in which a slot comprises a plurality of OFDM symbol periods in the time domain for downlink frames, while noting that other symbols may be used as well. (*Id.* at 0032 (referring to the use of other terminology including “SC-FDMA” symbols and a more generic “symbol period”).) Since Kim does not propose a modification to LTE’s uplink frame structure, a POSITA would expect Kim to use the conventional uplink frame organization whereby a frame is organized into subframes, subframes into slots, and slots in symbols (SC-FDMA symbols in the case of a conventional LTE uplink frame). (Ex-1003-Davies at ¶¶188-89.)

Second, Kim discloses “[a] control region of a subframe include[es] a plurality of control channel elements (CCEs).”²⁰ Kim discloses monitoring PDCCH

²⁰ A “CCE is a logical allocation unit,” and “a wireless device having a good DL channel can use one CCE in PDCCH transmission.” (Ex-1006-Kim at 0051-53 (noting that more CCEs may be used when needed).)

candidates (defined in terms of “control channel elements” [“CCEs”]) and enhanced PDCCH (“EPDCCH”) candidates (defined in terms of enhanced CCEs [“ECCEs”]) in different portions of a subframe. (*E.g.*, Ex-1006-Kim at 0096-98.) Kim also discloses two different examples (FIGS. 4-5) in which different PDSCH elements occupy different symbols within a subframe:



Ex-1006-Kim, FIGS. 4-5
(figure labels moved by Petitioner, annotations by Petitioner)

(Ex-1003-Davies at ¶¶190-97.) Kim does not expressly disclose when data resources may occupy different symbols in the data region of a subframe. (*Id.* at ¶¶190-91.)

A 2011 Samsung proposal discloses a way to “[e]xtend[] the capacity of the [downlink] control channel” by using the legacy PDSCH region for transmission of enhanced control information. (Ex-1010-R1-112517 at §1.) For example, in the subsection entitled “*Enhanced* DL Control Region Granularity and Multiplexing,” Samsung, like Kim, uses the term “eCCE” to refer to enhanced control channel

elements. (*Id.*; Ex-1003-Davies at ¶192.) R1-112517 discloses transmitting PDCCH signals in the conventional control region symbols, while also transmitting eCCEs for decoding EPDCCH signals in the conventional data region:

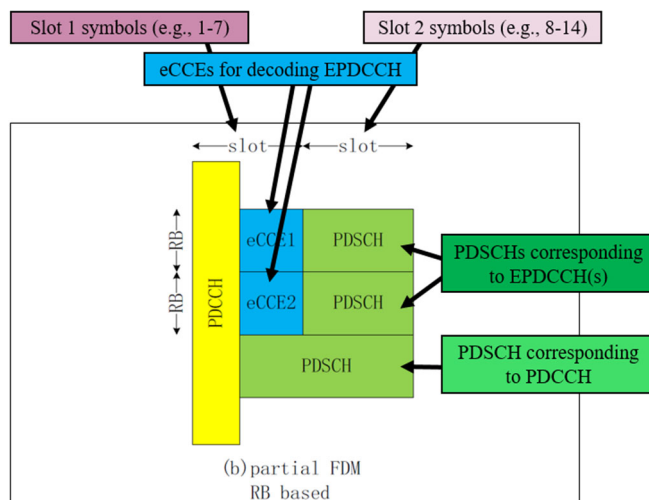


Fig. 1: Examples for RB-based ePDCCH Multiplexing

Ex-1012-R1-112517 at §2, p2
(PDCCH, eCCE, and PDSCH coloring original)

A POSITA would understand FIG. 1(b) teaches a PDCCH (yellow) indicating a PDSCH that occupies symbols in both slots (e.g., symbols 4-14 if the PDCCH spans 3 control region symbols), while the eCCEs are used to decode EPDCCH(s) in the blue portion of the first slot, which EPDCCH(s) indicate resources in the corresponding PDSCHs in the second slot (e.g., symbols 8-14). (Ex-1010-R1-112517 at §2; Ex-1003-Davies at ¶¶192-93.) A POSITA would have this understanding from the description of the figure, which states: “Such a design will also shorten the decoding time of an ePDCCH and PDSCH decoding can start from the second slot once a DL grant is detected.” (Ex-1010-R1-112517 at §2; Ex-1003-

Davies at ¶193.) This would have taught and suggested to a POSITA that the upper two PDSCH regions that appear only in the second slot relate to the corresponding eCCE elements that are in the left slot in the same horizontal position. (Ex-1003-Davies at ¶¶193-94.) Thus, R1-112517 discloses a downlink frame structure in which a PDCCH may indicate resources in the data region that occupy all of the data region symbols (the bottom PDSCH occupies both slots in FIG. 1(b)), while the enhanced control transmitted in the eCCE portions of the subframe may indicate resources in just the portion of the data region that is in the second slot of the subframe. (*Id.*; Ex-1003-Davies at ¶¶193-95.)

A POSITA would have been motivated and found it obvious to utilize the eCCE scheme of FIG. 1(b) of R1-112517 with Kim. As R1-112517 shows, Kim's downlink subframe structure would be improved by permitting data resources to be transmitted in a subframe's second slot rather than requiring both slots for PDSCH transmission. (Ex-1003-Davies at ¶196.) In this scenario, the common signals in the legacy control region may indicate data resource allocations that occupy all of the data region symbols, while the enhanced control signals in the EPDCCH control region indicate data resources in slot 2 only. (*Id.* at ¶¶196-97.) As R1-112517 recognizes, the scheme of FIG. 1(b) "will [] shorten the decoding time of an ePDCCH" with the additional benefit that "PDSCH decoding can start from the second slot once a DL grant is detected." A POSITA would have understood that

having a shortened PDSCH decoding for EPDCCH would benefit Kim by enhancing resource efficiency in a subframe. By transmitting EPDCCH(s) in a first slot and permitting data resources to occupy the second slot, the data region can carry more data and the UE can begin decoding it more quickly than if data resources were required to use symbols in both slots of a subframe. (*Id.*)

A POSITA also would have expected to succeed in combining Kim with R1-112517. Applying the teachings of R1-112517 to Kim would merely require implementing routine software and/or hardware to Kim's system to achieve the functionality described by R1-112517. As Mr. Davies explains, decoding a control signal (e.g., in a PDCCH or EPDCCH) from the first portion of a subframe and using that information to find corresponding data resources indicated by the signal in a second portion of the subframe merely required using conventional knowledge and technology in a predictable manner. (*Id.*) As such, a POSITA would have had no difficulty applying this routine and predictable functionality to Kim in view of R1-112517, including with respect to Fig.1(b) in which enhanced control signals in a first slot indicate data resources in a second slot of a subframe. (*Id.*)

B. Challenged Claims

Ground 2 addresses claims 11-24.

[11.0] A method for a User Equipment (UE), comprising:

Kim teaches the preamble. Specifically, Kim discloses “the present invention is applied according to” 3GPP LTE or LTE-A, which define communications networks having network nodes (BSs; eNBs) and user equipment (UE), and methods for the same. (Ex-1006-Kim at 0024-26.)

Thus, Kim teaches this preamble.

[11.1] communicating with a network node in a cell via downlink and uplink transmissions, wherein the downlink and uplink transmissions are organized into radio frames, each radio frame includes multiple subframes, and each subframe includes multiple symbols;

Kim alone and in view of 3GPP-36.300 teaches this limitation. Kim’s UEs communicate in a network (e.g., LTE) in the uplink (UL) and downlink (DL) directions with a base station (the claimed “network node”) in a cell:

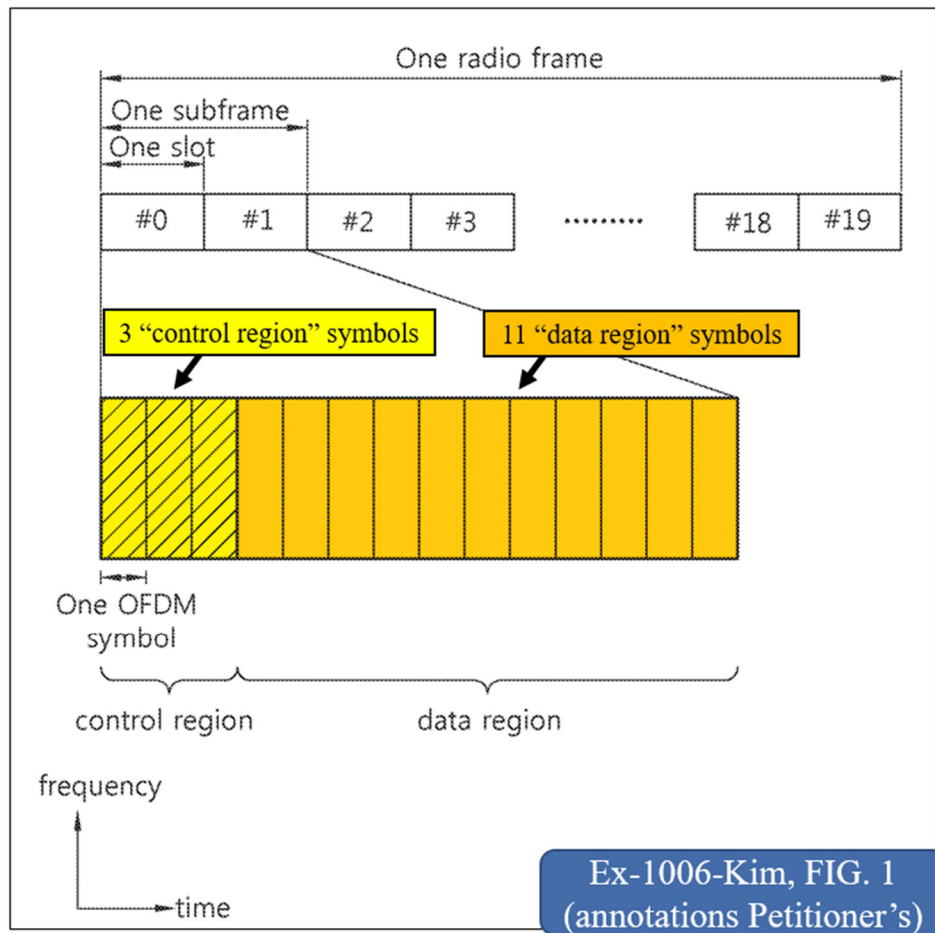
“A base station (BS) is generally a fixed station that communicates with the wireless device, and may be referred to as another terminology, such as an evolved-NodeB (eNB), a base transceiver system (BTS), an access point, etc.

Hereinafter, it is described that the present invention is applied according to a 3rd generation partnership project (3GPP) long term evolution (LTE) based on 3GPP technical specification (TS) release 8 or 3GPP LTE-advanced (LTE-A) based on 3GPP TS release 10. ... LTE and/or LTE-A are collectively referred to as LTE.

The wireless device may be served by a plurality of serving cells. Each serving cell may be defined with a downlink (DL) component

carrier (CC) or a pair of a DL CC and an uplink (UL) CC.” (Ex-1006-Kim at 0025-27.)

FIG. 1 of Kim discloses a downlink radio frame structure having multiple subframes, and with each subframe includes multiple symbols:



(*Id.* at 0016, 0030). Thus, Kim expressly describes a downlink frame “organized into radio frames, each radio frame includes multiple subframes, and each subframe includes multiple symbols.”

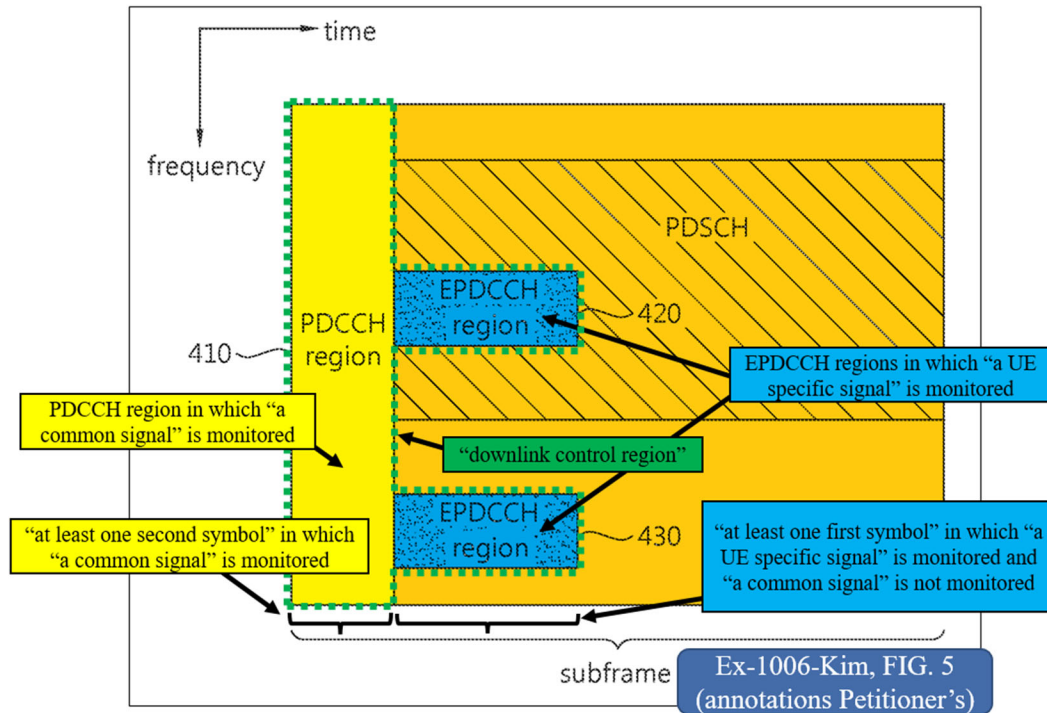
As it relates to the uplink radio frames, Kim refers the reader to 3GPP LTE technical specifications. (*Id.* at 0026.) 3GPP-36.300 discloses that uplink and

downlink transmissions are organized in frames. (Ex-1009-3GPP-36.300 at §5 [page 47] (disclosing “[d]ownlink and uplink transmission are organized into radio frames with 10ms duration” and that frames are divided into equally-sized subframes, with each subframe having two slots), §5.2 [page 52] (disclosing that normal LTE uplink slots have seven SC-FDMA symbols per slot); Ex-1001 at 5:18-25 (admitting the same via citation to 3GPP-36.300); *see id.* at 5:26-52 (further describing LTE frame structure from 3GPP-36.300); Ex-1003-Davies at ¶¶201-10.)

Thus, Kim in view of 3GPP-36.300 teaches this limitation.

[11.2] monitoring, in the cell, a UE specific signal in at least one first symbol of a downlink control region of a subframe,
[11.3] and not monitoring a common signal in the at least one first symbol; and
[11.4] monitoring, in the cell, the common signal in at least one second symbol of the downlink control region,

Kim teaches these limitations. FIG. 5 illustrates Kim’s pertinent disclosures at a high level; a more detailed explanation of each aspect of these limitations then follows.



As shown, FIG. 5 illustrates a “subframe” (bottom) including a PDCCH region (410; yellow) and two EPDCCH regions (420, 430; blue). (*Id.* at 0087-88.) The “PDCCH region 410 is located in up to first four OFDM symbols of the subframe, whereas the EPDCCH regions 420 and 430 may be flexibly scheduled in an OFDM symbol located after the PDCCH region 410.” (*Id.* at 0089.) The PDSCH “is allocated to the data region.” (*Id.* at 0035.)

The “downlink control region of a subframe” is circumscribed with green dashes and comprises both the yellow PDCCH region and the blue EPDCCH regions. (*See* §VIII (noting that Patentee’s apparent interpretation of the claims permits portions of the “control region” to be located in the same symbols as portions of the “data region.”).) UE-specific signals are monitored in the EPDCCH regions

in the “first” symbols corresponding to those regions, while the “common signal” is not monitored in those symbols and is monitored instead in the “second” symbols corresponding to the PDCCH region. (Ex-1003-Davies at ¶¶211-13.)

(a) “Monitoring, in the cell” UE-specific signals in a USS (UE-specific search space) and common signals in a CSS (common search space)

Kim teaches both UE-specific search spaces (called “USS”) and common search spaces (called “CSS”). (Ex-1006-Kim at 0105.) Kim teaches monitoring CSS and USS signals in their corresponding search spaces in a cell:

“Hereinafter, a USS and a CSS denote a USS and a CSS in a PDCCH region, and an enhanced-USS (E-USS) and an enhanced-CSS (E-CSS) denote a USS and a CSS in an EPDCCH region. The CSS is a region monitored by a plurality of wireless devices in a cell or all wireless devices in the cell.” (Ex-1006-Kim at 0126; *see id.* at 0105 (defining “CSS” as “common search space” and “USS” as “UE-specific search space”); 0058 (“The 3GPP LTE uses a search space to reduce a load of blind decoding. The search space can also be called a monitoring set of a CCE for the PDDCH. The wireless device monitors the PDCCH in the search space.”).)

“If the PDCCH is for a specific wireless device, a unique identifier (e.g., cell-RNTI (C-RNTI)) of the wireless device may be masked to the CRC. Alternatively, if the PDCCH is for a paging message, a paging indication identifier (e.g., paging-RNTI (P-RNTI)) may be masked to the CRC. If the PDCCH is for system information, a system information identifier (e.g., system information-RNTI (SI-RNTI)) may be masked to the CRC. ... When the C-RNTI is used, the

PDCCH carries control information for a specific wireless device (such information is called UE-specific control information), and when other RNTIs are used, the PDCCH carries common control information received by all or a plurality of wireless devices in a cell.” (Ex-1006-Kim at 0046-47.)

“The search space is classified into a common search space and a UE-specific search space. The common search space is a space for searching for a PDCCH having common control information and consists of 16 CCEs indexed with 0 to 15.” (Ex-1006-Kim at 0059.)

Thus, Kim teaches both “monitoring, in the cell, a UE specific signal” [11.2] and “monitoring, in the cell, the common signal” [11.4]. (Ex-1003-Davies at ¶¶214-19.)

(b) Kim’s E-USS signals are monitored in “at least one first symbol” while Kim’s CSS signals are monitored in “at least one second symbol” and without being monitored in the “at least one first symbol”

Kim discloses an enhancement pursuant to which UEs monitor an “enhanced” PDCCH region (referred to as “EPDCCH”), also referred to as an “EPDCCH search space.” (Ex-1006-Kim at 0097; *id.* at 0089 (“The EPDCCH regions 420 and 430 are regions in which a wireless device monitors the EPDCCH.”); *see id.* at 0086 (“an enhanced PDCCH (EPDCCH) is introduced.”).) As noted above, Kim uses an “E” to denote the user-specific and common search spaces that are located in EPDCCH regions. (Ex-1006-Kim at 0126.)

Kim further explains that the EPDCCH regions are scheduled in symbols located after the symbols corresponding to the PDCCH region:

“The PDCCH region 410 is located in up to first four OFDM symbols of the subframe, whereas the EPDCCH regions 420 and 430 may be flexibly scheduled in an OFDM symbol located after the PDCCH region 410.” (Ex-1006-Kim at 0089.)

This is shown pictorially in FIG. 5 (reproduced above), where the symbols corresponding to the PDCCH region do not overlap with the symbols corresponding to the EPDCCH region. Kim’s PDCCH reads on the “second symbol(s)” of limitation 11.4 because it is located in “up to first four OFDM symbols of the subframe” and Kim’s EPDCCHs read on the “first symbol(s)” of limitation 11.2 because they are located “in an OFDM symbol located after the PDCCH region 410.”

Kim discloses various subframe configurations that use both the PDCCH region and EPDCCH regions, as shown in Table 5 (annotated by Petitioner below):

“Now, a subframe configuration for a PDCCH and an EPDCCH will be described. The following table shows an example of the subframe configuration.

TABLE 5

Subframe configuration	CSS (PDCCH)	USS (PDCCH)	E-CSS	E-USS	Exemplary usage
2	○	○			CSS fallback
3			○		USS fallback
4				○	E-CSS only
5	○	○			E-USS only
6	○		○		PDCCH only
7	○		○	○	CSS/E-CSS partitioning
8		○	○		CSS/USS partitioning
9		○		○	
10		○	○	○	EPDCCH only
11	○	○	○	○	
12	○	○	○	○	CSS fallback
13	○	○	○	○	
14	○	○	○	○	
15	○	○	○	○	
16					N/A

“a common signal” is not monitored in the same symbols of the EPDCCH regions

In the above table, ‘O’ indicates that a corresponding search space exists in a corresponding subframe.” (Ex-1006-Kim at 0131-34.)

Configurations 7 and 12 are relevant here—in both configurations, the UE monitors an E-USS (blue boxes) for UE-specific signals in one or more first symbols corresponding to the EPDCCH regions without monitoring (red boxes) common signals in the same region. (Ex-1003-Davies at ¶¶220-27.) Thus, Kim discloses limitations 11.2-11.3. In this same configuration, the CSS is monitored in the PDCCH, located in one or more “second symbol(s)” (yellow boxes), which discloses limitation 11.4. (*Id.*)

Thus, Kim teaches limitations 11.2-11.4.

[11.5] wherein the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe.

Kim alone and Kim in view of R1-112517 teach this limitation. First, this limitation is taught, suggested, and obvious over Kim alone because Kim shows that the length of resources indicated by corresponding control signaling may vary.

FIGS. 4-5, below, illustrate two different options:

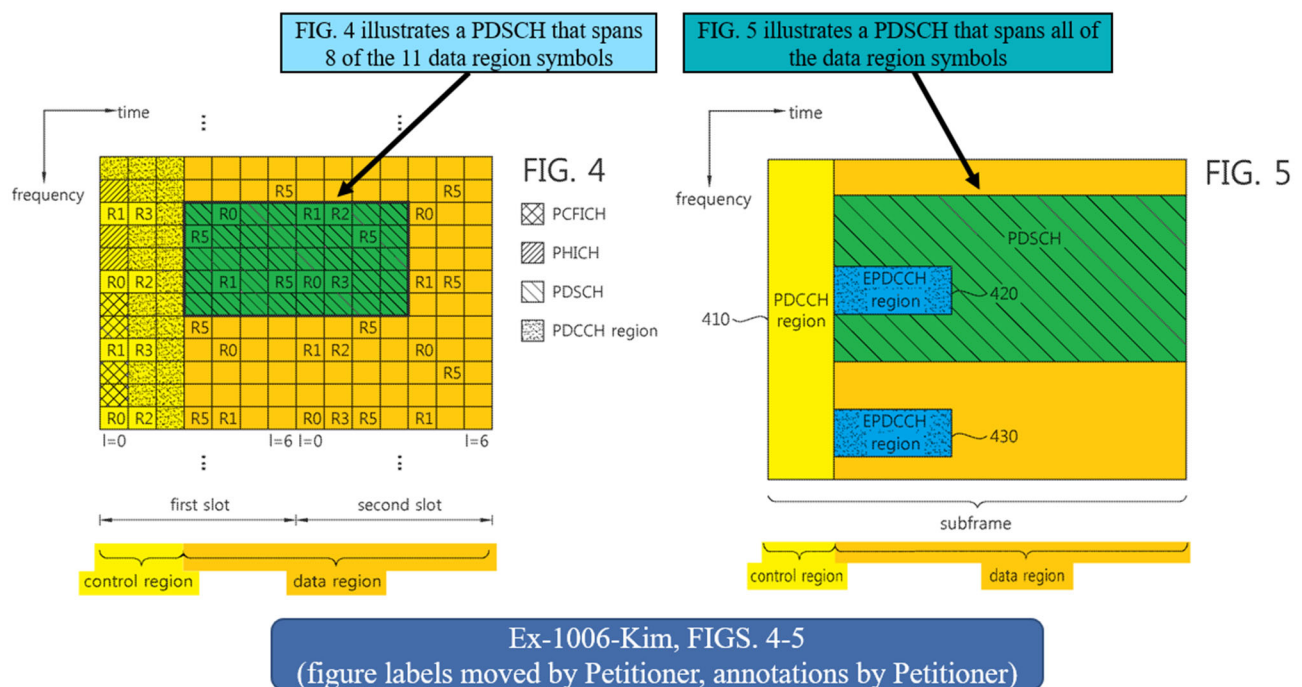


FIG. 4 shows a typical LTE subframe in which a PDSCH region spans symbols 4-11 of the subframe, while FIG. 5 shows a PDSCH region that spans all of the data region symbols (4-14). As such, Kim discloses and renders obvious limitation 11.5 by indicating that data resources of differing durations may be indicated by their corresponding control signals. (Ex-1003-Davies at ¶¶228-32.)

Kim in view of R1-112517 also teaches this limitation. Specifically, R1-112517 teaches transmitting legacy and enhanced control signals in the first slot of a subframe:

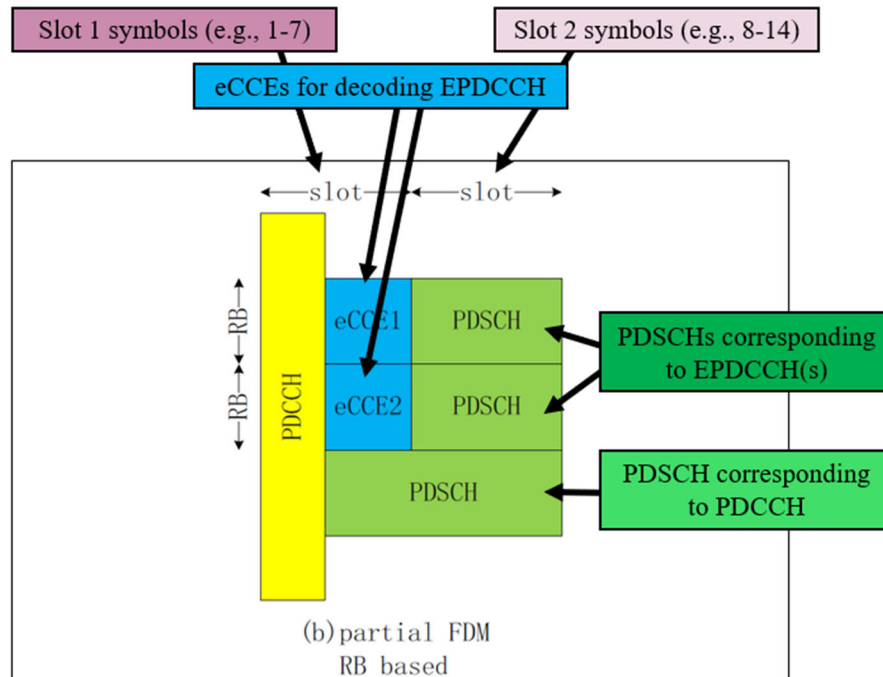


Fig. 1: Examples for RB-based ePDCCH Multiplexing

Ex-1010-R1-112517 at §2, p2
(PDCCH, eCCE, and PDSCH coloring original)

As explained in §XII.A, FIG. 1(b) teaches and suggests that a PDCCH indicates a data resource in the PDSCH that spans symbols in two slots, while the eCCEs are for decoding an EPDCCH that indicates data resources in the PDSCHs appearing in slot two only. (Ex-1003-Davies at ¶¶232-36.)

A POSITA would have been motivated and found it obvious to apply these teachings to Kim. As shown above, Kim discloses using common signals in a PDCCH region to indicate resources in a data region and UE-specific signals in

ePDCCH regions to indicate resources in a data region as well. R1-112517 teaches an efficiency enhancement wherein the enhanced signals may indicate resources in the second slot rather than in both slots. (Ex-1003-Davies at ¶¶239-40.) Kim's common and UE-specific control signals would indicate corresponding data resources in PDSCH regions that are not coextensive such that they are in different symbols—the resources indicated by the UE-specific signals would be in the symbols corresponding to the second slot of the subframe only, while the common signals may indicate resources in all of the data region symbols (e.g., symbols 4-14 in a typical subframe having a 3-symbol PDCCH region). (*Id.*)

Thus, Kim alone and in view of R1-112517 teaches this limitation, and Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 11.

[Claim 12] The method of claim 11, wherein the common signal and the UE specific signal indicate resources in completely different or partially different symbols of the data region of the subframe.

As explained above in limitation 11.5, Kim in view of 3GPP-36.300 and R1-112517 discloses resources in (at least) partially different symbols. (Ex-1003-Davies at ¶237.) Thus, Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 12 for the reasons discussed above.

[Claim 13] The method of claim 11, wherein the UE monitors the UE specific signal in the second symbol.

Kim teaches this limitation. Specifically, as discussed with respect to limitations 11.2-11.4, the PDCCH of Kim's FIG. 4-5 is located in the "second"

symbol(s). Kim discloses configuration 12 in Table 5 (annotated by Petitioner below):

TABLE 5				
Subframe configuration	CSS (PDCCH)	USS (PDCCH)	E-CSS	E-USS
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				

"a common signal" is monitored in the "second" symbols corresponding to the CSS in the PDCCH portion of the control region

"a UE specific signal" is monitored in the "first" symbols corresponding to the E-USS in the EPDCCH portion of the control region

UE-specific signal also monitored in PDCCH in configuration 12

"a common signal" is not monitored in the same symbols of the EPDCCH regions

Table 5 expressly shows monitoring the USS in both the PDCCH and EPDCCH regions. (Ex-1006-Kim at 0133.) Accordingly, Kim's configuration 12 discloses this limitation. (Ex-1003-Davies at ¶¶238-40.)

Thus, Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 13.

[Claim 14] The method of claim 11, wherein the UE does not monitor the UE specific signal in the at least one second symbol.

Kim discloses this limitation. Specifically, as discussed with respect to limitations 11.2-11.4, Kim discloses configuration 7 in Table 5 (reproduced above), in which a UE does not monitor UE-specific signals in the PDCCH region, and thus

does not monitor such signals in the “second” symbols. (Ex-1006-Kim at 0133; Ex-1003-Davies at ¶¶241-42.)

Thus, Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 14.

[Claim 15] The method of claim 11, wherein the UE specific signal is a signaling indicating resource allocation, a signaling indicating HARQ (Hybrid Automatic Repeat reQuest) feedback, and/or a reference signal for demodulation.

Kim in view of R1-112517 teaches this limitation. For the reasons discussed above relative to limitation 11.2-11.5, Kim in view of R1-112517 discloses monitoring a UE-specific signal that indicates one or more resources allocated to the UE in a PDSCH in the data region. (Ex-1003-Davies at ¶¶243-47.)

Kim also discloses this limitation in a second way: using a “DM-RS” that is transmitted in the EPDCCH regions. Specifically, Kim discloses:

“In the EPDCCH regions 420 and 430, instead of the CRS, a DM-RS may be defined for demodulation of the EPDCCH. An associated DM-RS may be transmitted in the EPDCCH regions 420 and 430.” (Ex-1006-Kim at 0092; *see id.* at 0080 (describing a UE-specific reference signal [“URS”] that is “also called a dedicated reference signal (DRS) or a demodulation reference signal (DM-RS).”)

Stated differently, Kim discloses monitoring a UE-specific signal (a “reference signal for demodulation” that Kim calls a “DM-RS”) in the EPDCCH region. (Ex-1003-Davies at ¶¶245-47.)

Thus, Kim in view of R1-112517 discloses this limitation, and Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 15.

[Claim 16] The method of claim 11, wherein the common signal is a signaling indicating a system frame number (SFN), a signaling indicating resource allocation for a broadcast message, a synchronization signal, or a reference signal for DL radio condition measurement.

Kim in view of R1-112517 teaches this limitation. For the reasons discussed above relative to limitations 11.2-11.5, Kim in view of R1-112517 discloses monitoring a common signal in the PDCCH that indicates resource allocation in a corresponding PDSCH. (Ex-1003-Davies at ¶¶248-51.) Kim also discloses monitoring the PDCCH for common signals, including those corresponding to a broadcast message and to a synchronization signal:

“The PDCCH subframe and the EPDCCH subframe may be properly combined and operated according to a feature of control information. For example, information for changing and updating importance information such as system information and cell selection/reselection information or broadcast information or information masked with SI-RNTI, P-RNTI, and RA-RNTI may be monitored in a PDCCH region, and scheduling information (i.e., DL grant and UL grant) may be monitored in the EPDCCH.” (Ex-1006-Kim at 0105.)

“[A] subframe in which a specific signal (e.g., PBCH, synchronization signal) is transmitted may be designated as the PDCCH subframe.” (*Id.* at 0104.)

Thus, Kim in view of R1-112517 discloses this limitation, and Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 15.

[Claim 17] The method of claim 11, wherein a length of the downlink control region is two symbols and the UE does not monitor the UE specific signal in the at least one second symbol.

Kim teaches and renders obvious a control region that is exactly two symbols and in which the UE-specific signal is not monitored in the “second symbol.” Specifically, in the context of Kim’s FIG. 5, Kim discloses:

“FIG. 5 is an example of a subframe having an EPDCCH.

The subframe may include zero or one PDCCH region 410 and zero or more EPDCCH regions 420 and 430.

The EPDCCH regions 420 and 430 are regions in which a wireless device monitors the EPDCCH. The PDCCH region 410 is located in up to first four OFDM symbols of the subframe, whereas the EPDCCH regions 420 and 430 may be flexibly scheduled in an OFDM symbol located after the PDCCH region 410. ... The number/location/size of the EPDCCH regions 420 and 430 and/or information regarding a subframe for monitoring the EPDCCH may be reported by a BS to the wireless device by using a radio resource control (RRC) message or the like.” (Ex-1006-Kim at 0087-91.)

As shown above in claim 11, the “control region” in this Ground includes the PDCCH region 410 and the EPDCCH regions 420 and 430. The excerpt above shows that the PDCCH region may be one symbol long (because, if it exists, it may be located in one or more of the “first four OFDM symbols”) and expressly refers scheduling an EPDCCH region in “an OFDM symbol” that follows the PDCCH region. Kim’s use of “*an*” OFDM signal implies the use of a single OFDM signal

for the EPDCCH region. (Ex-1003-Davies at ¶¶252-55.) Thus, Kim teaches and suggests a control region having a length of exactly two symbols. In such a scenario, and in the context of subframe configuration 7 in Kim (discussed above regarding claim 11), the downlink control region is two symbols, UE-specific signals are monitored in the “first” EPDCCH symbol, common signals are monitored in the “second” PDCCH symbol that precedes the EPDCCH region, and UE-specific signals are not monitored in the PDCCH region of the “second” symbol. (Ex-1003-Davies at ¶254.)

Thus, Kim teaches this limitation and Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 17.

[18.0] A User Equipment (UE) for communication with a network node, comprising:

Kim teaches this preamble for the reasons provided above regarding 11.0.

[18.0.1] a control circuit;

[18.0.2] a processor installed in the control circuit; and

[18.0.3] a memory installed in the control circuit and operatively coupled to the processor;

[18.0.4] wherein the processor is configured to execute a program code stored in the memory to:

Kim teaches these limitations. For example, Kim discloses implementing its teachings in a UE comprising a processor and memory, operatively coupled together and installed in control circuitry to execute program code in the memory for

performing limitations 18.1-18.5 and claims 19-24. (Ex-1006-Kim at 0152-53; *see id.* at FIG. 8; Ex-1003-Davies at ¶¶257-59.)

Thus, Kim teaches these limitations.

[18.1] communicate with the network node in a cell via downlink and uplink transmissions, wherein the downlink and uplink transmissions are organized into radio frames, each radio frame includes multiple subframes, and each subframe includes multiple symbols;

Kim in view of 3GPP-36.300 teaches this limitation for the reasons provided above regarding limitation 11.1. (Ex-1003-Davies at ¶260.)

[18.2] monitor, in the cell, a UE specific signal in at least one first symbol of a downlink control region of a subframe,
[18.3] and not monitoring a common signal in the at least one first symbol; and
[18.4] monitor, in the cell, the common signal in at least one second symbol of the downlink control region,

Kim teaches these limitations for the reasons provided above regarding limitations 11.2-11.4. (Ex-1003-Davies at ¶261.)

[18.5] wherein the common signal and the UE specific signal indicate resources in different symbols of a data region of the subframe.

Kim in view of R1-112517 teaches this limitation, and Kim in view of 3GPP-36.300 and R1-112517 renders obvious claim 18. (Ex-1003-Davies at ¶262.)

Claims 19-24

Claims 19-24 include the same limitations as claims 12-13, 15-17, and 14, respectively, and thus are obvious for the same reasons provided above relative to those claims. (Ex-1003-Davies at ¶263.)

XII. Conclusion

For the foregoing reasons, Petitioner respectfully requests cancellation of claims 11-24.

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CERTIFICATE OF SERVICE

The undersigned certifies that a true and correct copy of the Petition together with all exhibits identified in the above Table of Exhibits and Petitioner's Power of Attorney, have been served on the Patentee via Priority Mail Express or by means at least as fast and reliable as Priority Mail Express on the below date, at the following address:

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Petition Requesting *Inter Partes* Review

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