

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

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

v.

APEX BEAM TECHNOLOGIES LLC,
Patent Owner

Case IPR2023-00598
Patent No. 10,462,767

PETITION FOR *INTER PARTES* REVIEW

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PETITIONER’S EXHIBIT LIST

Exhibit	Description
Ex. 1001	U.S. Patent No. 10,462,767 to Zhang (“’767 patent”)
Ex. 1002	Declaration of Harry Bims, Ph.D. (“Bims”)
Ex. 1003	Reserved
Ex. 1004	Prosecution History of the ’767 patent (downloaded from Public PAIR)
Ex. 1005	International Patent Publication No. 2017/052199 to You et al., filed September 21, 2016, and published March 30, 2017 (“ <i>You</i> ”)
Ex. 1006	International Patent Publication No. 2018/126401 to Liu et al., filed January 5, 2017, and published July 12, 2018 (“ <i>Liu</i> ”)
Ex. 1007	International Patent Publication No. 2016/136143 to Mallick et al., filed January 28, 2016, and published September 1, 2016 (“ <i>Mallick</i> ”)
Ex. 1008	International Patent Publication No. 2018/081913 to Liu et al., filed November 3, 2016, and published May 11, 2018 (“ <i>Liu913</i> ”)
Ex. 1009	U.S. Patent Publication No. 2011/0038330 to Luo et al., filed July 29, 2010, and published February 17, 2011 (“ <i>Luo</i> ”)
Ex. 1010	U.S. Patent Publication No. 2011/0176519 to Vitthaladevuni et al., filed November 15, 2010, and published July 21, 2011 (“ <i>Vitthaladevuni</i> ”)
Ex. 1011	U.S. Patent Publication No. 2013/0308608 to Hu et al., filed March 15, 2013, and published November 21, 2013 (“ <i>Hu</i> ”)
Ex. 1012	U.S. Patent Publication No. 2017/0331670 to Parkvall et al., filed May 13, 2016, and published November 16, 2017 (“ <i>Parkvall</i> ”)
Ex. 1013	U.S. Patent Publication No. 2012/0122495 to Weng et al., filed November 11, 2010, and published May 17, 2012 (“ <i>Weng</i> ”)
Ex. 1014	U.S. Patent Publication No. 2017/0094547 to Yum et al., filed September 23, 2016, and published March 30, 2017 (“ <i>Yum</i> ”)
Ex. 1015	International Patent Publication No. 2017/174469 to Wong et al., filed March 31, 2017, and published October 12, 2017 (“ <i>Wong</i> ”)
Ex. 1016	International Patent Publication No. 2017/079574 to Lee et al., filed November 4, 2016, and published May 11, 2017 (“ <i>Lee</i> ”)
Ex. 1017	International Patent Publication No. 2015/113664 to Webb et al., filed November 13, 2014, and published August 6, 2015 (“ <i>Webb</i> ”)
Ex. 1018	U.S. Patent Publication No. 2010/0202382 to Park et al., filed September 11, 2008, and published August 12, 2010 (“ <i>Park</i> ”)

Exhibit	Description
Ex. 1019	Erik Dahlman et al., <i>4G LTE/LTE-Advanced for Mobile Broadband</i> , 2011 (“ <i>Dahlman</i> ”)
Ex. 1020	International Patent Publication No. 2017/079530 to Pelletier, filed November 4, 2016, and published May 11, 2017 (“ <i>Pelletier</i> ”)
Ex. 1021	International Patent Publication No. 2016/130175 to Fwu et al., filed August 11, 2015, and published August 18, 2016 (“ <i>Fwu</i> ”)
Ex. 1022	Frank Schaich et al., <i>Subcarrier Spacing - How to Make Use of This Degree of Freedom</i> , 2016 IEEE 83rd Vehicular Technology Conference (“ <i>Schaich</i> ”)
Ex. 1023	U.S. Patent No. 9,131,490 to Feng et al., issued September 8, 2015 (“ <i>Feng</i> ”)
Ex. 1024	U.S. Patent No. 9,380,568 to Harrison et al., issued June 28, 2016 (“ <i>Harrison</i> ”)
Ex. 1025	International Patent Publication No. 2017/023352 to Xiong et al., filed December 16, 2015, and published February 9, 2017 (“ <i>Xiong</i> ”)
Ex. 1026	International Patent Publication No. 2017/026983 to Khoryaev et al., filed December 26, 2015, and published February 16, 2017 (“ <i>Khoryaev</i> ”)
Ex. 1027	International Patent Publication No. 2017/171398 to Yi et al., filed March 29, 2017, and published October 5, 2017 (“ <i>Yi</i> ”)
Ex. 1028	U.S. Patent Publication No. 2017/0215170 to Islam et al., filed January 26, 2016, and published July 27, 2017 (“ <i>Islam</i> ”)
Ex. 1029	<i>Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.</i> , Case No. 2:22-cv-00188-JRG, Dkt. No. 1, Complaint for Patent Infringement (E.D. Tex. June 1, 2022).
Ex. 1030	<i>Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.</i> , Case No. 2:22-cv-00188-JRG, Plaintiff’s Infringement Contentions Claim Chart for U.S. Patent No. 10,462,767 (E.D. Tex. Jan. 5, 2023)
Ex. 1031	United States District Courts – National Judicial Caseload Profile, available at https://www.uscourts.gov/sites/default/files/fcms_na_distprofile0630.2022_0.pdf (retrieved Feb. 5, 2023)
Ex. 1032	<i>Apex Beam Technologies LLC v. ZTE Corp.</i> , No. 2:22-cv-00031-JRG-RSP, Dkt. No. 37, Docket Control Order (E.D. Tex. Feb. 6, 2023)
Ex. 1033	<i>Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.</i> , Case No. 2:22-cv-00188-JRG, Plaintiff’s Infringement Contentions Cover Pleading (E.D. Tex. Jan. 5, 2023)

Exhibit	Description
Ex. 1034	3GPP TS 36.211 v11.3.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical Channels and Modulation (Release 11)”) (June 2013)
Ex. 1035	3GPP TS 36.304 v13.0.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) procedures in idle mode (Release 13)”) (December 2015)
Ex. 1036	3GPP TS 36.331 v13.0.0 (“Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 13)”) (December 2015)
Ex. 1037	Declaration of Friedhelm Rodermund

I. PRELIMINARY STATEMENT

Petitioner Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc. (collectively “Samsung”), requests *inter partes* review of U.S. Patent No. 10,462,767 (Ex. 1001), assigned to Patent Owner Apex Beam Technologies LLC, and cancellation of claims 1-20.

The challenged claims are directed to methods and devices for wireless communication, and relate to a scheme to transmit and receive paging scheduling information. Paging scheduling information (a.k.a. “paging control information”) helps address the long common need for User Equipment (UE, e.g., smartphone) to receive paging messages from a Base Station (BS, e.g., cell tower) by informing the UE of where (in the frequency domain) and when (in the time domain) to receive the paging messages. *Infra*, §§II.B.1, II.B.3, II.B.4. To receive the paging scheduling information, the UE must monitor (i.e., search for) paging scheduling information transmissions in certain time occasions, referred to as “monitoring occasions.” *Infra*, §II.B.4. The monitoring occasions are defined by frames, sub-frames, slots, and symbols (collectively called “frame structure”). *Infra*, §II.B.1. As known in the art, the term “numerology” provides subcarrier spacing information that defines the frame structure. *Infra*, §II.C.1.

Although conventional 4G technology supports multiple subcarrier spacings, it uses only one (15 kHz) for transmission of the paging scheduling information;

thus, the frame structure, and in turn the monitoring occasions, are fixed. *Infra*, §II.B.2. In contrast, emerging 5G technology supports multiple numerologies with differing subcarrier spacings (e.g., 3.75, 15, 30, 60 kHz). *Infra*, §II.C.1. For example, different subbands may use different subcarrier spacings, or the subcarrier spacing used by a subband may change over time. *Id.*

The '767 patent tries to claim as inventive using different subcarrier spacings to determine monitoring occasions. For example, claim 1 of the '767 patent requires that the “subcarrier spacing . . . [be] used for determining the . . . time intervals” for the UE to receive the paging scheduling information. '767 patent, 23:16-20.

However, the 5G problem and solution of the '767 patent were already described in International Publication WO2018/126401 (Ex. 1006, “*Liu*”). As disclosed by *Liu* and further explained by Petitioner’s expert, Dr. Bims, 5G necessitated using the subcarrier spacings to determine the monitoring occasions, a relationship that was well known in the art. *Infra*, §II.C.2.

Other limitations of the challenged claims merely recite 4G and older network features, and were taught by *Liu* in combination with International Publications WO2017/052199 (Ex. 1005, “*You*”) and/or WO2016/136143 (Ex. 1007, “*Mallick*”). None of these references were considered by the Examiner during examination.

As set forth below, claims 1-20 would have been obvious based on *You* in view of *Liu* alone, or further in view of *Mallick*. The Board should thus institute review and cancel all challenged claims.

II. STATE OF THE ART

A. 3rd Generation Partnership Project (3GPP)

As the “Background” of the ’767 patent acknowledges, the alleged invention was aimed at responding to the call of “the 3rd Generation Partner Project (3GPP)¹ . . . to conduct the study of New Radio (NR) . . . to standardize the 5G NR.” ’767 patent, 1:25-31. The development of specifications by 3GPP has been and remains an ongoing, collaborative effort involving hundreds of engineers from many companies. Bims, ¶40. These efforts often focus on the speed and efficiency (e.g., conserving UE battery power) of transmissions, whether through communications between UEs, “uplink” communications from the UE to the BS, or “downlink” communications from the BS to the UE. *Id.*

¹ 3GPP is a consortium of standards-setting organizations that has developed technical standards for multiple generations of mobile communication technologies, including 3rd generation wireless networks (3G), 4th generation wireless networks/Long Term Evolution (4G/LTE), and 5th generation wireless networks/new radio (5G/NR). Bims, ¶39.

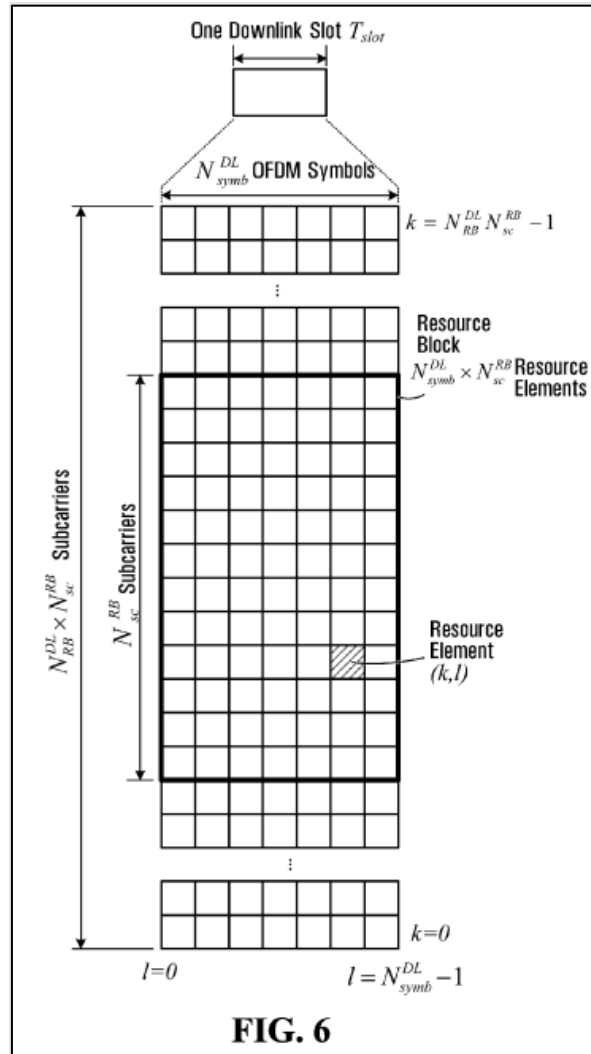
The '767 patent and the prior art cited in this IPR pertain to physical layer (PHY) downlink (DL) signaling from the BS to the UE. '767 patent, 1:37-41; Bims, ¶41.

B. Features of 4G/LTE and Older Networks

The '767 patent describes several concepts common to both conventional 4G/LTE and emerging 5G/NR technologies. The similarities extend from basic concepts of resource grids, frame structures, and numerologies to using subcarrier spacing to determine the monitoring occasions of the paging scheduling information. While presented in a complex manner in the '767 patent's claims, these were fundamental and well-known technologies before the patent's filing.

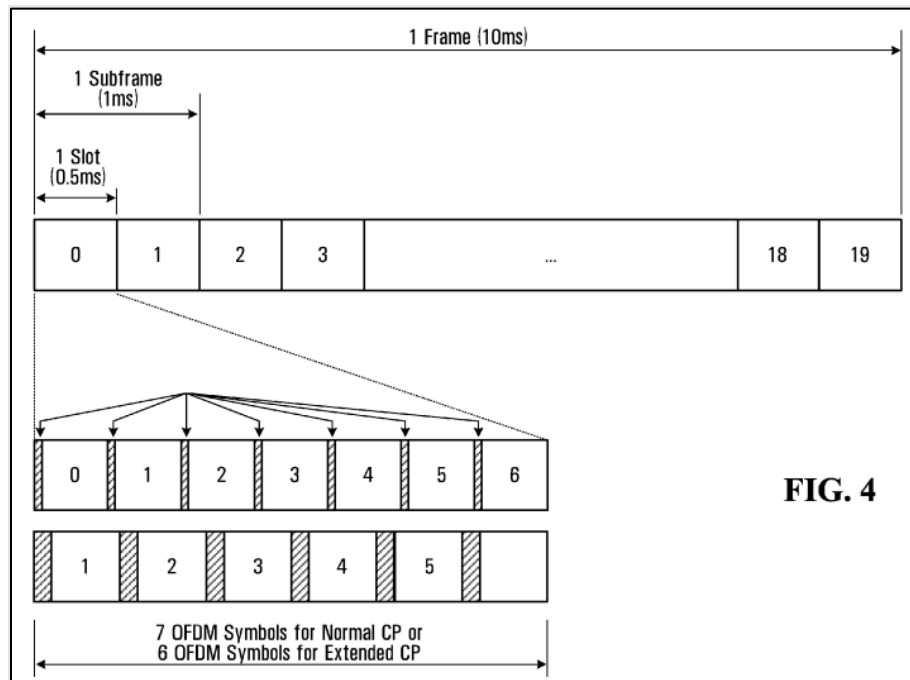
1. Resource Grid and Frame Structure

In both 4G/LTE and 5G/NR, the radio resources used in the transmission of signals can be represented through a time-frequency resource grid. Bims, ¶45. The following figure illustrates an example of a resource grid in which the horizontal axis represents the time domain and the vertical axis represents the frequency domain. *Weng*, [0191]-[0196], Fig. 6. The smallest rectangles in the grid are called “resource elements,” each of which spans one symbol in the time domain and one subcarrier in the frequency domain. *Wong*, 5:27-30.



Weng, Fig. 6.

In the frequency domain, the frequency span of a subcarrier is called “subcarrier spacing.” Bims, ¶45. And within the time domain, the radio resources are scheduled using time units such as frame, subframe, slot, and symbol, as shown in the below frame structure. *Id.*, ¶46.



Weng, Fig. 4.

2. Subcarrier Spacing

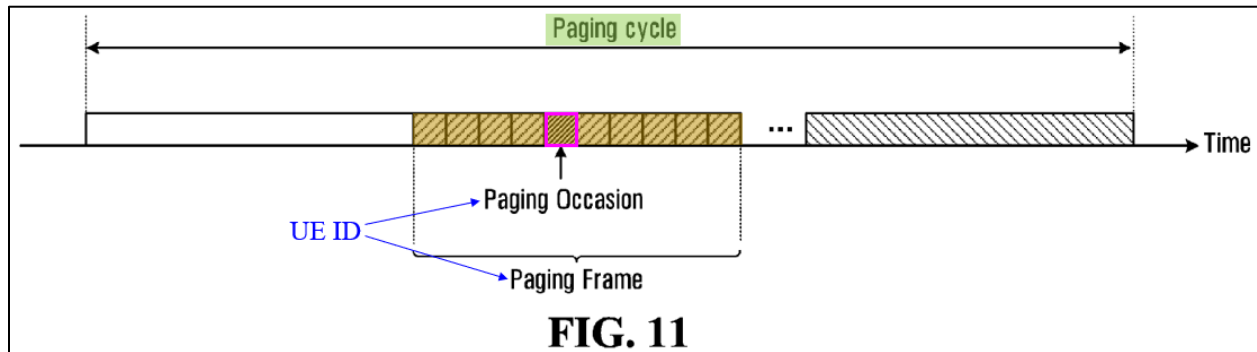
In the context of any particular network, subcarrier spacing correlates to the time duration of a symbol and/or a slot (referred to as “symbol duration” and “slot duration,” respectively). Bims, ¶48. For example, in the physical downlink signaling (e.g., paging) for 4G/LTE technology, a frame “is 10 ms long,” and “[w]ithin each frame, there are 10 equal-length subframes with two slots in each subframe,” and “[w]ithin each slot, there are [multiple] symbols.” Weng, [0178]-[0180]; Bims, ¶46. In this same example, the subcarrier spacing is fixed at 15 kHz with a corresponding symbol duration of 66.7 μ s, though 4G/LTE also uses other subcarrier spacings in other situations, e.g., a 7.5 kHz subcarrier spacing with

a corresponding symbol duration that is twice as long. *Dahlman*, 127-128; *see also Khoryaev*, 9:19-31; Bims, ¶48. It was thus understood that in addition to the subcarrier spacing of 15 kHz, 4G/LTE also uses other subcarrier spacings that could result in different frame structures (e.g., 133.4 μ s at 7.5 kHz). Bims, ¶48.

3. Paging

In wireless network transmissions, paging is a mechanism commonly used to conserve UE battery power. *Weng*, [0003]; Bims, ¶50. Specifically, when there is no data exchanged between a UE and a base station for an extended period, the UE will switch from an active/connected mode to an idle mode. In the idle mode, the UE periodically checks whether the base station is sending any paging messages to the UE. Bims, ¶50. If a paging message for the UE is detected, the UE will switch back to the active/connected mode and start to exchange data with the base station again. *Id.* The occasions at which the UE checks for the paging messages are called “paging occasions,” and the period of paging occasions is called a “paging cycle.” *Id.* The following figure illustrates the concept of a **paging cycle** and a **paging occasion** associated with a UE. *Weng*, [0240]. The **paging occasion** may correspond to a subframe contained in a frame called a “**paging frame**,” and the **paging cycle** length may range from a few subframes to hundreds of frames. *Id.*, [0228]-[0229], [0235]-[0236]. The location of the **paging frame** in the **paging cycle**

and the location of the **paging occasion** in the **paging frame** are determined based on the **UE's ID**. *Id.*, [0235]-[0236].



Weng, Fig. 11.²

4. Monitoring of Physical Downlink Control Channel (PDCCH)

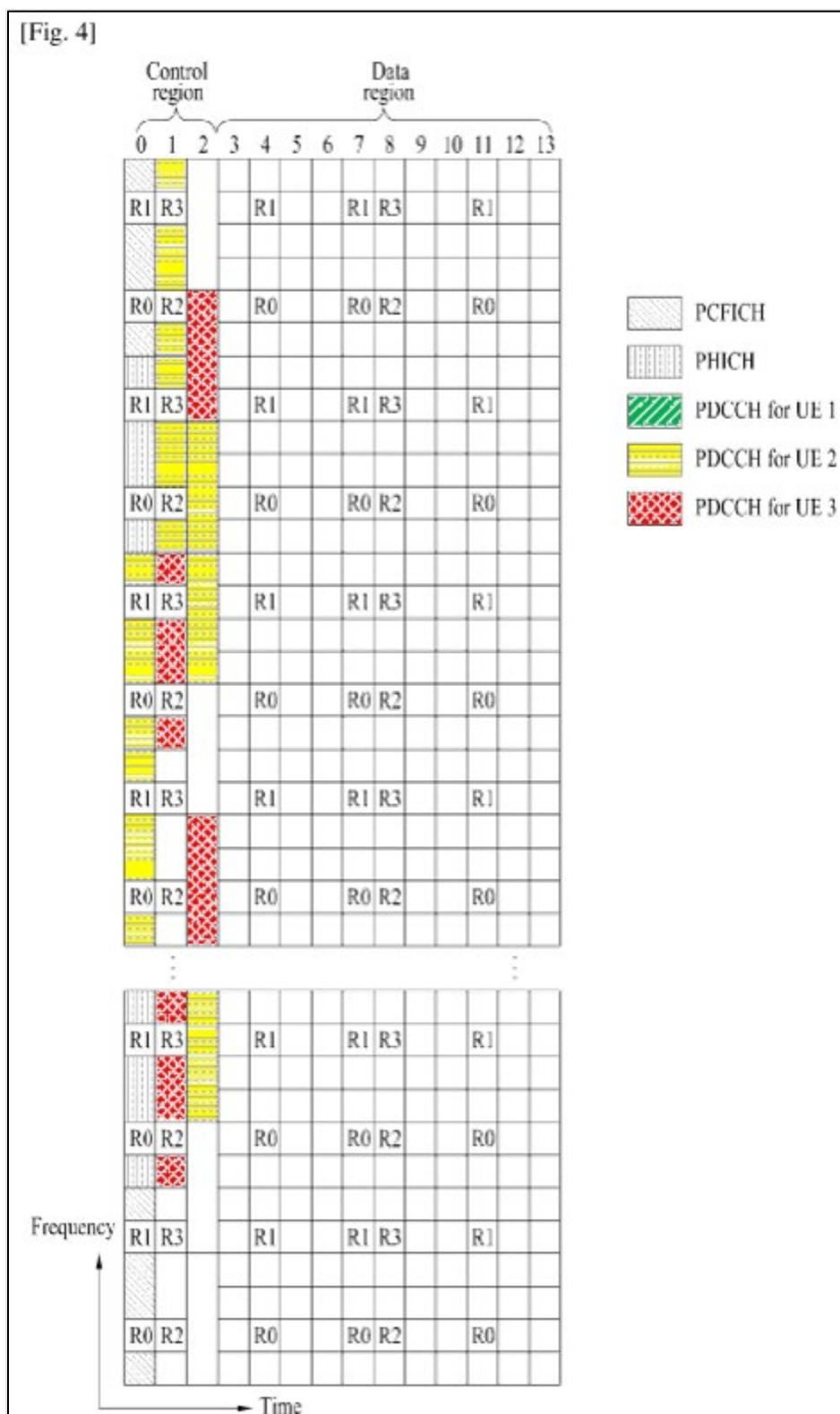
The part of the resource grid used for transmitting control information (e.g., paging scheduling information) is called the control region, while the part of the resource grid used for transmitting the actual data (e.g., the actual paging message) is called the data region. In the time domain, a subframe can be “divided into a control region and a data region.” *Yum*, [0058]. In one possible configuration, the first 1-4 symbols in the subframe are allocated to the control region, while the remaining symbols of the subframe are allocated to the data region. *Id.*

² All figures in this Petition containing color are annotated relative to the original figures in the patent or prior art, and all text in color is added.

Alternatively, the control region may be located in the rear portion of the subframe. *You*, [144]. Regardless of the approach, the control region contains control information that can be used by a UE to decode the information transmitted in the data region. Bims, ¶47.

As an exemplary implementation, the control region of a subframe may contain one or more physical downlink control channels (PDCCHs), and the data region of that subframe may contain one or more physical downlink shared channels (PDSCHs), where each of these channels is a frequency band. *You*, [95]; Bims, ¶55. The PDCCH is used for transmitting control information (called “downlink control information” or “DCI”) for locating and decoding the resources on the PDSCH that are in a subsequent subframe. *Weng*, [0226]; *You*, [104]; Bims, ¶55. In the context of paging, the PDCCH is a control channel for transmitting paging scheduling information, and the PDSCH is a data channel for transmitting paging messages. *You*, [105] (Table 7), [178], [189], [193]; Bims, ¶60.

In terms of receiving DCIs, a UE typically does not know which PDCCH(s) in the control region contain a DCI intended for it. *You*, [121]; Bims, ¶58. This is because the DCIs transmitted through different PDCCHs in the control region of a subframe may be directed to different UEs. *You*, [107]. For example, as shown below, each PDCCH occupies a different group of resource elements in the resource grid. *Id.*, Fig. 4; Bims, ¶57.



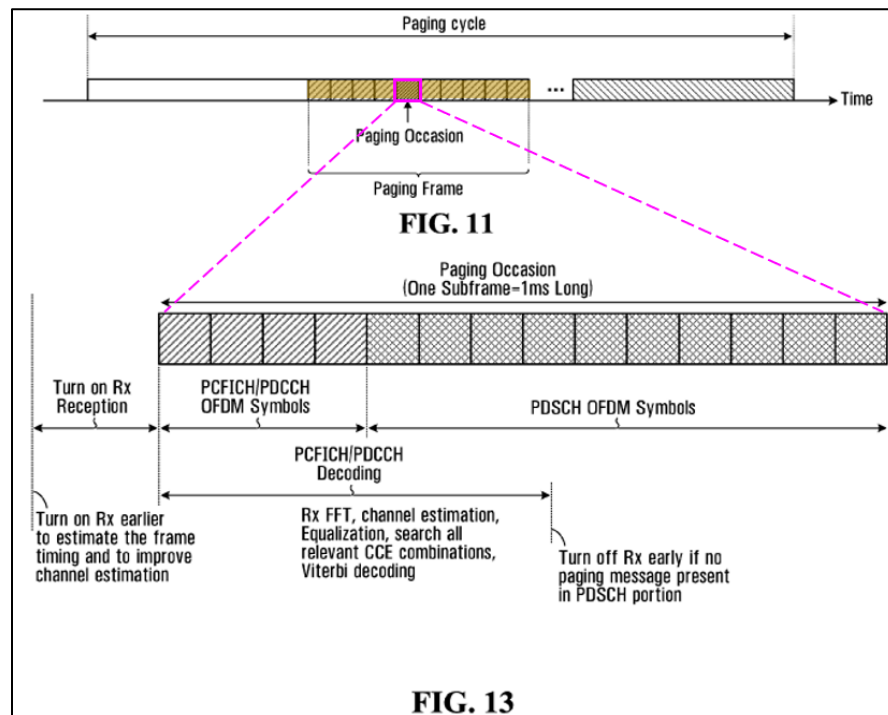
You, Fig. 4.

Thus, the UE has to search through a set of PDCCHs in the control region (a “PDCCH search space”) by decoding each one to determine whether any of the PDCCHs are encoded by an identifier associated with the UE. *Id.*, [117]; *Yum*, [0061]; Bims, ¶58. The PDCCHs in the set are called “PDCCH candidates,” which suggests that any of them may potentially contain a DCI that is intended for the UE. *You*, [117]; Bims, ¶58. Different sets of PDCCH candidates (i.e., different PDCCH search spaces) can be defined, and the search spaces can be searched by all the UEs in a cell (called “common search space” or “CSS”) or only searched by a specific UE or UE group (called “UE-specific search space” or “USS”). *You*, [117], [119] (Table 9); Bims, ¶59.

A UE can monitor a PDCCH search space to determine whether the DCI for the UE is transmitted on any of the PDCCH candidates. *You*, [121]; Bims, ¶61. “Here, monitoring refers to attempting to decode each PDCCH in the corresponding search space” *Yum*, [0062]; *You*, [121]. Because “the UE does not know the location at which a PDCCH thereof is transmitted,” it “attempts to decode all PDCCHs . . . for each subframe until a PDCCH having an ID thereof is detected and this process is referred to as blind detection (or blind decoding (BD)).” *You*, [121]; *Yum*, [0062]; Bims, ¶61. If none of the PDCCH candidates in a current subframe’s control region contain any DCI encoded with the UE’s

identifier, the UE will continue to decode and examine the PDCCH candidates in a next subframe's control region, and so on. Bims, ¶61.

PDCCH monitoring in the context of paging is illustrated below. Specifically, at a subframe corresponding to a **paging occasion**, the UE initiates a reception (“Rx”) process to monitor (i.e., to blind decode) the PDCCH search space. *Weng*, [0257]-[0258]. If none of the PDCCH candidates in the search space has any DCI encoded with the UE's ID, the UE turns off the Rx process and waits for the next paging occasion; however, if DCI with the UE's ID is detected, the UE continues to obtain the paging message by locating and decoding the corresponding PDSCH based on the DCI. *Id.*, [0260]; Bims, ¶60.

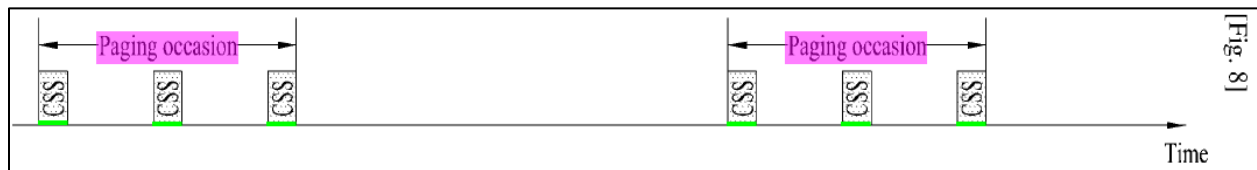


Weng, Figs. 11, 13.

5. Coverage Enhancement (CE)

Conventional 4G/LTE provides a coverage enhancement (CE) mode in which a base station may repeat a transmission of a signal, such that a corresponding UE may attempt repeated receptions to achieve an increased likelihood of successfully decoding the signal. *Webb*, 13:22-24, 14:3-15:11, 15:23-16:8, Fig. 6; *Lee*, [0061]-[0063]. This is particularly useful when the signal reception is weak, e.g., at the edge of a cell. *Bims*, ¶62.

When applying the CE mode to paging, at each **paging occasion**, the same PDCCH may be repeatedly transmitted in a plurality of common search spaces (CSSs) over **a plurality of subframes**, respectively; accordingly, a UE may monitor the PDCCH CSSs in these **subframes** (i.e., **monitoring occasions**). *You*, [186]-[187], [195]-[196], [199]-[200]; *Bims*, ¶63.

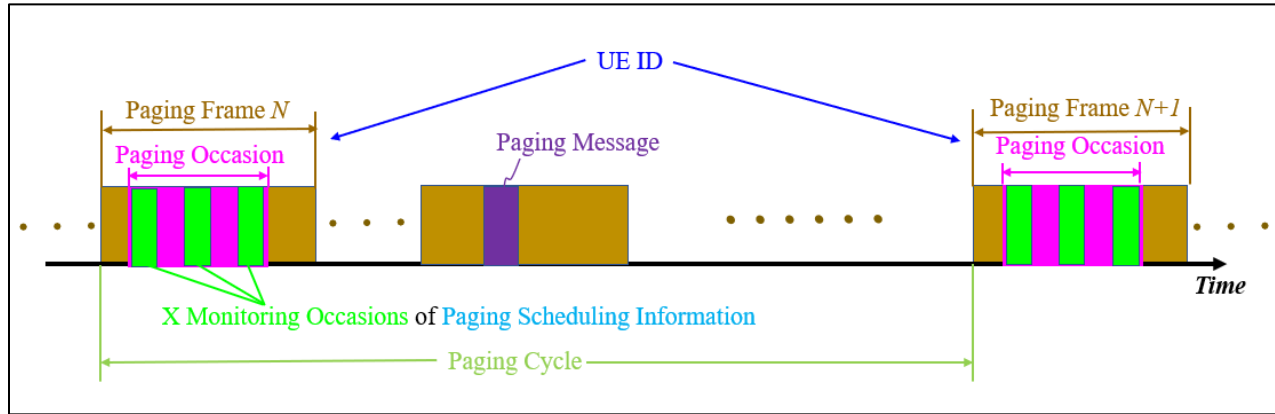


You, Fig. 8.

6. Summary

The above well-known 4G/LTE paging procedure is recapped below: a UE uses a **UE ID** to determine **paging frames** and **paging occasions** in **paging cycles**; in each **paging occasion**, the UE monitors the **paging scheduling information** in **X**

monitoring occasions, with $X > 1$ when CE mode is applied; and the UE locates the paging messages based on the paging scheduling information.



Bims, ¶64.

C. 5G/NR Networks

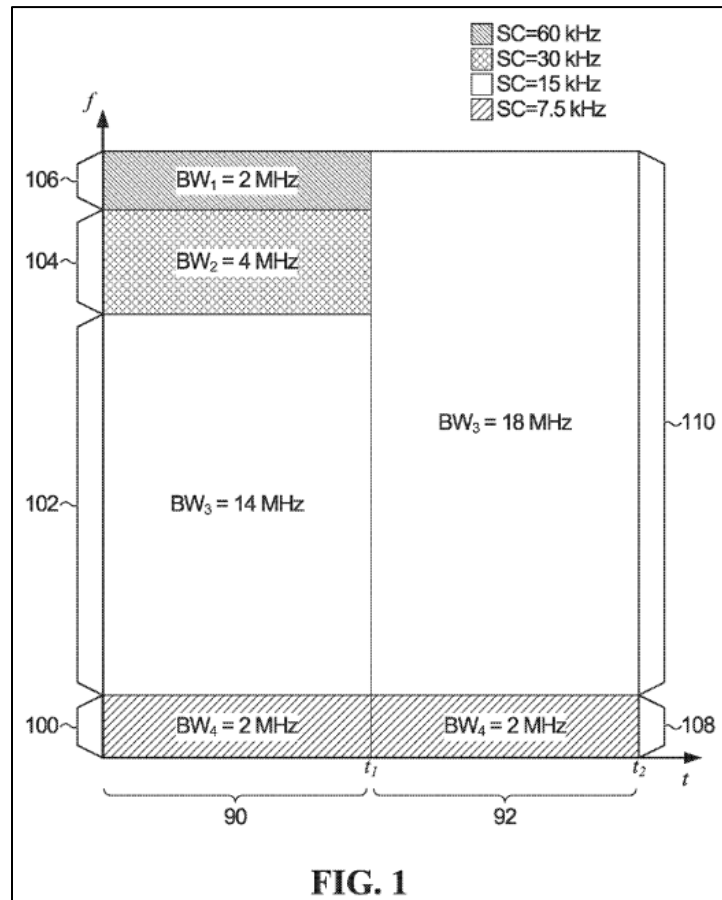
While the '767 patent was first filed in the U.S. in April 2018, 3GPP began its 5G standardization effort years earlier, in 2015. *Parkvall*, [0009].

1. Flexible Numerology

For various reasons, including the potential for a wide range of frequency bands, *Fwu*, [0033], [0040], the 5G system was proposed to support “configurable numerology including subcarrier spacing and symbol duration.” *Id.*, [0057];

Schaich, p. 1; Bims, ¶¶65-67. For example, as shown below, during time period 90, an available bandwidth is divided between four subbands “BW” with 7.5, 15, 30, and 60 kHz subcarrier spacings, respectively; while during time period 92, a new division is used to obtain two subbands with differing subcarrier spacings. *Islam*,

[0035], Fig. 1. It was understood that each of these subcarrier spacings would correspond to a different symbol duration and/or slot duration because “different sub-carrier spacing[s] may lead to different time durations for a symbol.” *Pelletier*, [0072]; Bims, ¶68.

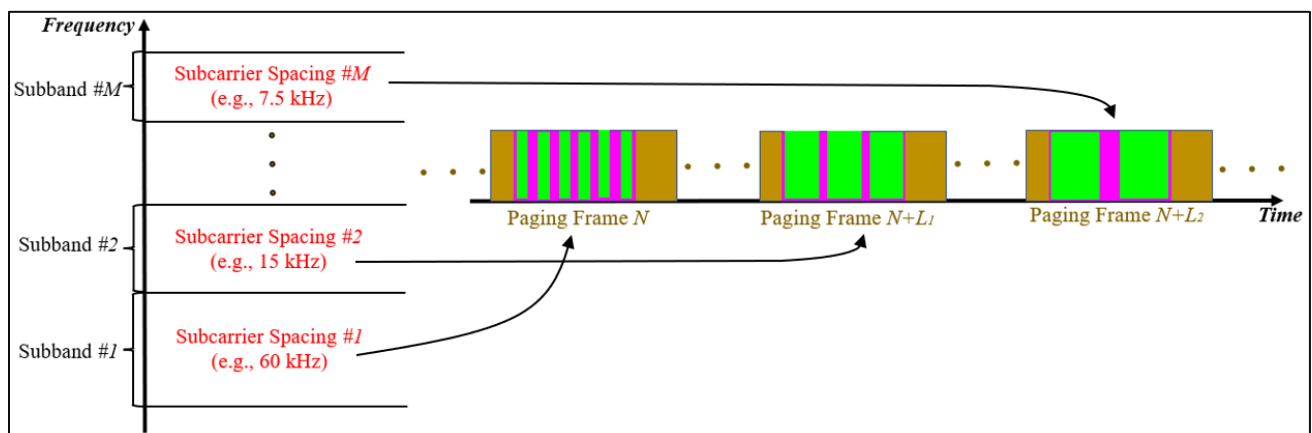


Islam, Fig. 1.

2. Various Frame Structures

As discussed in §II.B.2, different subcarrier spacings were already known to result in different frame structures. Thus, the flexible numerology in 5G was already understood to mean that multiple frame structures may be used to schedule

the transmission/monitoring of DCI, e.g., paging scheduling information. *Yi*, [155]-[163] (Tables 1-3); *Bims*, ¶¶69-70. While the '767 patent tries to portray this flexibility as inventive, it already existed in the state of the art, including in exemplary prior art references *Liu*, *Schaich*, *Fwu*, *Pelletier*, etc. *Bims*, ¶71. For example, as shown below, *Liu* teaches that the “subband” used to transmit the **paging scheduling information** may change over time due to “frequency hopping.” *Liu*, [0053]-[0056]. Since different subbands may be assigned to different numerologies, *Islam*, [0035], the subband switch, and in turn the change of **subcarrier spacing**, changes the number and durations of the **monitoring occasions** in a **paging occasion**. *Liu*, Abstract, [0019], [0040]. This calls for the UE to determine the change of the **monitoring occasions** based on differing **subcarrier spacing** because otherwise it will have difficulty in receiving the **paging scheduling information**. *Id.*



Bims, ¶71.

III. THE '767 PATENT

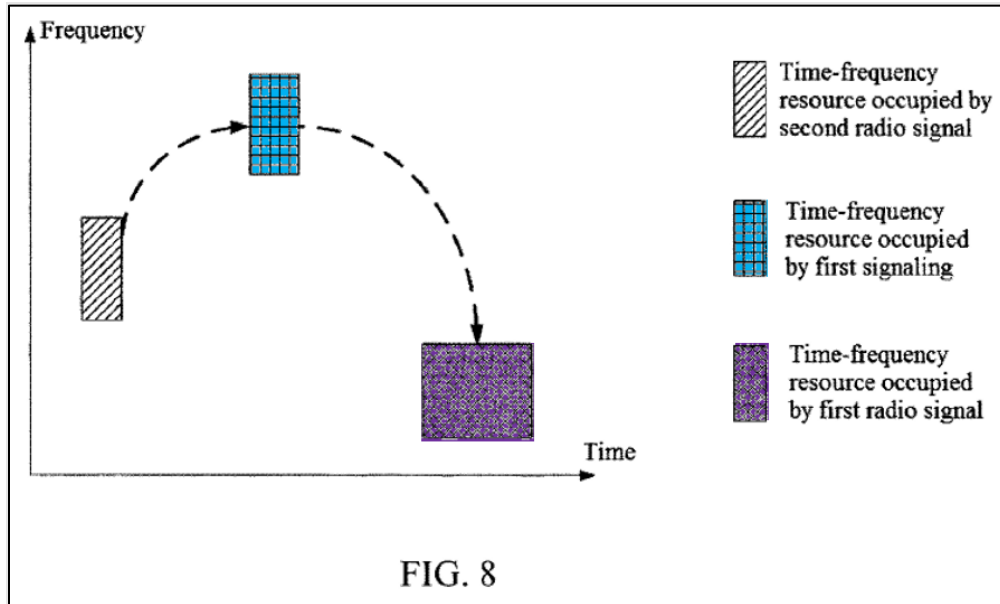
A. Alleged Invention

The '767 patent relates “to a method and a device for paging transmission in a communication system supporting multiple numerologies,” with “[t]he various numerologies refer[ring] to various subcarrier spacings” and “various symbol time lengths” ’767 patent, 1:15-18, 1:34-37. The '767 patent provides a process that “determines the transmission opportunities of paging according to the numerology employed by the paging.” *Id.*, 2:1-9. For example, it broadly claims:

- (i) using a first signaling to determine scheduling of a paging message;
- (ii) monitoring the first signaling in X time intervals; and
- (iii) using the subcarrier spacing associated with the first signaling to determine the X time intervals.

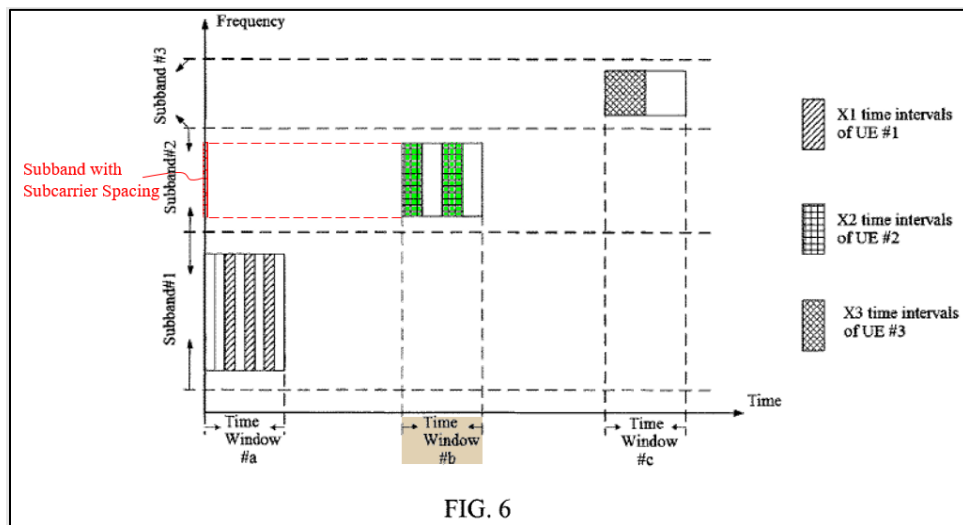
See id., 23:2-20; Bims, ¶72.

Concept (i) is illustrated in Figure 8, which shows that “the first signaling is used for determining scheduling information for the first radio signal.” ’767 patent, 19:54-64. The first signaling may be “a physical layer signaling,” such as “DCI” (i.e., downlink control information), and may be “transmitted through a PDCCH.” *Id.*, 20:8-14. The first radio signal carrying the paging message may be “transmitted through a PDSCH.” *Id.*, 20:18-19.



Id., Fig. 8.

Concept (ii) is illustrated in Figure 6, in which each filled rectangle represents a time interval monitored by a particular UE in a particular time window. *Id.*, 17:47-54. For example, the UE#2 monitors a **first signaling** in **X2 time intervals**, which belong to the **time window #b**. *Id.*, 17:47-56, 17:63-64.



Id., Fig. 6.

Regarding concept (iii), the '767 patent says that, for each UE, the subband of the frequency domain resource used for transmitting the **first signaling** “includes a positive integer number of consecutive subcarriers in frequency domain.” *Id.*, 17:58-59. Figure 7 shows a special case (**X=1**) for using the **subcarrier spacing** to determine the **X time intervals**. *Id.*, 18:49-54. Specifically, each UE (UE_a, UE_b, UE_c, or UE_d) is associated with a respective **time window**. *Id.*, 18:55-64, Fig. 7. The **subcarrier spacing** associated with each UE is used to divide the respective **time window** into **Y time intervals**, and the **feature ID** of the UE is used to determine which one of the **Y time intervals** includes the **X=1 time interval**. *Id.* Moreover, the '767 patent explains that “the time length of each one of the **X time intervals** is correlated to the **subcarrier spacing** of subcarriers.” *Id.*, 19:7-10. This way, the **subcarrier spacing** is used to determine both the time-domain location (i.e., which **Y time interval**) and duration (i.e., time length) of each one of the **X time intervals**. Bims, ¶76.

	Index of X=1 time interval in the first time window			
	Feature ID=a	Feature ID=b	Feature ID=c	Feature ID=d
Y=1	0	0	0	0
Y=2	0	1	0	1
Y=4	0	1	2	3
Y=8	1	3	5	7
Y=16	2	6	10	14

E.g., time window for Feature ID=b is divided into **Y=16 time intervals**, and the **X=1 time interval** is in the **7th time interval** of the time window.

FIG. 7

'767 patent, Fig. 7; Bims, ¶76 (explaining annotations, including why “6” corresponds to the 7th time interval).

None of the three concepts, however, was inventive in view of the prior art. *Compare* '767 patent, Fig. 6, *with supra*, §II.C.2. And as explained below, everything claimed by the '767 patent had already been disclosed or rendered obvious by *You*, *Liu*, and/or *Mallick*.

B. Prosecution History

The application that issued as the '767 patent was filed on April 18, 2018. It claims priority to Chinese Application No. 201710255811.X, filed on April 19, 2017. Ex. 1004, 92, 99. During prosecution, the application received a first-action allowance. *Id.*, 38-45.

C. Claim Construction

The Board construes claims per *Phillips v. AWH Corp.*, 415 F.3d 1303 (Fed. Cir. 2005) (en banc). 37 C.F.R. §42.100(b). Claims must be construed only to the extent necessary to resolve a controversy. *Nidec Motor Corp. v. Zhongshan Broad*

Ocean Motor Co., 868 F.3d 1013, 1017 (Fed. Cir. 2017). Here, no terms need construction to resolve the controversy in this forum.³

IV. STATEMENT OF PRECISE RELIEF REQUESTED

A. Prior Art

- Ex. 1005, WO2017/052199 (“*You*”), published March 30, 2017, is prior art to the ’767 patent under AIA 35 U.S.C. §102(a)(1) and (a)(2).
- Ex. 1006, WO2018/126401 (“*Liu*”), filed January 5, 2017, and published July 12, 2018, is prior art to the ’767 patent under AIA 35 U.S.C. §102(a)(2).
- Ex. 1007, WO2016/136143 (“*Mallick*”), published September 1, 2016, is prior art to the ’767 patent under AIA 35 U.S.C. §102(a)(1) and (a)(2).

B. Challenges

Ground	Challenged Claims	Basis	Prior Art
1	1, 4-6, 9-11, 14-16, 19, and 20	§103	<i>You</i> and <i>Liu</i>
2	2, 3, 7, 8, 12, 13, 17, and 18	§103	<i>You</i> , <i>Liu</i> , and <i>Mallick</i>

³ Petitioner reserves the right to argue in an appropriate forum that certain limitations in the challenged claims are indefinite. Petitioner also reserves the right to challenge the priority date here and/or in other proceedings.

V. LEVEL OF ORDINARY SKILL IN THE ART

A person of ordinary skill in the art (POSA) at the time of the purported invention of the '767 patent (April 19, 2017) would have had at least a master's degree in electrical engineering or a related field, and five years of work/research experience in the field of wireless networking. Additional education beyond a master's degree can make up for a lack of work and/or research experience, and more than five years of relevant work and/or research experience can compensate for a lesser level of education. Bims, ¶¶93-95.

VI. CLAIMS 1-20 ARE UNPATENTABLE

A. Claims 1, 4-6, 9-11, 14-16, 19, and 20 Are Obvious over *You* and *Liu* (Ground 1)

1. Overview of *You*

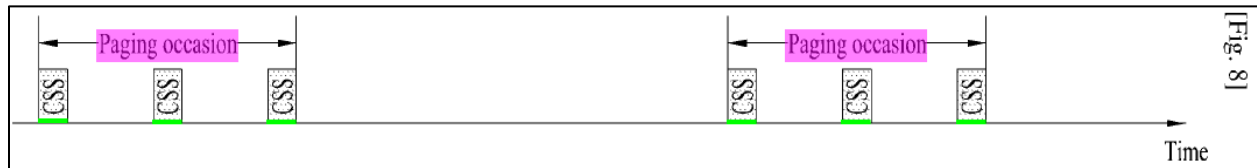
You discloses “a method for transmitting or receiving downlink control information” in 4G/LTE systems. *You*, [1], [51]. The method can be used in “machine type communication (MTC)” that involves machine-to-machine communication with minimal human intervention. *Id.*, [173]. A MTC UE can be a smartphone, tablet PC, meter, camera, vending machine, etc., located in diverse environments. *Id.*, [2], [173], [179]. When located in places where the wireless coverage is bad, “the MTC UE has difficulty in receiving” downlink transmissions

such as “the PDCCH, the PDSCH, etc.” *Id.*, [173]-[174]. To solve this problem, *You* “proposes that the eNB [base station] apply a coverage enhancement scheme” to repeat the transmission of a signal in multiple subframes respectively, so that a UE can effectively receive the signal. *Id.*, [174]; *see also id.*, [178], [182]-[183]. For example, to repeat the transmission of an MTC PDCCH (referred to as “M-PDCCH”), “a search space for reception of the same M-PDCCH may be configured in each of one or more [consecutive or nonconsecutive] downlink subframes.” *Id.*, [177], [185].

Figure 8 of *You* discloses a method of applying the coverage enhancement (CE) scheme to paging message scheduling. *Id.*, [187]-[188]. *You* discloses that “a paging occasion may be defined as an interval where a UE monitors a paging M-PDCCH.” *Id.*, [199]. If there is no CE, a paging occasion only includes one such M-PDCCH search space (i.e., one downlink subframe), whereas if there is CE, a paging occasion includes multiple repetitions of the M-PDCCH search space over multiple downlink subframes respectively. *Id.*, [186]-[187].

Similar to concept (ii) in the ’767 patent, *supra*, §III.A, *You* discloses that “a UE can monitor a common search space (CSS)” in “multiple CSS monitoring opportunities within a paging occasion” *Id.*, [196]. And similar to concept (i) in the ’767 patent, *You* discloses that “[i]f the paging M-PDCCH . . . is received

within” the **paging occasion**, “the UE may receive a **PDSCH** carrying the corresponding paging message.” *Id.*, [199].



Id., Fig. 8.

You discloses that not all UEs require the same level of CE. *Id.*, [179]. For example, low-mobility UEs located in remote areas may need high CE (i.e., more repetitions of the same M-PDCCH), while movable UEs only require low or no CE. *Id.*; Bims, ¶100.

You is analogous art to the '767 patent because *You*, like the '767 patent, discloses transmission/monitoring schemes in wireless communication systems relating to, for example, paging transmission. *Compare You*, [185], [188]-[189], with '767 patent, Abstract, 1:15-18, 3:7-14; Bims, ¶101.

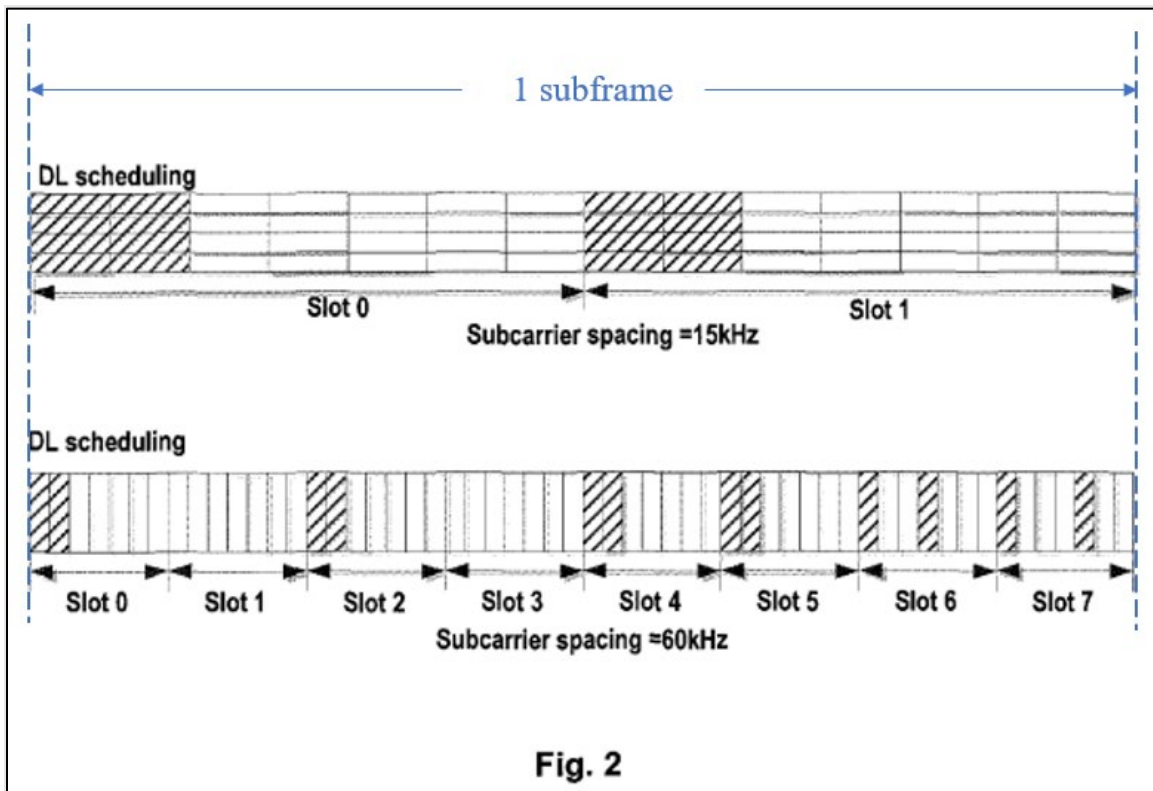
2. Overview of *Liu*

Like the '767 patent, *Liu* recognizes that the DCI transmission/reception solution employed by earlier networks will not work properly in 5G/NR networks because of the different numerologies supported by 5G/NR networks.

Compare '767 patent, 1:58-64, with *Liu*, [0003]-[0005]; Bims, ¶102. *Liu* is analogous art to the '767 patent and indeed provides the same solution as concept

(iii) of the '767 patent: it enables a UE to determine “**monitoring occasion[s]**” based on “**numerology**.” *Compare* '767 patent, 2:1-9, with *Liu*, [0040], [0044]; Bims, ¶103.

Specifically, *Liu* explains that a 5G/NR system supports different numerologies, which use “different subcarrier spacings.” *Liu*, [0045]. For example, in addition to supporting the 15 kHz subcarrier spacing used in 4G/LTE, a 5G/NR system may also support a 60 kHz spacing. *Id.*, Fig. 2. “[F]or 15 kHz subcarrier spacing, its symbol will have a time length four times as that for 60 kHz subcarrier spacing.” *Id.*, [0045]. Relatedly, with 15 kHz subcarrier spacing, a subframe is divided into two slots, whereas with 60 kHz subcarrier spacing, a subframe is divided into eight slots. *Id.*, Fig. 2; *supra*, §II.C. Thus, the symbol and slot durations depend on the subcarrier spacing. *Liu*, [0005], [0019], [0040].



Id., Fig. 2.⁴

⁴ A POSA reading *Liu* would have understood that the time window shown in *Liu*'s Figure 2 corresponds to one subframe. Bims, note 5. This is because the known 4G/LTE system uses a 15 kHz subcarrier spacing and the associated subframe includes two slots. *Supra*, §§II.B.2. Moreover, *Liu913*, with the same inventors as *Liu*, states that “a numerology for a subcarrier spacing of 15KHz may include 14 symbols” and “[a] numerology for a subcarrier spacing of 30KHz may include 28 symbols in one subframe.” *Liu913*, [0036]. It follows that a numerology

Liu discloses that the DCI can be transmitted per slot or multi-slots. *Id.*, [0048]-[0049]. Changing the subcarrier spacing would change the symbol/slot sizes, which in turn would change the DCI monitoring occasions. *Id.*, [0005], [0019], [0040]. *Liu* recognizes that this makes it difficult for a UE to receive the DCI. *Id.*

Liu proposes a method to solve this problem. As shown in Figure 1, in step 101, a base station first transmits a DCI configuration parameter to a UE before the actual DCI is transmitted. *Id.*, [0019], [0043]. “[T]he DCI configuration parameter indicates time-frequency resources for a following DCI [transmission]” and may include information specifying:

- “a numerology to be used” for the DCI transmission;
- “DCI occurrence occasions,” i.e., the periodicity or aperiodic pattern of the DCI occurrences over the slots;
- “a duration for a single DCI” occurrence;
- “a valid duration for the DCI configuration parameter”;
- a “frequency domain resource unit,” namely, the subband location and bandwidth used for the DCI transmission; and

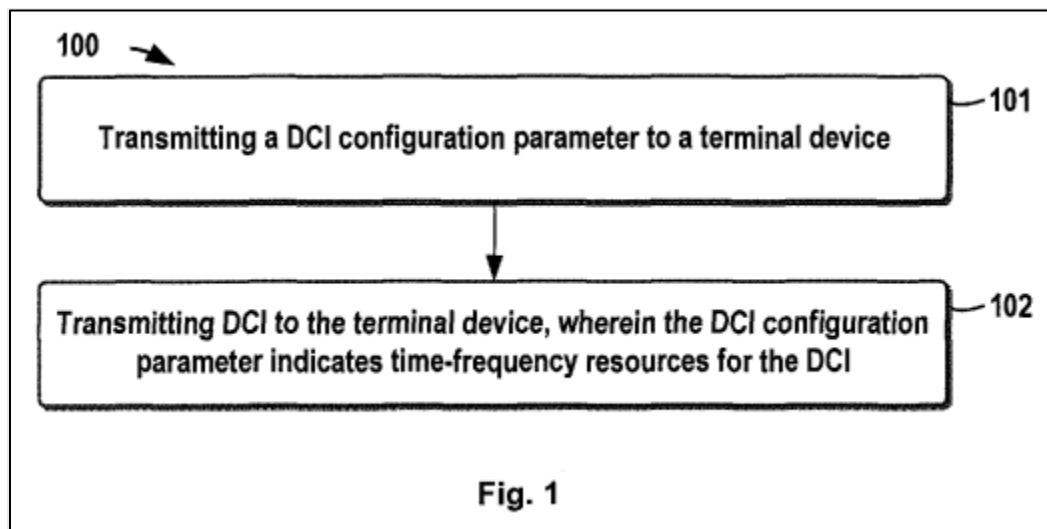
for a subcarrier spacing of 60 kHz may include 56 symbols in one subframe, as shown in Figure 2 of *Liu*.

- a “frequency hopping pattern.”

Id., [0019], [0043]-[0044], [0053]; *see also id.*, [0045]-[0052], [0054]-[0056];

Bims, ¶106. Then, “in step 102, the DCI can be transmitted to the terminal device,” which “may learn the time-frequency resource for the DCI from the DCI configuration parameter and monitor the DCI within the time-frequency resource.”

Liu, [0057].



Id., Fig. 1.

3. Rationale for Combining *You* and *Liu*

a. A POSA would have been motivated to combine the teachings of *You* and *Liu*

A POSA would have been motivated to combine the teachings of *You* and *Liu* for several reasons. Bims, ¶¶107-115.

You and *Liu* both contemplate the same use case: monitoring M-PDCCH/DCI in an on duration of a paging (DRX)/DRX cycle. Bims, ¶111.

Specifically, *You* discloses that a “UE may use discontinuous reception (DRX) in an idle mode to reduce power consumption” and “monitors only one paging occasion per DRX cycle.” *You*, [192]. Likewise, *Liu* suggests that its DCI monitoring method can be applied to the “on duration of the discontinuous reception (DRX) active state.” *Liu*, [0004]. Accordingly, a POSA would have appreciated that *Liu*’s technique can be used to improve *You* in the same way taught by *Liu*.

Indeed, *Liu* is directed at solving problems caused by the movement to 5G/NR in the context of *You*. For example, *You* pertains to monitoring M-PDCCH used in machine-type communication (MTC). *You*, [173], [197]. Relatedly, *Liu* discloses that 5G/NR’s wide range of frequency spectrum and the resulting flexible numerology are aimed at addressing requirements such as “massive machine-type communications.” *Liu*, [0002]; Bims, ¶111. Accordingly, a POSA would have been motivated to apply *Liu*’s teachings to modify *You*’s M-PDCCH monitoring scheme, so that it can support communications among a massive number of machines using 5G. Bims, ¶111; *Xiong*, [0021].

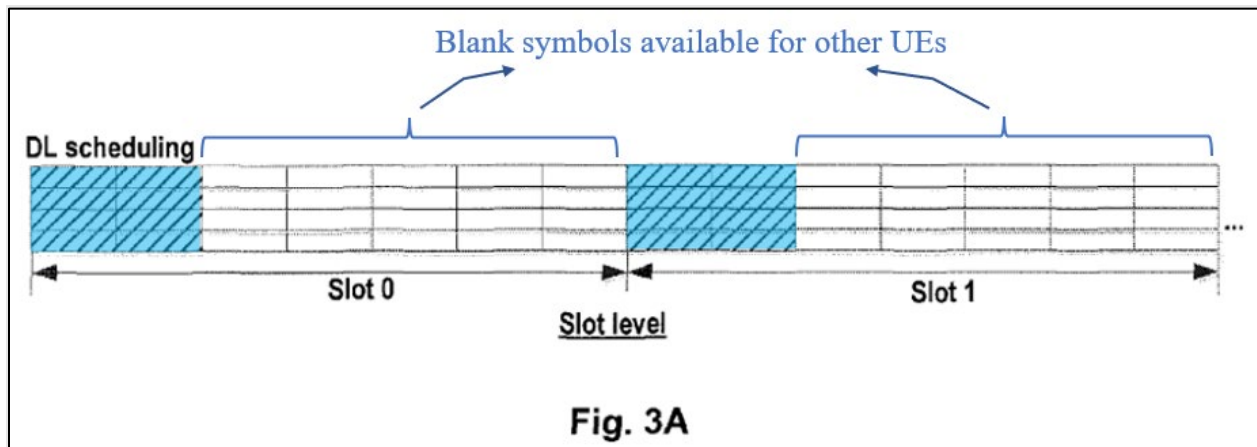
Moreover, as part of the evolution of 3GPP systems, a POSA would have been motivated to improve *You*’s 4G/LTE system based on *Liu*’s 5G/NR-oriented solutions. Bims, ¶112. Both *You* and *Liu* pertain to 3GPP systems and refer to various 3GPP technical documents. *You* states that its solution is applicable to “the

3GPP LTE/LTE-A system.” *You*, [41]; *see also id.*, [40], [43], [93]. And *Liu* attempts to address the challenges posed by the 3GPP’s technical requirements for 5G/NR. *Liu*, [0002]-[0003]. Thus, as part of the natural transition to 5G for *You*’s MTC, a POSA would have modified *You*’s technique based on *Liu*’s teachings to meet the requirements of the emerging 5G/NR system. Bims, ¶112.

In addition, a POSA would have appreciated that *Liu*’s transmission monitoring method is advantageous because it reduces the UE’s burden in monitoring the paging scheduling information in *You*. Bims, ¶113. As discussed in §II.B.4, “monitoring” means blind decoding the transmission search space for the paging scheduling information, without pre-knowledge about when (starting time point, duration) and where (subband location, bandwidth) the time-frequency resources for the transmission are located. *Id.* *Liu* explains that the flexible numerology used by 5G/NR adds extra uncertainty to the blind decoding because a switch of the numerology (i.e., subcarrier spacing) will change the “DCI monitoring occasion[s],” i.e., the occasions when the transmissions occur and the blind decoding should be performed. *Liu*, Abstract, [0005], [0019], [0040], [0095], Fig. 2; Bims, ¶113 (explaining that the UE, without knowing when and how the transmission occasions will change, would have to perform the blind decoding in *all* the possible transmission occasions). Because *Liu*’s DCI configuration parameter can “mitigate or at least alleviate” the uncertainty and thus save the

UE's battery energy in performing the blind decoding, a POSA would have been motivated to modify *You* according to *Liu*'s teachings. *Liu*, [0010]; Bims, ¶113. Efforts to improve UE battery consumption had long been a focus in 3GPP. *Supra*, §II.B.3.

A POSA would have also been motivated by *Liu*'s teachings to modify *You*'s M-PDCCH monitoring from subframe level to slot level, so as to more efficiently allocate the time-frequency resources in the control region. Bims, ¶114; *supra*, §II.B.1. Specifically, *You* suggests that its subframe-level M-PDCCH monitoring may have to be configured on nonconsecutive subframes because different subframes may be restricted to different UEs or control channels not related to paging M-PDCCH. *You*, [184]; Bims, ¶114. *Liu* solves this problem by expanding the transmission/monitoring opportunities from “subframe level (multi-slot)” to “slot level” and “symbol level.” *Liu*, [0048]; Bims, ¶114. “For example, with [a] slot-level DCI monitoring configuration, [a] UE can . . . be configured with a scheduling unit starting and ending from the symbol boundary rather than a slot boundary” or subframe boundary. *Liu*, [0062]. Thus, as shown in Figure 3A, “the remaining blank symbols can . . . be allocated to other UE[s] . . .” *Id.* Accordingly, applying *Liu*'s teachings to *You* would enable it to support massive MTC contemplated by 5G/NR. *Id.*, [0002]; Bims, ¶114.



Liu, Fig. 3A.

In summary, a POSA would have been motivated to modify *You*'s coverage enhancement scheme to harvest the many benefits of *Liu*'s technique and to address the challenges imposed by the emerging 5G/NR system. Bims, ¶115.

b. The combination of *You* and *Liu* would have yielded a predictable result

A POSA would have had a reasonable expectation of success in combining *You* and *Liu* and would have expected the combination to yield a predictable solution because they propose that UEs use highly analogous and compatible configuration parameters to determine monitoring occasions. Bims, ¶116. In particular, both *You* and *Liu* describe a UE that monitors one or more PDCCH/DCI occasions in the on duration of a paging (DRX)/DRX cycle. *You*, [174], [192]; *Liu*, [0004], [0048]-[0049]. *You* expressly addresses paging configuration parameters used for determining “CSS monitoring opportunities within a paging occasion,” while *Liu* expressly addresses DCI configuration parameters used for determining

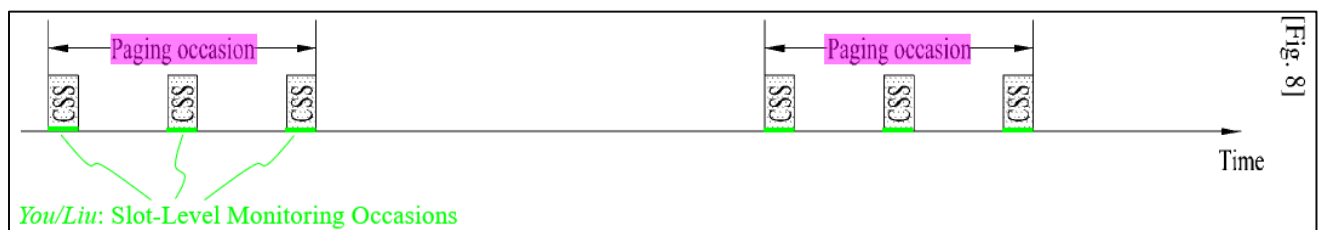
“DCI monitoring occasion[s].” *You*, [194], [196], [200]; *Liu*, Abstract, [0046]-[0049]; Bims, ¶116.

A simple substitution of some of *Liu*’s DCI configuration parameters for *You*’s paging configuration parameters would yield slot-level M-PDCCH monitoring occasions within a paging occasion. Bims, ¶117. Specifically, *You* discloses that a paging occasion is an interval including one or more subframes for a UE to monitor a paging M-PDCCH. *You*, [199]-[200]. *You* further discloses that these subframes can be specified by a periodicity and offset. *Id.*, [196]. As shown in the figure below, a POSA would have readily recognized that the *You/Liu* combination’s slot-level M-PDCCH/DCI monitoring occasions may be defined as follows:

- the duration of the **paging occasion** is set to be equal to *Liu*’s “valid duration for the DCI configuration parameter,” which could be a single subframe containing multiple slots;
- the **paging occasion** includes one or more M-PDCCH **monitoring occasions** that have a periodicity and offset specified by *Liu*’s “DCI occurrence occasions,” with the periodicity being zero if no coverage enhancement is used; and

- the duration of each M-PDCCH **monitoring occasion** is specified by *Liu*'s "duration for a single DCI," rather than being based on subframe durations.

Liu, [0046]-[0049], Fig. 2; *see also id.*, [0050]-[0051] (the DCI occurrence occasions can be "aperiodic," i.e., have zero periodicity); Bims, ¶117.



You, Fig. 8.

A POSA would have known how to use *Liu*'s DCI configuration parameters to determine the resulting M-PDCCH monitoring occasions. Bims, ¶118. Specifically, as explained by Dr. Bims, a UE could use *Liu*'s "numerology" (**subcarrier spacing**) to determine the number of **slots** in a subframe. *Liu*, [0045], Fig. 2; Bims, ¶¶118-119. Then, the UE could use *Liu*'s "DCI occurrence occasions" (periodicity, offset from the starting time point) to determine the locations of the M-PDCCH **monitoring occasions** with respect to the **slots**. *Liu*, [0045], [0048]-[0049]; Bims, ¶¶118-119. The UE could also use *Liu*'s "duration for a single DCI" to determine the duration of each M-PDCCH **monitoring occasion**. *Liu*, [0047]; ¶¶118-119. And the UE could use *Liu*'s "valid duration for the DCI configuration parameter" to determine the duration of the **paging occasion**.

Liu, [0046]; ¶¶118-119. Finally, the UE could use *Liu*'s "frequency domain resource unit" and "frequency hopping pattern" to determine the subband location and bandwidth for monitoring the M-PDCCH. *Liu*, [0054]-[0055]; Bims, ¶118.

A POSA would have had a reasonable expectation of success for the resulting combination because the purpose of *Liu*'s solution is to mitigate or alleviate the uncertainty "due to [the change of] numerology," and to make the M-PDCCH/DCI monitoring occasions predictable by a UE. *Liu*, Abstract, [0019]; Bims, ¶120. Thus, the UE would have a higher success rate in finding the right M-PDCCH/DCI monitoring occasions. Bims, ¶120. Moreover, the modification requires less time and battery power to locate the time-frequency resources for receiving the M-PDCCH/DCI, so the UE operation is less likely to experience interruption or crash. *Id.*

A POSA would also have had a reasonable expectation of success for the resulting combination because it merely requires combining prior elements according to known methods. *Id.*, ¶121. Particularly, *You* discloses that the paging M-PDCCH search space is specified by a set of paging parameters. *You*, [250] (Table 13). *You* discloses that a base station can transmit the paging parameters to a UE via a system information block (SIB) or radio resource control (RRC) message, so that the UE may monitor the paging M-PDCCH according to the parameters. *Id.*, [235], [293]. Similarly, *Liu* discloses that the DCI configuration

parameter can be transmitted to the UE by a high-layer signaling like RRC signaling, or another DCI. *Liu*, [0058]-[0059]. Thus, a POSA would have found it straightforward to transmit *Liu*'s DCI configuration parameters to *You*'s UE using one of the SIB, RRC, or DCI messages. Bims, ¶121. These messages are old, routine communication methods used in the art to signal control data. *Id.*

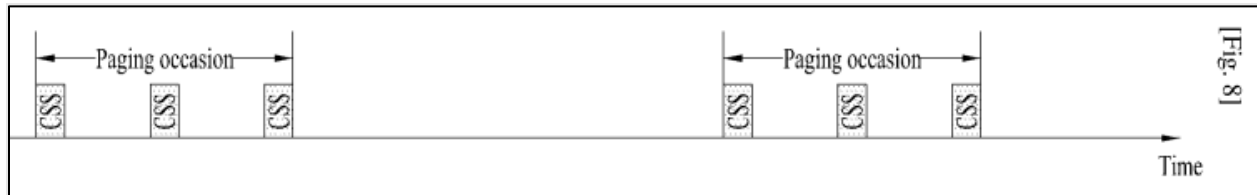
Additionally, a POSA would have had a reasonable expectation of success because *Liu* teaches that there is no fundamental difference between *You*'s subframe-level monitoring and *Liu*'s monitoring at the slot level, multi-slot level, or even symbol level. *Liu*, [0049] (describing the “periodicity” can be flexibly configured at “symbols, slots, or frames”); Bims, ¶¶122. Moreover, a POSA would have appreciated that changing to the slot or symbol levels would have been advantageous because it reduces system latency, which is one of the goals of 5G/NR. Bims, ¶¶122.

4. Independent Claim 1

a. [1pre]: “A method in a User Equipment (UE) for paging, comprising:”

As shown in Figure 8, *You* discloses a method in a UE for paging, for example, to monitor a paging M-PDCCH in a paging occasion, by searching through an M-PDCCH common search space (CSS) that is configured over one or

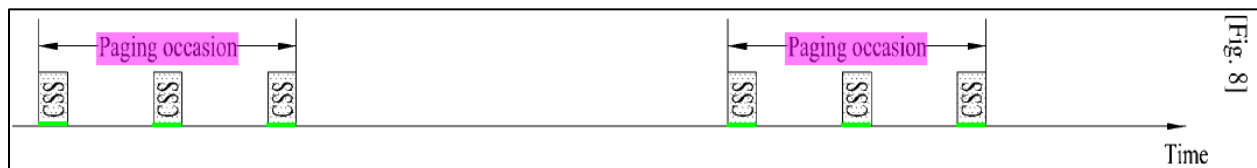
more downlink subframes of a paging occasion. *You*, [185]-[187], [199]; Bims, ¶124.



You, Fig. 8.

- b. [1a]: “monitoring a first signaling in X time intervals; and”

You alone or in view of *Liu* teaches this limitation. Bims, ¶¶125-127. *You* discloses that the UE monitors a paging M-PDCCH in one or more downlink subframes of a paging occasion. *You*, [185]-[187], [199]. Specifically, when coverage enhancement is applied, in the paging occasion, multiple repetitions of an M-PDCCH search space in which the paging M-PDCCH could be found are configured over multiple subframes respectively, wherein the multiple subframes may be consecutive or nonconsecutive. *Id.*, [183]-[185], [187]. When coverage enhancement is not applied, the M-PDCCH search space is not repeated, i.e., it only exists in one subframe. *Id.*, [186].



Id., Fig. 8.

You's **paging M-PDCCH** constitutes the claimed "**first signaling**" because *You* discloses that "a physical downlink control channel (PDCCH) . . . refer[s] to a set of time-frequency resources or resource elements (REs) carrying downlink control information (DCI)" *Id.*, [47]; *compare id.*, with '767 patent, 20:10, 20:13-14; Bims, ¶126. And *You*'s **one or more downlink subframes** in a paging occasion constitute the claimed "**X time intervals**" because each subframe is a time interval. *Supra*, §II.B.1; Bims, ¶126.

Moreover, as discussed in §VI.A.3, *Liu* discloses a method for a UE to monitor **DCI** in **one or more DCI monitoring occasions at the slot level**, and it would have been obvious to adapt *You*'s subframe-level monitoring for *Liu*'s slot-level monitoring. *Liu*, [0044], [0046], [0048]; Bims, ¶127. Therefore, *You* in view of *Liu* also teaches limitation [1a].

c. [1b]: "receiving a first radio signal;"

You discloses this limitation by disclosing that "[i]f the **paging M-PDCCH** . . . is received within the corresponding interval [of a current paging occasion], the UE may receive a **PDSCH carrying the corresponding paging message**." *You*, [199]; Bims, ¶128. Here, the **PDSCH** constitutes the claimed "**first radio signal**" because *You* discloses that "a physical downlink shared channel (PDSCH) refer[s] to . . . a set of time-frequency resources or REs carrying downlink data" *You*, [47]. A POSA would have understood that the set of

time-frequency resources occupied by the PDSCH is a radio signal. *See* '767 patent, 19:54-62, 20:18-19; Bims, ¶128.

d. [1c]: “wherein X is a positive integer;”

As discussed for limitation [1a], *You* alone or in view of *Liu* teaches that the paging M-PDCCH is monitored in one or more (i.e., a positive integer) time intervals. Bims, ¶129.

e. [1d]: “the first signaling is used for determining scheduling information for the first radio signal;”

You alone or in view of *Liu* teaches this limitation. Bims, ¶¶130-132. In particular, *You* discloses that “the PDSCH carrying the paging message may be scheduled by PDCCH/M-PDCCH.” *You*, [193]; *see also id.*, [188], [194], [196], [199], [293]; Bims, ¶130.

Further, *You* discloses that the DCI transmitted on the paging M-PDCCH contains scheduling information for the PDSCH carrying the paging message. Bims, ¶131. *You* discloses that 3GPP defines various DCI formats to specify the size and usage of the DCI. *You*, [104]. Among them, “DCI format 1C” corresponds to “[v]ery compact resource assignments for PDSCH (e.g. paging/broadcast system information).” *Id.*, [105] (Table 7). Here, the DCI resource assignments are used for scheduling the PDSCH carrying the paging message. Bims, ¶131.

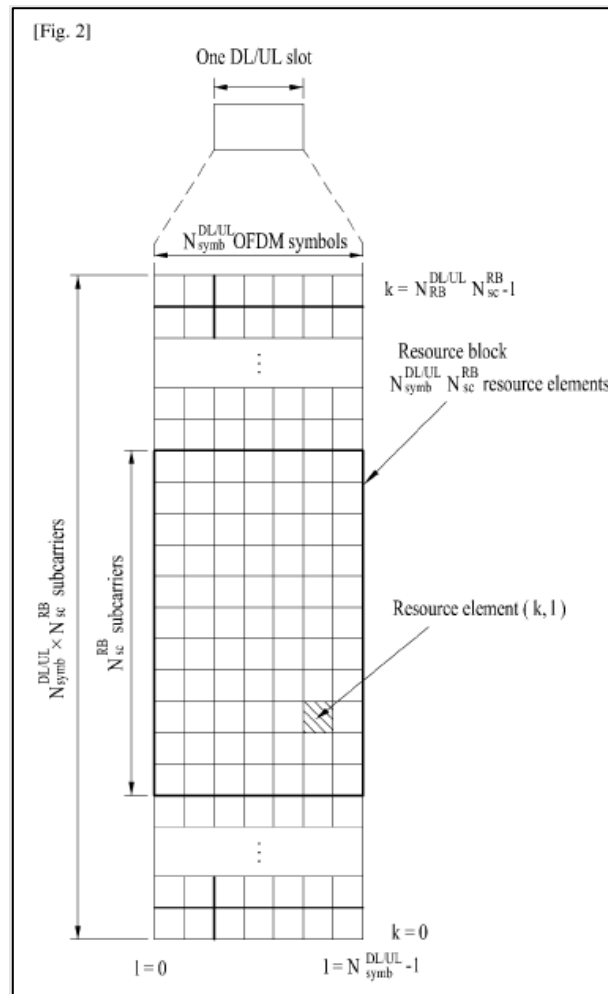
Moreover, *Liu* discloses that the DCI can include scheduling information, *Liu*, [0085], and it would have been obvious to modify *You*'s paging M-PDCCH monitoring method according to *Liu*'s DCI monitoring method. *Supra*, §VI.A.3; Bims, ¶132. Therefore, *You* in view of *Liu* also teaches limitation [1d].

- f. [1e]: “the scheduling information comprises at least one of {occupied time-frequency resource, adopted Modulation Coding Scheme (MCS), subcarrier spacing of subcarriers in occupied frequency domain resource};”

You alone or in view of *Liu* teaches this limitation. Bims, ¶¶133-135. The phrase “at least one of {}” in limitation [1e] is disjunctive because there is no basis in the specification or prosecution history for reading it to require all the limitations recited in the curly brackets “{}.” Notably, Patent Owner's infringement contentions do not address all the listed alternatives of limitation [1e]. Ex. 1030, 9-10. The obviousness of one of the limitations in the curly brackets “{}” is likewise sufficient here.

You discloses that the DCI transmitted on the paging M-PDCCH includes information such as “RB allocation,” “modulation coding scheme (MCS),” etc. *You*, [104]. “RB” is the abbreviation for “resource block,” which is defined to contain a predetermined number of consecutive symbols in the time domain and a predetermined number of consecutive subcarriers in the frequency domain. *Id.*, [59], [61], Fig. 2. Accordingly, *You* discloses limitation [1e] by disclosing that the

scheduling information includes both an occupied time-frequency resource and an adopted Modulation Coding Scheme (MCS), either of which is sufficient to meet the limitation. Bims, ¶134.



You, Fig. 2.

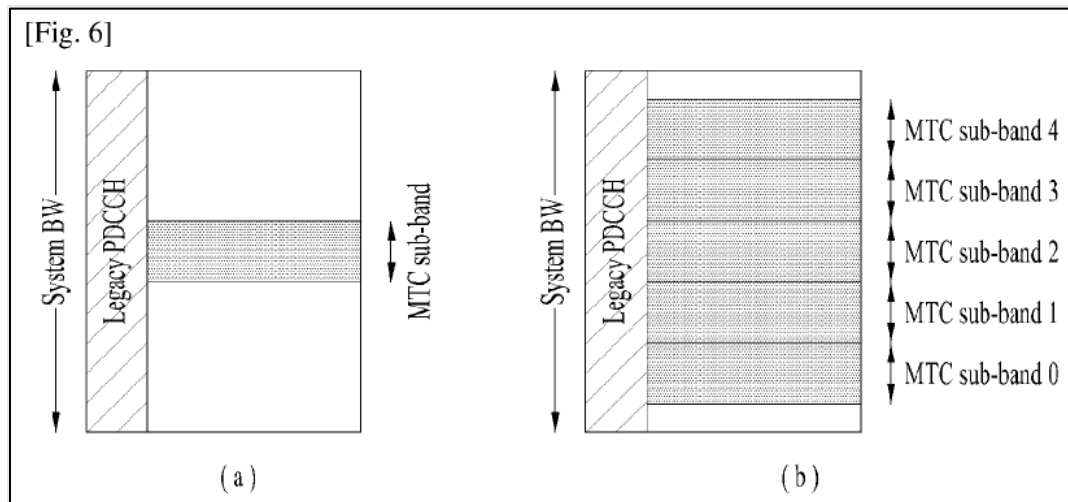
Moreover, *Liu* discloses that the DCI includes information of “MCS” and “resource allocation,” *Liu*, [0083], [0085], and it would have been obvious to apply *Liu*’s teachings to *You*’s paging M-PDCCH monitoring method. *Supra*, §VI.A.3; Bims, ¶135. Therefore, *You* in view of *Liu* also teaches limitation [1e].

g. [1f]: “the first radio signal carries a paging message;”

As discussed for limitation [1b], *You* discloses that the “PDSCH” received by the UE “carr[ies] the corresponding paging message.” *You*, [199]; *see also id.*, [193]; Bims, ¶136.

h. [1g]: “the frequency domain resource used for transmitting the first signaling belongs to a first subband;”

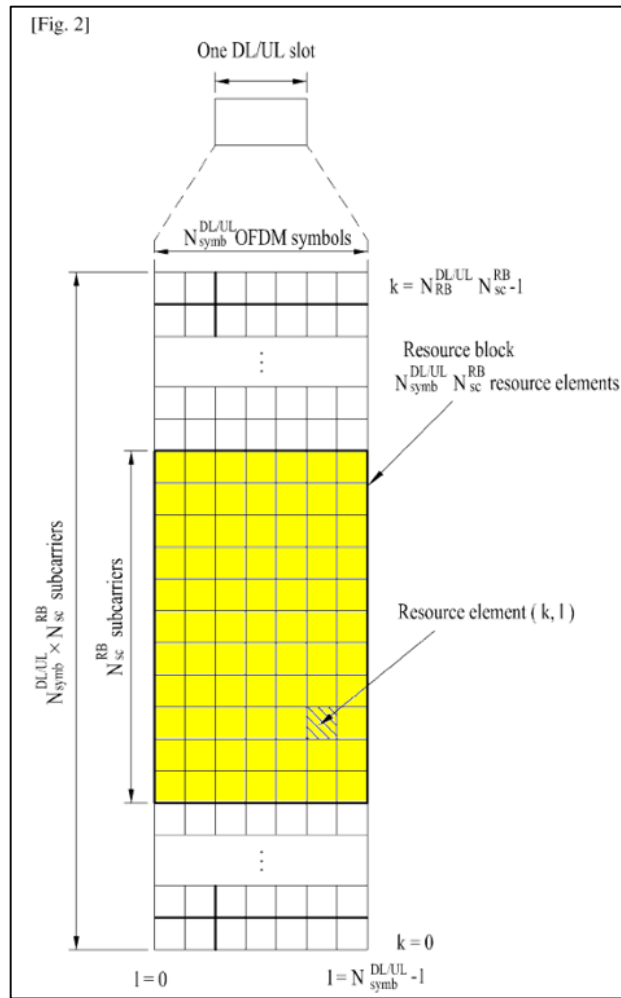
You discloses this limitation. Bims, ¶137. *You* discloses that the paging M-PDCCH is monitored by a machine-type communication (MTC) UE that operates “at a reduced UE downlink and uplink bandwidth.” *You*, [176]. Figure 6 of *You* shows exemplary subbands (i.e., narrowbands) for the MTC. *Id.*, [175], Fig. 6. *You* discloses that an M-PDCCH is “a control channel transmitted within a subband where MTC is operated for the MTC UE.” *Id.*, [177]. *You* further discloses that the M-PDCCH is monitored at a specific narrowband location. *Id.*, [194], [235]. In view of these teachings, a POSA would have understood that the frequency domain resource used for transmitting the paging M-PDCCH belongs to an MTC subband (claimed “first subband”). Bims, ¶137.



You, Fig. 6.

- i. [1h]: “the first subband comprises a positive integer number of consecutive subcarriers in frequency domain; and”

You discloses this limitation. Bims, ¶138. Specifically, *You* discloses that the subband for monitoring the paging M-PDCCH is configured on several physical resource blocks (PRBs). *You*, [176], Fig. 6 (above). Referring to Figure 2, below, *You* further discloses that “[a] PRB is defined as . . . $N^{\text{RB}}_{\text{sc}}$ (e.g. 12) **consecutive subcarriers** in the frequency domain.” *Id.*, [62] (emphasis added). As shown in Figure 2, *You* explains that a PRB can be mapped to a resource block (highlighted below), which includes $N^{\text{RB}}_{\text{sc}}$ consecutive subcarriers. *Id.*, [61]-[62]; Bims, ¶138. Therefore, the subband for monitoring the paging M-PDCCH comprises a positive integer number of consecutive subcarriers in the frequency domain. Bims, ¶138.



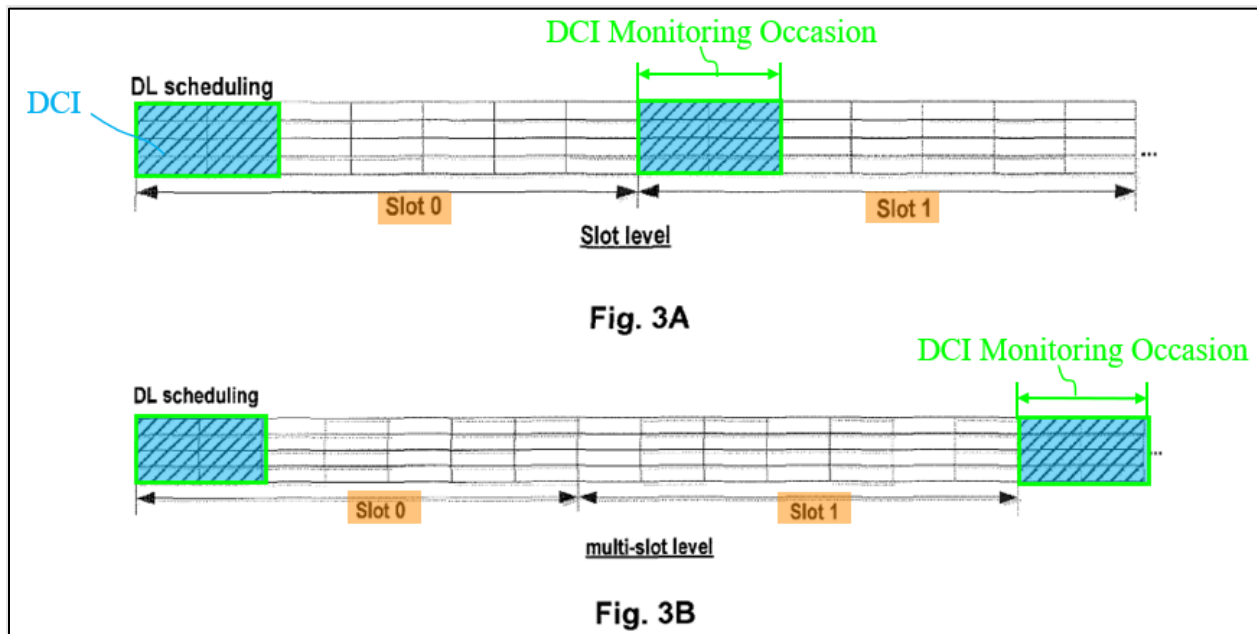
You, Fig. 2.

- j. [1i]: “at least one of {location of the first subband in frequency domain, **subcarrier spacing** of subcarriers included in the first subband} is used for determining the **X time intervals**.”

You in view of *Liu* teaches this limitation. Bims, ¶¶139-147. *Liu* discloses using **subcarrier spacing**⁵ to determine **X time intervals** for monitoring **DCI**. And it would have been obvious to apply this teaching to *You*’s **M-PDCCH** monitoring method.

Specifically, *Liu* discloses that a UE monitors **DCI** at one or more **DCI monitoring occasions**, namely, the “DCI occurrence occasions” specified by the DCI configuration parameter. *Liu*, [0044], [0048]. The DCI occurrence occasions (**DCI monitoring occasions**) can be periodically arranged at, for example, the **slot** level. *Id.*, [0048]-[0049]. Figure 3A shows that the **DCI monitoring occasions** are at every **slot**, while Figure 3B shows that the **DCI monitoring occasions** are at every two **slots**. *Id.*, [0049]. Here, *Liu*’s **DCI monitoring occasions** constitute the claimed “**X time intervals**” for monitoring the **DCI** (claimed “**first signaling**”). Bims, ¶140.

⁵ Similar to the discussion for limitation [1e], the phrase “at least one of {}” is disjunctive. Accordingly, the cited prior art references can disclose limitation [1i] if they teach one of the alternative elements recited in “{}.”



Liu, Figs. 3A and 3B.

Liu discloses that the UE “may learn the time-frequency resource for the DCI from the DCI configuration parameter,” which includes the **subcarrier spacing** information, “and monitor the DCI within the time-frequency resource.” *Id.*, [0057]; *see also id.*, [0095]. As discussed below, *Liu* discloses using the **subcarrier spacing** to determine three different aspects of the time-frequency resource associated with the “**X time intervals**”:

- time-domain locations (**slot** location) of the claimed “**X time intervals**”;
- duration of each one of the claimed “**X time intervals**”—the duration of each **DCI monitoring occasion**; and

- the number of the claimed “X”—the number of DCI monitoring occasions in an on duration of a DRX cycle, e.g., a paging occasion.

Bims, ¶141.

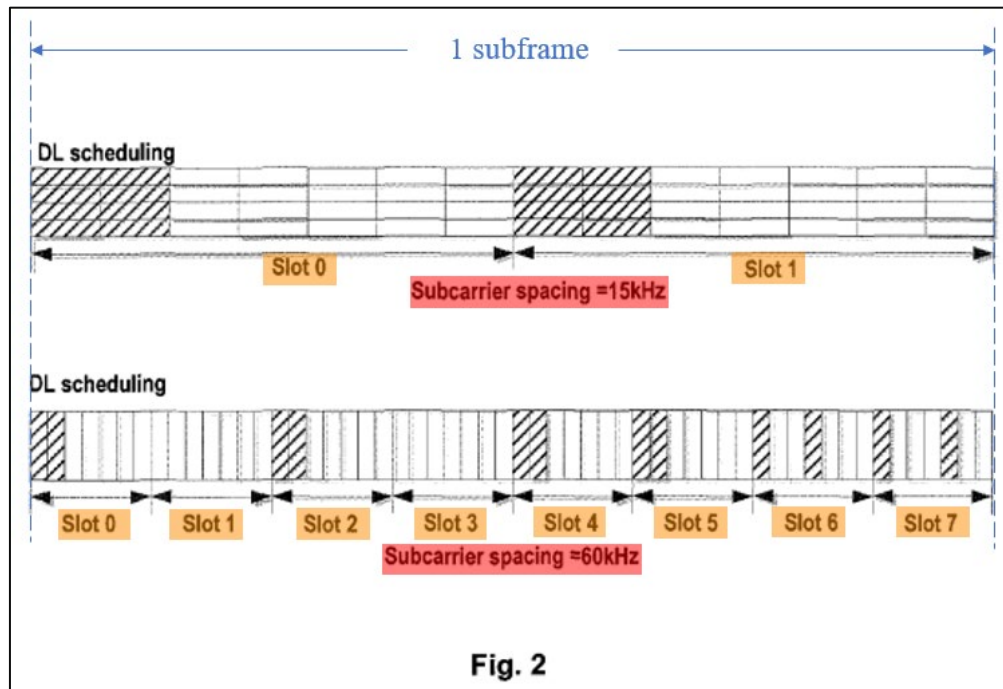
Patent Owner’s infringement contentions do not address all these aspects of the “X time intervals,” Ex. 1030, 18-22, so the obviousness of any one of them should individually be sufficient to render the claim obvious. But even if the claim was interpreted to require more, *You* in view of *Liu* renders all obvious.

i. Time-domain locations of the “X time intervals”

The ’767 patent describes a method that first determines Y time intervals based on the subcarrier spacing, and then determines which one(s) of the Y time intervals include(s) the X time intervals. *Supra*, §III.A. The same method is disclosed by *Liu*. Bims, ¶¶142-144.

Liu discloses that the UE uses the DCI configuration parameter to determine the time-frequency resources for monitoring the DCI. *Liu*, [0057], [0095]. To that end, *Liu* discloses that the “numerology to be used” (subcarrier spacing) is used for determining the slots in a subframe, and the “DCI occurrence occasions” (periodicity, offset) are used to determine the time-domain locations of the DCI monitoring occasions with respect to the slots. *Id.*, [0044]-[0045], [0049]; Bims, ¶143. The above process is illustrated by *Liu*’s Figure 2. Different subcarrier spacings correspond to different symbol durations and thus cause a subframe to be

divided into different numbers of **slots**: under the **15 kHz subcarrier spacing**, the UE divides a subframe into two longer **slots**, whereas under the **60 kHz subcarrier spacing**, the UE divides a subframe into eight shorter **slots**. *Liu*, [0045]; Bims, ¶143. Due to the differing **slot** numbers and durations, corresponding **slots** (e.g., slot 0 or slot 1 in Figure 2) under different **subcarrier spacings** occupy different locations in the time domain. Bims, ¶143. It follows that the **DCI monitoring occasions** in the **slots** have different time-domain locations. *Id.*



Liu, Fig. 2.

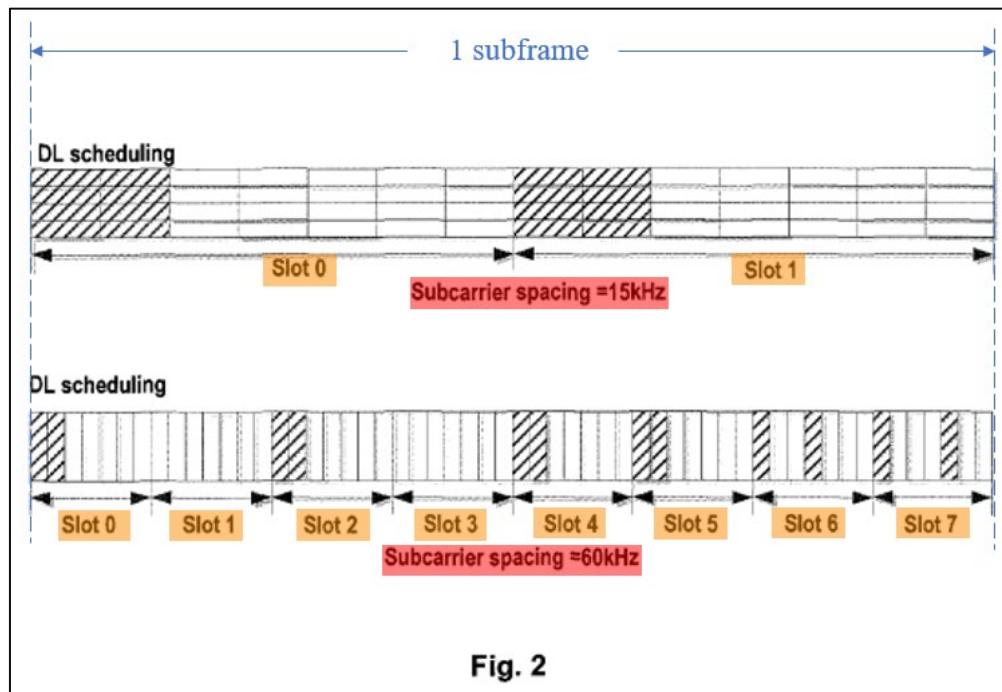
Thus, a POSA would have understood that the UE would use the **subcarrier spacing** to determine the time-domain locations of the **DCI monitoring occasions** (claimed “**X time intervals**”). Bims, ¶¶143-144.

ii. Duration of each one of the “X time intervals”

Liu also discloses that the UE uses the **subcarrier spacing** to determine the duration of each **DCI monitoring occasion**. Bims, ¶145. *Liu* discloses that the “duration for a single DCI” indicates the time length of a single **DCI monitoring occasion**, which “can be a number of symbols.” *Liu*, [0047]. *Liu* further discloses that “different **subcarrier spacings** mean different symbol lengths,” e.g., the symbol length for 15 kHz has “a time length four times as that for 60 kHz.” *Id.*, [0045]. It follows that the **subcarrier spacing** is used to determine the duration of each of the **DCI monitoring occasions** (claimed “X time intervals”). Bims, ¶145.

iii. Number of “X”

Liu also discloses that the UE uses the **subcarrier spacing** to determine the number of **DCI monitoring occasions** in a DCI search space. Bims, ¶146. As shown in the following annotated Figure 2 of *Liu*, the number of **slots** under the **60 kHz subcarrier spacing** is four times the number of **slots** under the **15 kHz subcarrier spacing**. *Liu*, [0045]; Bims, ¶146. Thus, for a given periodicity of the **DCI monitoring occasions** over the **slots**, the number of **DCI monitoring occasions** depends on the **subcarrier spacing**. Therefore, a POSA would have understood that the **subcarrier spacing** must be used to determine the number of **DCI monitoring occasions**. Bims, ¶146.



Liu, Fig. 2.

iv. Resulting combination

As discussed in §VI.A.3, a POSA would have found it obvious to substitute *Liu*'s DCI configuration parameters for *You*'s paging configuration parameters. In the resulting combination, a UE would use *Liu*'s "numerology" and "DCI occurrence occasions" to determine the time-domain locations and number of the M-PDCCH monitoring occasions, and use the "numerology" and "duration for a single DCI" to determine the duration of each M-PDCCH occasion. *Liu*, [0045], [0047]-[0049], Fig. 2; Bims, ¶147. A POSA would have appreciated that the resulting slot-level M-PDCCH monitoring, compared to the subframe-level monitoring, would be advantageous because it would reduce system latency. Bims,

¶147. This would be particularly useful in *You*'s coverage enhancement mode, which requires multiple repetitions of the M-PDCCH transmission. *Id.* A POSA would have expected the resulting combination to work well in a 5G/NR system because, by using *Liu*'s method, the UE would be able to determine the time-domain locations, durations, and number of the M-PDCCH monitoring occasions at the slot level, despite the symbol duration and the number of slots in a subframe changing with the subcarrier spacing. *Id.*

5. Claim 4

- a. [4a]: “The method according to claim 1, further comprising: receiving a second radio signal;”

You in view of *Liu* teaches claim 1 and this limitation. Bims, ¶148-151. First, *You* discloses a method for a UE to receive a system information block (SIB) message that includes information for reconfiguring the time-frequency resources for monitoring the paging M-PDCCH. *Id.*, ¶148. Specifically, *You* discloses that the “CSS_paging [is] configured by SIB,” which is transmitted through “broadcast” or “dedicated” channels. *You*, [235], [70]. The base station “may configure or reconfigure CSS_paging,” and the UE may “receive configuration or reconfiguration information on CSS_paging from the eNB [base station].” *Id.*, [293]. The CSS_paging configuration/reconfiguration information includes parameters that are “configured by SIB” and describe the time domain resources

(e.g., repetition number “ $R_{\max}$ ”) and the frequency domain resources (e.g., “PRB-sets” and “[n]arrowband[s]”) used for transmitting the CSS_paging. *Id.*, [250] (Table 13).

Second, *Liu* discloses that the UE can receive information for reconfiguring the time-frequency resources for monitoring DCI. Bims, ¶149. Specifically, *Liu* discloses that the UE receives “a DCI configuration parameter” that “indicates the time-frequency resources for the following DCI.” *Liu*, [0088]. The DCI configuration parameter may include, among others, “numerology to be used” and “a frequency domain resource unit.” *Id.*, [0089]-[0090]. Because *Liu* discloses that the numerology can change, a POSA would have understood that the DCI configuration parameter is transmitted in real time to reconfigure the DCI monitoring occasions upon a change of the numerology. *Id.*, [0003], [0005], [0019], [0040]; Bims, ¶149.

It would have been obvious to modify *You*’s SIB message for reconfiguring CSS_paging to include *Liu*’s DCI configuration parameter. Bims, ¶150. Specifically, for the reasons discussed in §VI.A.3, a POSA would have been motivated to combine the teachings of *You* and *Liu*. *Id.* Additionally, a POSA would have appreciated that *You*’s method can be improved by *Liu*’s DCI configuration parameter, because it enables the UE to operate in a 5G/NR system and determine a monitoring occasion change caused by a numerology change. *Liu*,

Abstract, [0019], [0040], [0095]; Bims, ¶150. Moreover, because both *You*'s SIB message and *Liu*'s DCI configuration parameter serve the same purpose of reconfiguring the time-frequency resources used for monitoring M-PDCCH/DCI, it would have been a natural choice to transmit *Liu*'s DCI configuration parameter via *You*'s SIB message. Bims, ¶150. Moreover, a POSA would have had a reasonable expectation of success because the modification would require no more than combining prior art elements (*You*'s SIB message for reconfiguring CSS_paging and *Liu*'s DCI configuration parameter for reconfiguring monitoring occasions) according to known methods (transmitting the SIB message and DCI configuration parameter to the UE before the actual M-PDCCH/DCI occurrence) to yield predictable results (expanding the CSS_paging configuration parameters shown in *You*'s Table 13 to include *Liu*'s DCI configuration parameter) and therefore make it compatible with 5G/NR. *Id.*

In summary, *You* in view of *Liu* teaches a method for the UE to receive an SIB message for reconfiguring the time-frequency resources for monitoring the M-PDCCH. *Id.*, ¶151. The '767 patent states that the "second radio signal" may carry "System Information Block (SIB) information." '767 patent, 5:43-44. Just like the '767 patent, *You/Liu*'s SIB message constitutes the claimed "second radio signal." *You*, [70]; Bims, ¶151.

- b. [4b]: “wherein the second radio signal is used for determining at least one of {location of the first subband in frequency domain, subcarrier spacing of subcarriers included in the first subband}.”**

As discussed for limitation [4a], it would have been obvious to modify *You*’s SIB message (claimed “second radio signal”) to include *Liu*’s DCI configuration parameter. *Liu* further discloses that the DCI configuration parameter includes “a numerology to be used” and a “frequency domain resource unit.” *Liu*, [0044], [0053]. *Liu* discloses that the numerology corresponds to a “subcarrier spacing[]” (claimed “subcarrier spacing”) and the frequency domain resource unit specifies “a subband” (claimed “location of the first subband”). *Id.*, [0045], [0054]; Bims, ¶152. Therefore, the combination renders this limitation obvious. Bims, ¶152.

6. Claim 5

- a. [5a]: “The method according to claim 1, further comprising: receiving a second signaling;”**

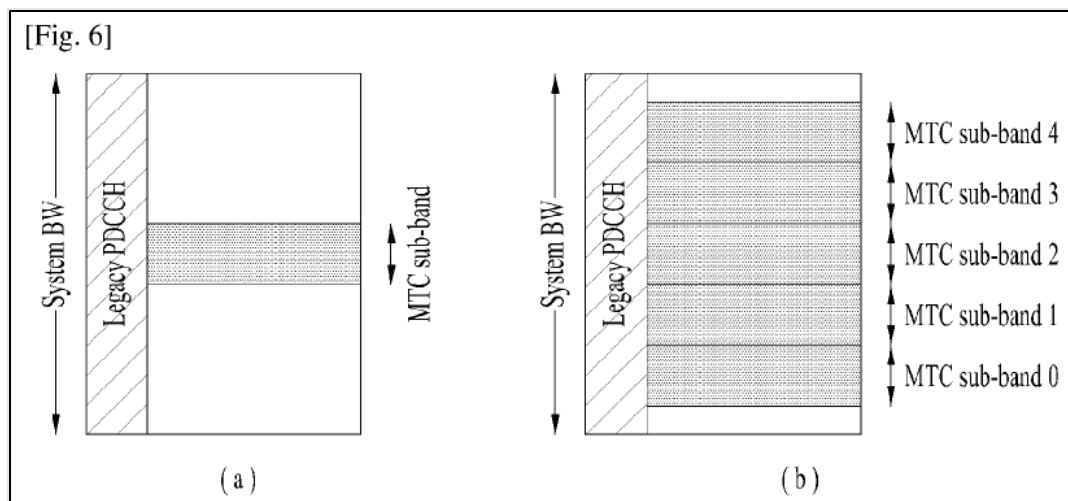
You in view of *Liu* teaches claim 1, and *You* discloses this limitation. Bims, ¶153. The ’767 patent’s specification states that the “second signaling” may be an “[R]RCC[] signaling” or “an SIB.” ’767 patent, 6:33-35. Likewise, *You* discloses that “[t]he eNB processor may control the eNB RF unit to transmit [an] SIB or RRC message, which includes configuration for CSS_paging, to the UE” *You*, [293]; *see also id.*, [235]. *You* also discloses that “[t]he UE may attempt reception of paging M-PDCCH from CSS_paging according to the CSS_paging

configuration.” *Id.*, [293]. Thus, *You* discloses that the UE receives an SIB/RRC message that includes a CSS_paging configuration (claimed “second signaling”).

Bims, ¶153.

b. [5b]: “wherein the second signaling is used for determining Q subbands, Q being a positive integer;”

You discloses this limitation by disclosing that the CSS_paging configuration includes, for example, five “paging narrowbands configured by SIB.” *You*, [250] (Table 13), Fig. 6; Bims, ¶154.



You, Fig. 6.

c. [5c]: “the first subband belongs to one of the Q subbands;”

As discussed for limitation [1g], *You* discloses the claimed “first subband” by disclosing that the UE performs paging M-PDCCH monitoring in a narrowband. *Id.*, [194]. *You* further discloses that this narrowband is “[d]etermined

by [a] UE ID among paging narrowbands configured by SIB.” *Id.*, [250] (Table 13); Bims, ¶155.

d. [5d]: “any one of the Q subbands comprises a positive integer number of consecutive subcarriers; and”

As discussed for limitation [1h], *You* discloses that the UE monitors the paging M-PDCCH on a subband comprising consecutive subcarriers. *You*, [62], [176]. Therefore, a POSA would have understood that any one of the paging narrowbands configured by SIB (claimed “Q subbands”) comprises consecutive subcarriers. Bims, ¶156.

e. [5e]: “the feature ID of the monitor of the first signaling is used for determining the first subband in the Q subbands.”

As discussed for limitation [1a], *You* discloses a UE for “monitoring a first signaling.” *You*, [185]-[187], [199]. And as discussed for limitation [5c], *You* discloses that the UE ID (claimed “feature ID of the monitor”) is used for determining a narrowband (claimed “first subband”) among paging narrowbands configured by SIB (claimed “Q subbands”). *Id.*, [250] (Table 13); *see also id.*, [176] (“[T]he UEs may use their respective subbands different from each other”); Bims, ¶157. *You* further discloses that the UE ID can be a cell-RNTI (C-RNTI). *You*, [85], [107]; ’767 patent, 19:47 (“[T]he feature ID refers to a C-RNTI.”); Bims, ¶157.

7. **Claim 6**

a. **[6pre]: “A method in a base station for paging, comprising:”**

As discussed for claim [1pre], *You* discloses a method for a UE to monitor a paging M-PDCCH over one or more downlink subframes in a paging occasion. *You*, [185]-[187], [199]. Although this wireless communication method is primarily described from the perspective of the UE, *You* also discloses the corresponding method performed by the base station because the method involves the UE wirelessly interfacing with the base station. Bims, ¶158. For example, a radio signal that is transmitted from the UE is also received by the base station for wireless communication. *Id.* Likewise, a radio signal that is received by the UE is also transmitted by the base station for wireless communication. *Id.*

b. **[6a]: “transmitting a first signaling in a positive integer number of time intervals of X time intervals; and”**

As discussed for claim [1a], *You* alone or in view of *Liu* teaches a UE monitoring a paging M-PDCCH (claimed “first signaling”) in one or more X time intervals. *You*, [183]-[187], [199]; *Liu*, Abstract, [0019], [0044], [0046]-[0048]. Thus, *You* alone or in view of *Liu* also teaches the base station “transmitting a first signaling in a positive integer number of time intervals of X time intervals.” Bims, ¶159.

c. [6b]: “transmitting a first radio signal;”

As discussed for claim [1b], *You*’s UE receives a PDSCH carrying a paging message (claimed “first radio signal”). *You*, [199]. Thus, *You* also discloses the base station “transmitting a first radio signal.” Bims, ¶160.

d. Remaining limitations of claim 6

The remaining limitations of claim 6 are substantially similar to limitations [1c]-[1i] of claim 1, and thus are respectively taught by *You* alone or in view of *Liu* for the same reasons discussed above for limitations [1c]-[1i]. See Bims, ¶¶161-167 (comparing claim features).

8. Claim 9

You in view of *Liu* teaches claim 6. The remaining limitations of claim 9 are substantially similar to claim 4, and thus are taught by *You* in view of *Liu* for the reasons discussed for claim 4. Bims, ¶¶168-169.

9. Claim 10

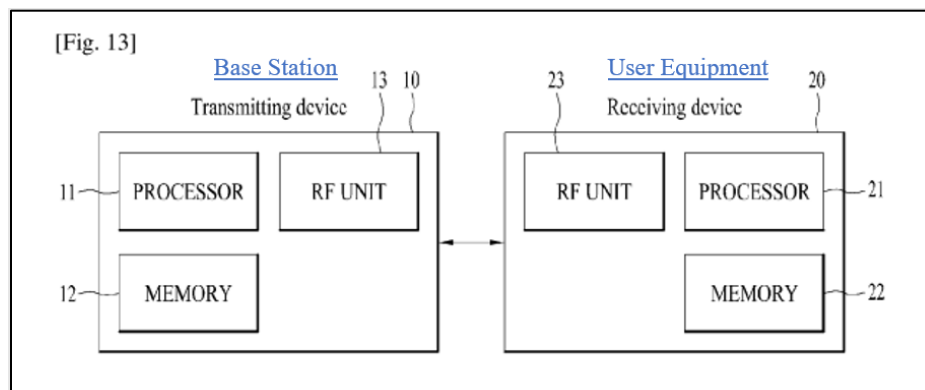
You in view of *Liu* teaches claim 6. The remaining limitations of claim 10 are substantially similar to claim 5, and thus are taught by *You* for the reasons discussed for claim 5. Bims, ¶¶170-174.

10. Claims 11, 14, and 15

Independent claim 11 is substantially similar to claim 1, except it is an apparatus claim directed to “[a] UE for paging,” and requires (1) “a first receiver

module” to monitor a first radio signaling in X time intervals, and (2) “a second receiver module” to receive a first radio signal. Bims, ¶175. *You* discloses or suggests these apparatus-related limitations. *Id.*, ¶¶175-179.

Figure 13 of *You* discloses a wireless communication system including “a transmitting device 10 and a receiving device 20,” in which a UE operates as the receiving device 20 for a downlink transmission. *You*, [285], [292]. *You* discloses that the receiving device 20 includes a radio frequency (RF) unit 23 capable of receiving radio signals carrying information, data, signals, and/or messages; a memory 22 for storing information related to communication in a wireless communication system; and a processor 21 configured to control the memory 22 and/or the RF unit 23 so that the receiving device 20 may perform the disclosed methods. *Id.*, [286]. The processor 21 controls the RF unit 23 to receive radio signals transmitted by the transmitting device 10. *Id.*, [290]. The processor 21 also decodes and demodulates the received radio signals. *Id.*



Id., Fig. 13.

a. “A UE for paging”

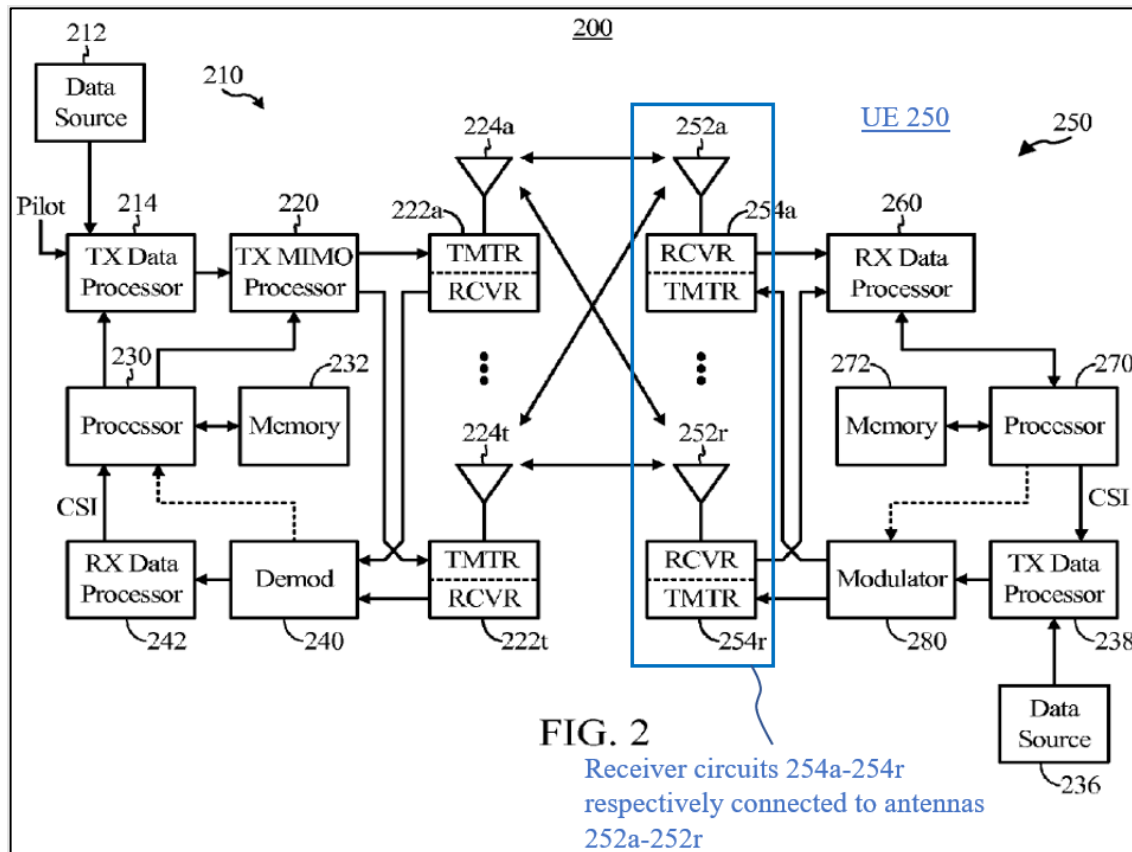
You’s receiving device 20 constitutes the “UE for paging” recited in claim 11, because *You* discloses that the receiving device 20 is used for implementing the disclosed paging method. *Id.*, [285], [293]; Bims, ¶177.

b. “a first receiver module” and “a second receiver module”

You’s RF unit 23 discloses or at least renders obvious the claimed “first receiver module” and “second receiver module.” Bims, ¶¶178-179. Specifically, *You* discloses that the receiving device 20’s RF unit 23 includes multiple receive antennas to support a multiple-input multiple-output (MIMO) function. *You*, [291]. *You* further discloses that the RF unit 23 “frequency down-converts each signal received through receive antennas into a baseband signal.” *Id.*, [290]. A POSA would have understood that the frequency down-conversion is performed by a receiver circuit. Bims, ¶178. Moreover, a POSA would have found it obvious to include multiple receiver circuits respectively connected to the multiple receive antennas, each receiver circuit being used for down-converting the signal received from the respective receive antenna. *Id.* Such parallel processing of the antenna signals, *see Luo*, Fig. 2 (showing one receiver at each antenna), would allow *You*’s processor 21 to simultaneously decode and demodulate the signals received from

multiple receive antennas, thereby improving the system speed. *Id.*, [0037]-[0038];

Bims, ¶178.



Luo, Fig. 2.

Therefore, *You* discloses or at least renders obvious multiple receiver modules, each including a receive antenna and an associated receiver circuit. Bims, ¶179. A POSA would have reasonably expected to succeed in providing two receiver modules, each receiving the claimed “first radio signaling” and “first radio signal” respectively, in *You*’s UE because multiple receiver modules receiving these signals were conventional and routine in the MIMO antennas described in

You. Id.; Luo, Fig. 2. As such, the combination represents nothing more than known components operating according to their ordinary and expected functions to yield predictable results (receiving signals). Bims, ¶179.

c. Remaining limitations of claims 11, 14, and 15

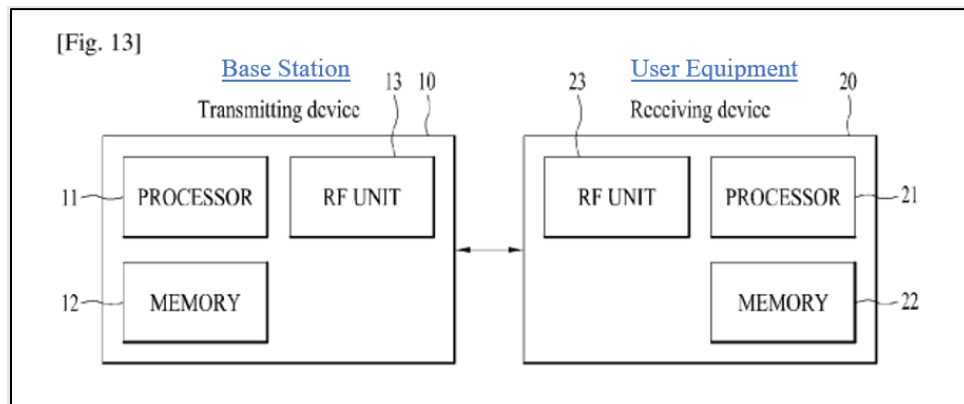
Given the similarity between claims 1 and 11, the remaining features of claim 11 are respectively disclosed or suggested for the same reasons discussed above for the corresponding features of claim 1 in §§VI.A.4.b through VI.A.4.j. *See id.*, ¶180 (comparing claim features).

Similarly, claims 4 and 14, and 5 and 15, are respectively similar to one another and are obvious for the same reasons discussed in §§VI.A.5 and VI.A.6, respectively. *See id.*, ¶181 (comparing claim features). Additionally, “the first receiver module” recited in claims 14 and 15 is disclosed or at least rendered obvious by *You* for the same reasons discussed in §VI.A.10.b. *Id.*

11. Claims 16, 19, and 20

Independent claim 16 is substantially similar to claim 6, except it is an apparatus claim directed to a base station for paging, and requires (1) “a first transmitter module” to transmit a first signaling in a positive integer number of time intervals of X time intervals, and (2) “a second transmitter module” to transmit a first radio signal. Bims, ¶182. *You* discloses or suggests these apparatus-related limitations. *Id.*, ¶¶182-186.

Figure 13 of *You* discloses a wireless communication system including “a transmitting device 10 and a receiving device 20,” in which a base station operates as the transmitting device 10 for a downlink transmission. *You*, [285], [292]. *You* discloses that the transmitting device 10 includes a radio frequency (RF) unit 13 capable of transmitting radio signals carrying information, data, signals, and/or messages; a memory 12 for storing information related to communication in a wireless communication system; and a processor 11 configured to control the memory 12 and/or the RF unit 13 so that the transmitting device 10 may perform the disclosed methods. *Id.*, [286]. The processor 11 performs coding and modulation for a signal and/or data scheduled to be transmitted to the outside, and then transfers the coded and modulated data to the RF unit 13. *Id.*, [289].



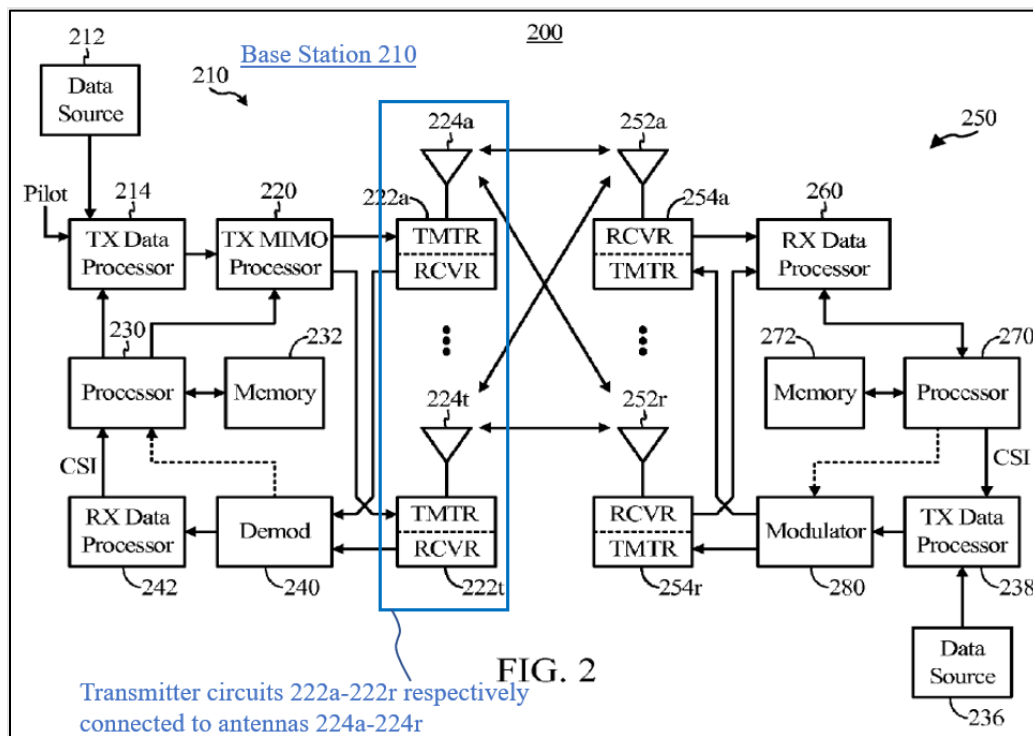
Id., Fig. 13.

a. “A base station for paging”

You’s transmitting device 10 constitutes the “base station for paging” recited in claim 16, because *You* discloses that the transmitting device 10 is used for implementing the disclosed paging method. *Id.*, [285], [293]; Bims, ¶184.

b. “a first transmitter module” and “a second transmitter module”

You’s RF unit 13 discloses or renders obvious the claimed “first transmitter module” and “second transmitter module.” Bims, ¶185. Specifically, *You* discloses that the transmitting device 10’s RF unit 13 includes multiple transmit antennas to support a multiple-input multiple-output (MIMO) function. *You*, [291]. *You* further discloses that the RF unit 13 includes “an oscillator” that performs “frequency up-conversion” to provide signals to be transmitted by the transmit antennas. *Id.*, [289]. A POSA would have found it obvious to include multiple oscillators (i.e., transmitter circuits) respectively connected to the multiple transmit antennas, each oscillator being used for up-converting signals for the respective transmit antenna. Bims, ¶185. Because *You*’s oscillator is slower than the processor 11 and usually the speed bottleneck, the parallel arrangement of the oscillator-antenna pairs, *see Luo*, Fig. 2 (showing one transmitter circuit at each antenna), would allow simultaneous frequency up-conversion for the multiple transmit antennas, thereby improving the system speed. *Id.*, [0035]-[0036]; Bims, ¶185.



Luo, Fig. 2.

Therefore, *You* discloses or at least renders obvious multiple transmitter modules, each including a transmit antenna and an associated oscillator. Bims, ¶186. A POSA would have reasonably expected to succeed in providing two transmitter modules, each transmitting the claimed “first signaling” and “first radio signal” respectively, in *You*’s base station because multiple transmitter modules transmitting these signals were conventional and routine for the MIMO systems described in *You. Id.*; Luo, Fig. 2. As such, the combination represents nothing more than known components operating according to their ordinary and expected functions to yield predictable results (transmitting signals). Bims, ¶186.

c. Remaining limitations of claims 16, 19, and 20

Given the similarity between claims 6 and 16, the remaining features of claim 16 are respectively disclosed or suggested for the same reasons discussed above for the corresponding features of claim 6 in §§VI.A.7.b through VI.A.7.d. *See* Bims, ¶187 (comparing claim features).

Similarly, claims 9 and 19, and 10 and 20, are respectively similar to one another and are obvious for the same reasons discussed in §§VI.A.8 and VI.A.9, respectively. *See* Bims, ¶188 (comparing claim features). Additionally, “the first transmitter module” recited in claims 19 and 20 is disclosed or at least rendered obvious by *You* for the same reasons discussed in §VI.A.11.b. *Id.*

B. Claims 2, 3, 7, 8, 12, 13, 17, and 18 Are Obvious over *You*, *Liu*, and *Mallick* (Ground 2)

1. Overview of *Mallick*

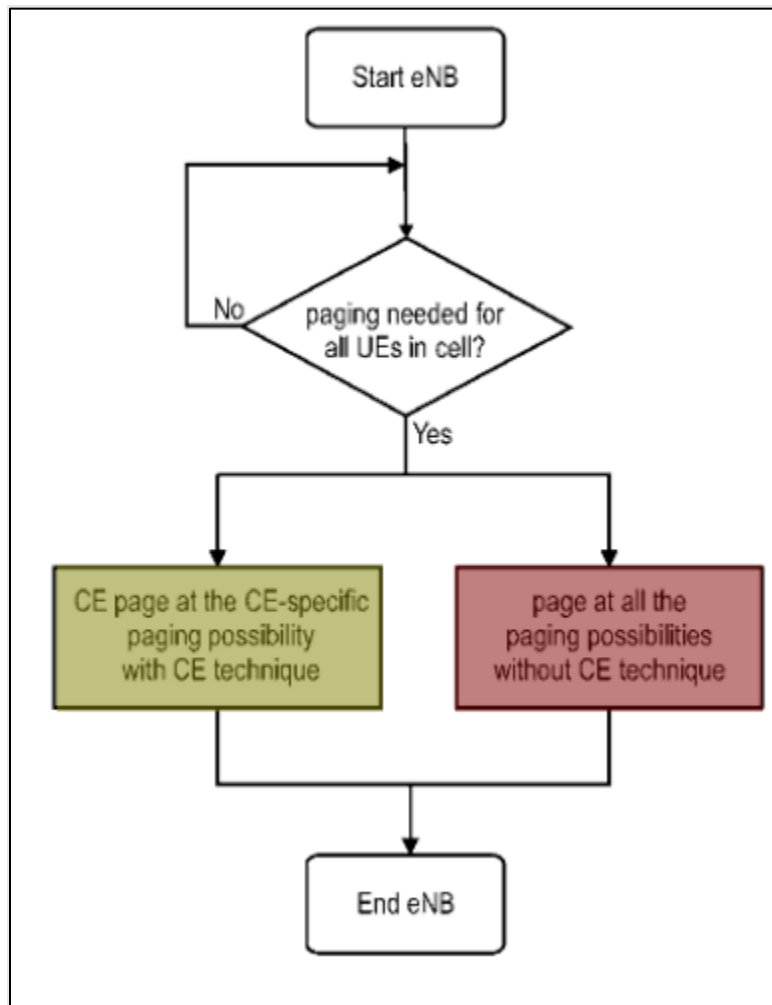
Like *You*, *Mallick* relates to using coverage extension (CE) to page MTC devices. *Mallick*, Abstract, [0140]-[0141], [0145].⁶ *Mallick* recognizes that CE requires repeated transmission of paging control information and/or increased power, imposing a heavier burden on the base station than normal coverage. *Id.*,

⁶ *Mallick* explains that “[c]overage [e]xtension” is another term for coverage enhancement. *Mallick*, [0060].

[0072], [0078], [0151]. To alleviate this problem, instead of indiscriminately applying CE to all UEs in a cell and at all the possible paging occasions, *Mallick* proposes limiting CE to only a selected group of UEs at a subset of the paging occasions. *Id.*, [0160].

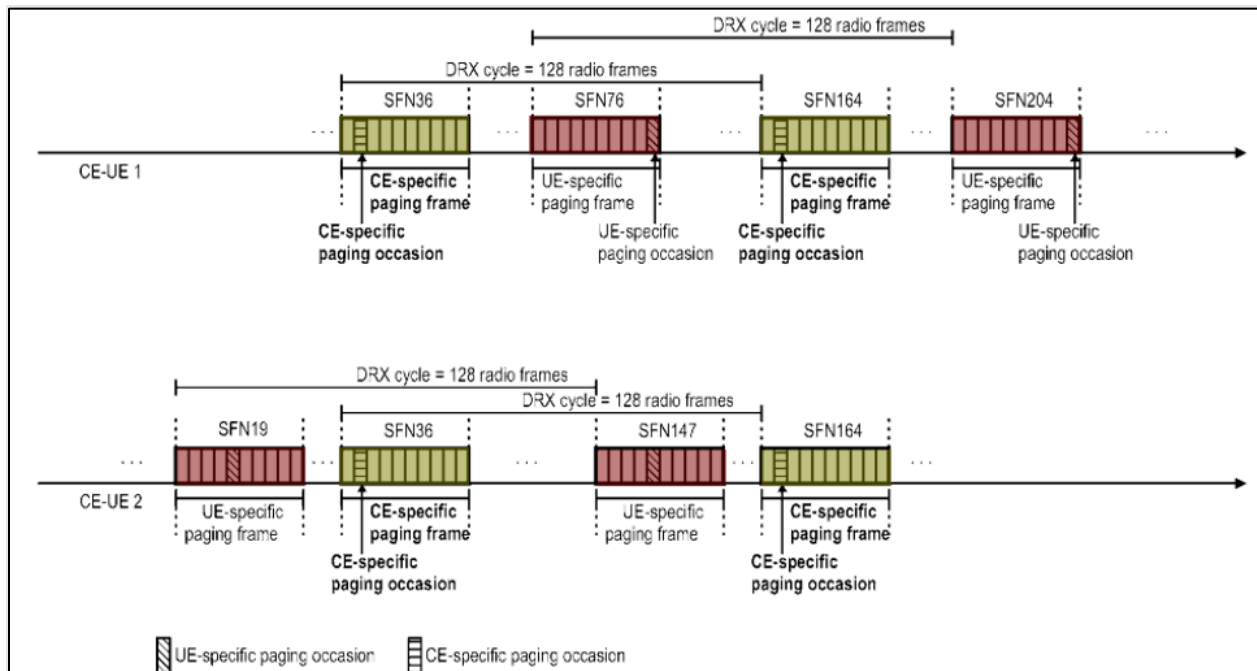
Specifically, the UEs in a cell covered by a base station are divided into UEs that experience bad radio conditions and thus require CE (“CE-UEs”), and normal UEs that do not require CE (“non-CE-UE[s]”). *Id.*, [0075], [0135]. As shown in Figure 7, the base station (i.e., eNB) may page all the UEs in its cell (including the CE-UEs and non-CE-UEs) at **UE-specific paging possibilities without using the CE technique**. *Id.*, [0146], [0159], Fig. 7. Additionally, the eNB also pages the CE-UEs at **CE-specific paging possibilities by using the CE technique**. *Id.* The term “paging possibility” refers to the combination of a paging frame (i.e., a radio frame) and a paging occasion (i.e., one or more subframes within the paging frame). *Id.*, [0024], [0072], [0148], [0161].

The **UE-specific paging possibilities** are determined based on the ordinary UE identifiers (UE-specific IDs), in the same way defined in the 4G/LTE standards, and thus are specific to the UEs. *Id.*, [0025]-[0029], [0148]. The **CE-specific paging possibilities** may be determined based on a CE-specific ID common to a group of CE-UEs, and thus are the same for these CE-UEs. *Id.*, [0079], [0093], [0101], [0107], [0148], [0169]-[0170], claim 5.



Id., Fig. 7.

Figure 5 shows two CE-specific UEs monitoring the normal paging PDCCHs at different **UE-specific paging possibilities**, and monitoring the CE paging PDCCHs at the same **CE-specific paging possibilities**. *Id.*, [0157]-[0158]. Meanwhile, non-CE-UEs (not shown) only monitor their respective **UE-specific paging possibilities**. *Id.*, [0148], [0154].



Id., Fig. 5.

By limiting the CE to the **CE-specific paging possibilities**, the downlink resources can be saved and the burden on the base station can be reduced. *Id.*, [0078], [0160], [0174]-[0175].

Mallick is analogous art to the '767 patent because *Mallick*, like the '767 patent, discloses methods for a UE to monitor paging scheduling information for a number of times. *Compare id.*, [0001], [0139], [0152], with '767 patent, Abstract, 2:20-32; Bims, ¶¶189-195.

2. Rationale for combining *You/Liu* with *Mallick*

A POSA would have been motivated to combine *You/Liu* with *Mallick*'s improved CE paging procedure, including its teachings about how to determine the

UE-specific paging possibilities and CE-specific paging possibilities. Bims, ¶¶196-200.

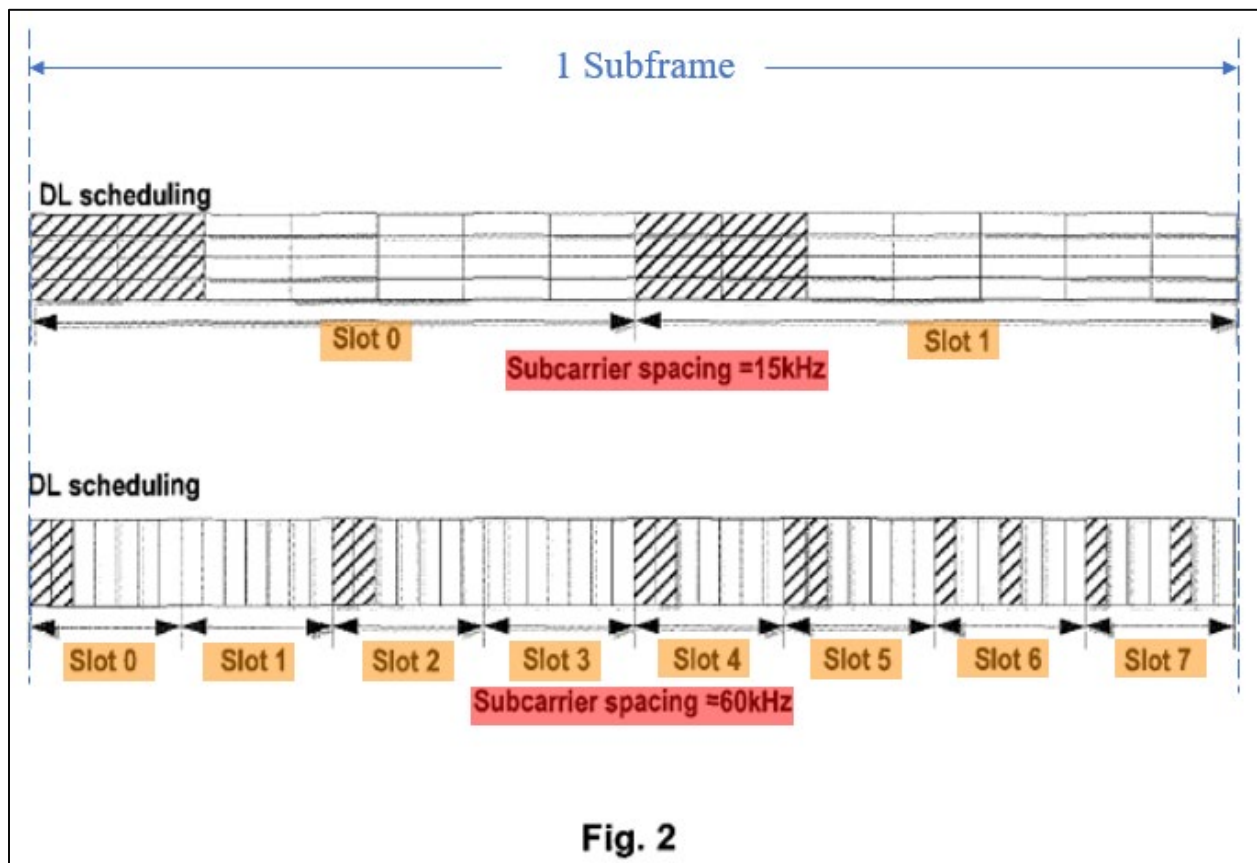
Mallick, *You*, and *Liu* are all related to paging/DRX procedure in MTC UEs that are compliant with 3GPP 4G/LTE or 5G/NR standards. *You*, [41], [180], [188]; *Liu*, [0002], [0004]; *Mallick*, Abstract, [0143], [0145]; 767 patent, 1:45-47, 5:1-3. *Mallick* discloses that limiting the CE to CE-UEs and the CE-specific paging possibilities can save downlink resources and reduce the burden on the base station. *Mallick*, [0078], [0160], [0174]-[0175]. Moreover, for a higher granularity, *Mallick*'s CE-specific IDs and CE-specific paging possibilities can be further classified according to the CE levels, such that a CE-UE can skip monitoring the CE-specific paging possibilities not associated with its CE level, thereby reducing the CE-UE's power consumption. *Id.*, [0169]-[0172]. And *You* discloses that a UE may be paged with or without CE, and not all UEs require the same level of CE. *You*, [179], [186]-[187]. Thus, *You*'s CE paging method is ready for improvement according to *Mallick*'s advantageous design. Bims, ¶198.

A POSA would have expected the combination of *You/Liu* and *Mallick* to yield predictable results because it only requires combining elements according to known methods. Bims, ¶199. *You* discloses that "a CSS starting subframe may mean a first subframe of paging occasions for allowing a UE to monitor M-PDCCH for a paging message." *You*, [186]. *You*, however, does not disclose how a

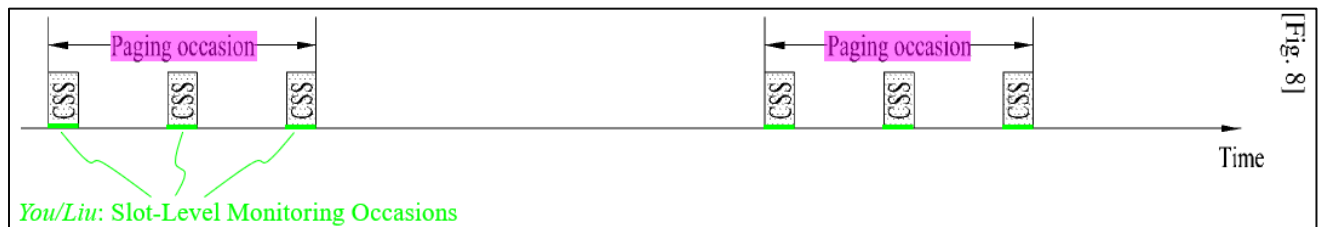
UE can determine the CSS starting subframe, despite that information being necessary to determining the “CSS monitoring opportunities within a paging occasion.” *Id.*, [196]; Bims, ¶199. To that end, *Mallick* supplements the background knowledge about how *You*’s UE determines the CSS starting subframe in 4G CE mode, namely, using the formula “ $\text{SFN mod } T = (T \text{ div } N) * (\text{UE_ID mod } N)$ ” to determine the paging frame number SFN, and using “ $i_s = \text{floor}(\text{UE_ID}/N) \text{ mod } N_s$ ” to determine the paging occasion index i_s . *Mallick*, [0025], [0027]. A POSA would have understood that the i_s specifies which subframe of the paging frame is the starting subframe of the paging occasion. *Id.*, [0028]-[0030]; Bims, ¶199.

Although presented as a solution for 5G/NR, *Liu* does not change the way *You/Mallick* (i.e., 4G/LTE) determines paging frames and paging occasions. First, *Liu*’s Figure 2, below, shows that the subframe duration is independent from the numerologies. *See also, supra*, note 4. It follows that the frame duration, which is a multiple of subframe durations, is also independent from the numerologies. *Supra*, §II.B.1; Bims, ¶200. Thus, the flexible numerology in *Liu* and 5G/NR would not disturb the existing way of arranging frames (paging frames) and subframes (paging occasions) in paging cycles. Second, *You*’s Figure 8, as modified below, shows that the *You/Liu* combination’s slot-level monitoring solution only changes how the monitoring occasions are distributed within a paging occasion, but does

not affect the subframe-level (**paging occasion** level) or frame-level (**paging frame** level) structures. Bims, ¶200. Accordingly, a POSA would have understood that *Mallick*'s 4G/LTE method of determining **paging occasion** and **paging frame** can be applied to *You/Liu* in the same way, and would have expected such combination to yield the same solution contemplated by the '767 patent. *Id.*; compare *Mallick*, [0024]-[0025], with '767 patent, 5:15-19.



Liu, Fig. 2.



You, Fig. 8.

3. Claim 2

- a. [2a]: “The method according to claim 1, wherein any one of the **X time intervals** belongs to a **first time window** in time domain;”

You in view of *Liu* teaches claim 1 and this additional limitation. Bims, ¶201. As discussed in §VI.A.3.b, *You/Liu* teaches that the **M-PDCCH/DCI monitoring occasions** belong to a paging occasion. *You*, [199]-[200]; *Liu*, [0004], [0044], [0046]. *You* further discloses that the paging occasion belongs to a **paging frame**, which is also a **radio frame**. *You*, [191] (“A paging frame (PF) means one radio frame that includes one or a plurality of paging occasion(s).”). It follows that the **M-PDCCH/DCI monitoring occasions** belong to a **paging frame**. Bims, ¶201.

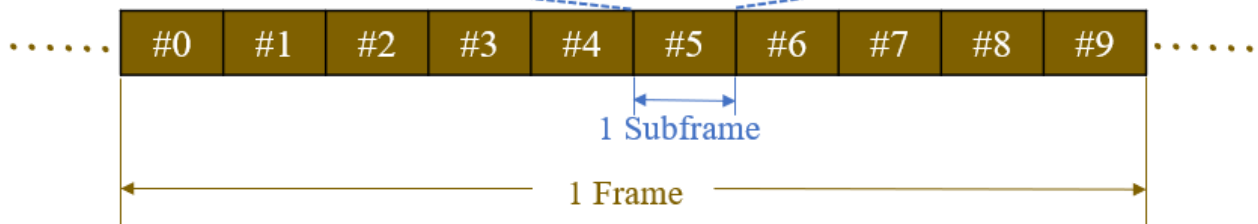
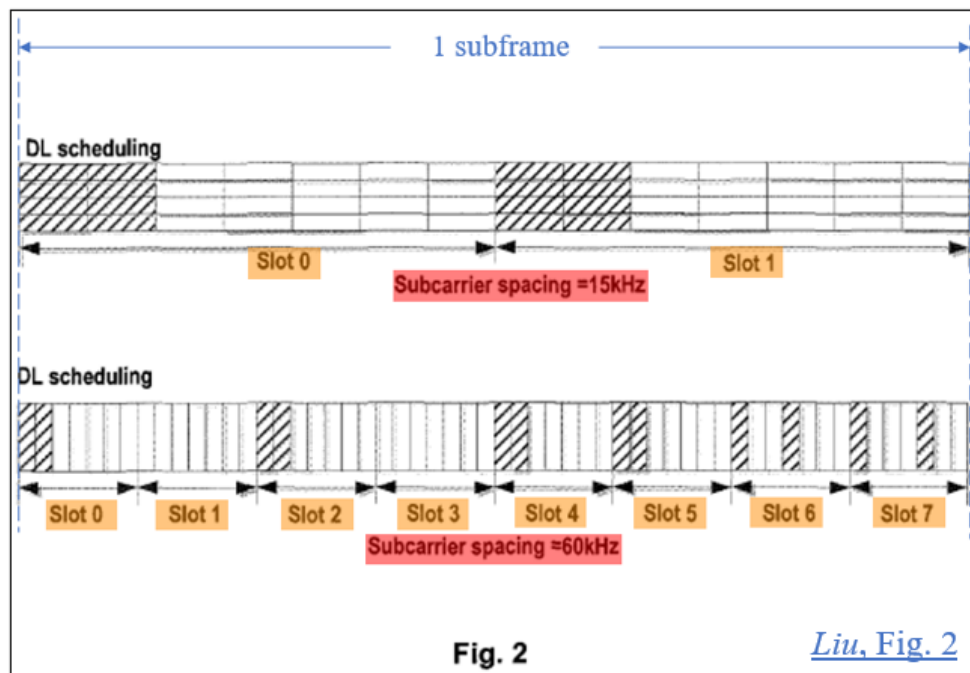
- b. [2b]: “the time length of the **first time window** is predefined;”

You in view of *Liu* teaches this limitation. Bims, ¶202. As discussed for limitation [2a], *You* discloses that the **paging frame** is a **radio frame**. Further, *You* discloses that “a 3GPP LTE/LTE-A **radio frame** is 10ms (307,200T_s) in duration.” *You*, [52]. The *You/Liu* combination does not change this predefined frame

duration because *Liu*'s slot-level transmission/monitoring does not change the subframe duration, let alone the subframe-frame hierarchy. Note 4; Bims, ¶202. Indeed, 5G/NR's flexible numerology does not require the frame duration to be changed because, even before the time of *Liu*, members of the 3GPP working group had contemplated to keep using the same 10ms frame duration in the then-proposed 5G network. *Parkvall*, [1033] ("As an example, a System Frame Number (SFN) length of 16 bits may be used, which would allow a 10 minutes DRX given a radio frame length of 10 ms."). Thus, *You/Liu* teaches that the time length of the **paging frame** is predefined. Bims, ¶202.

c. [2c]: "the **first time window** is divided into **Y time intervals**;"

You in view of *Liu* teaches this limitation. Bims, ¶203. *You* discloses that a **radio frame** is divided into 10 subframes. *You*, [52]. Moreover, as shown below, *Liu* discloses that a subframe is divided into **2 slots** under **15kHz subcarrier spacing**, and **8 slots** under **60kHz subcarrier spacing**. *Liu*, Fig. 2; Bims, ¶203. It follows that *You* in view of *Liu* teaches that a **radio frame** is divided into various numbers of **slots** depending on the **subcarrier spacing** (e.g., **20 slots** under **15kHz subcarrier spacing**, and **80 slots** under **60kHz subcarrier spacing**). Bims, ¶203. Moreover, as discussed in §VI.A.3, it would have been obvious to combine the teachings of *You* and *Liu*. *Id.*



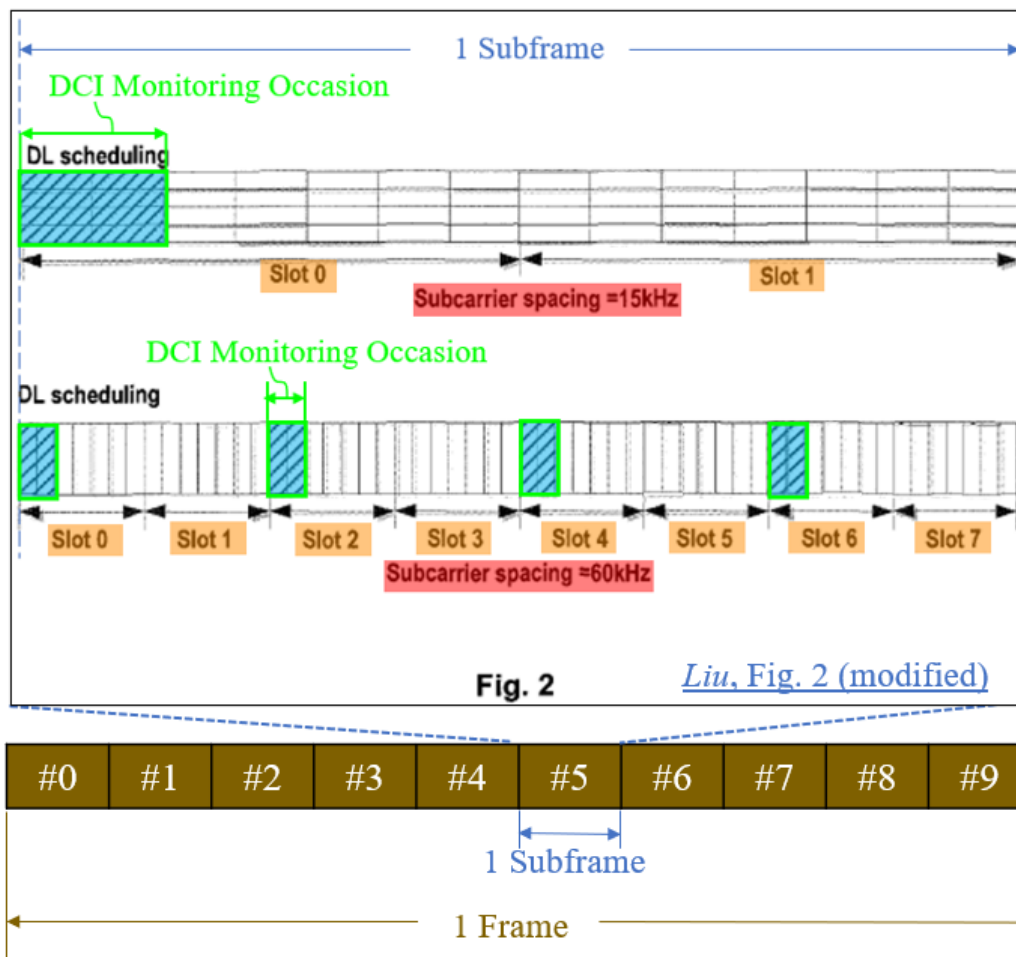
Id.

- d. [2d]: “the **X time intervals** are **X time intervals** of the **Y time intervals**, Y being a positive integer not smaller than X;”

You in view of *Liu* teaches this limitation. Bims, ¶204. As shown in the drawings below, *You/Liu* teaches that each **PDCCH/DCI monitoring occasion** is in a respective **slot**. *Supra*, §VI.A.3.b. Moreover, in *You/Liu*’s slot-level transmission/monitoring, the **PDCCH/DCI monitoring occasions** are repeated per **slot** or per **multi-slots**. *Liu*, [0048]-[0049]. Thus, the number of the **slots** is not

smaller than the number of the PDCCH/DCI monitoring occasions. Bims, ¶204.

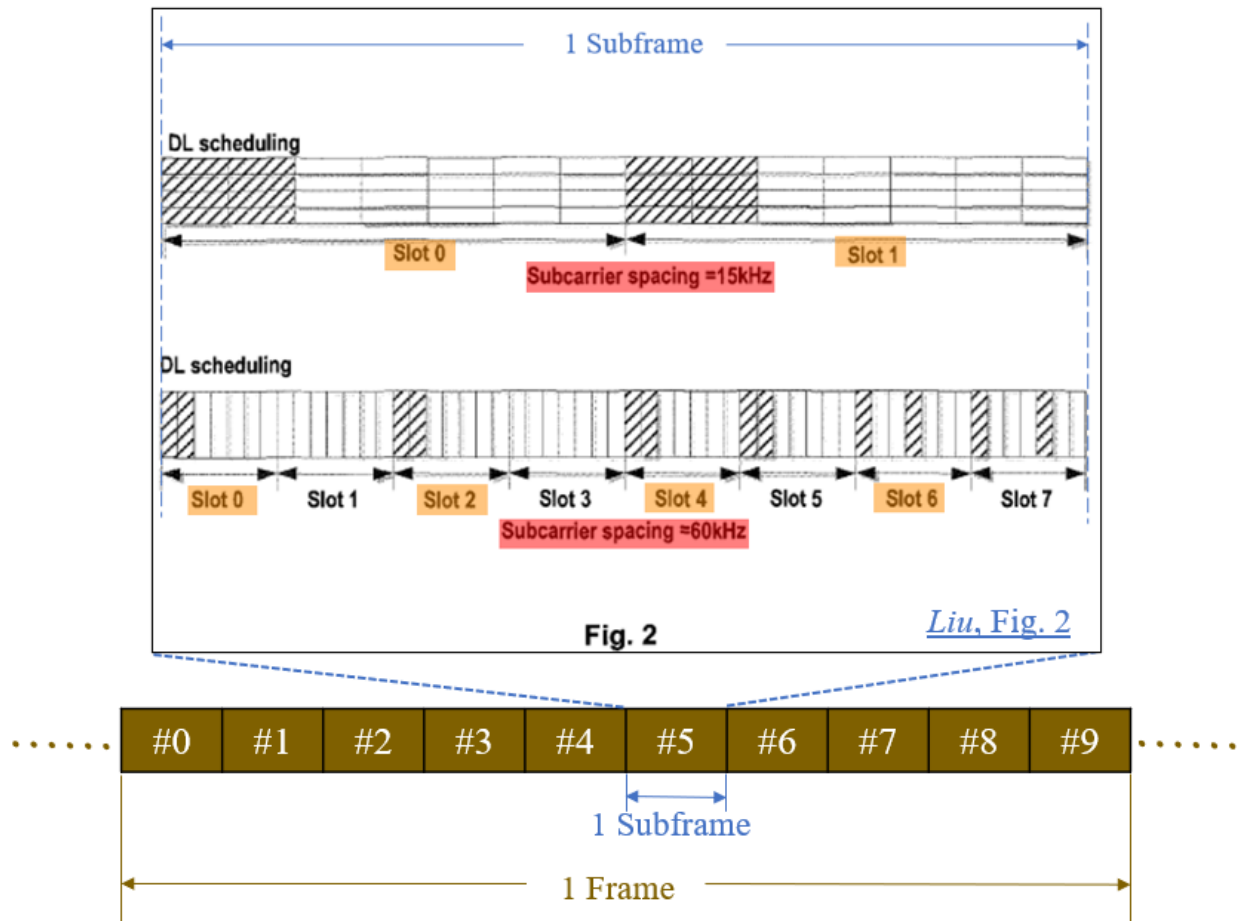
Finally, for the reasons discussed in §VI.A.3, it would have been obvious to combine the teachings of *You* and *Liu* such that the PDCCH/DCI monitoring occasions are located in one or more slots of the paging frame. *Id.*



Id.

- e. [2e]: “the **subcarrier spacing** of subcarriers included in the first subband is used for determining **Y**; and”

For the reasons discussed for limitation [2c], *You* in view of *Liu* teaches that the number (Y) of the slots in a radio frame depends on the **subcarrier spacing**.

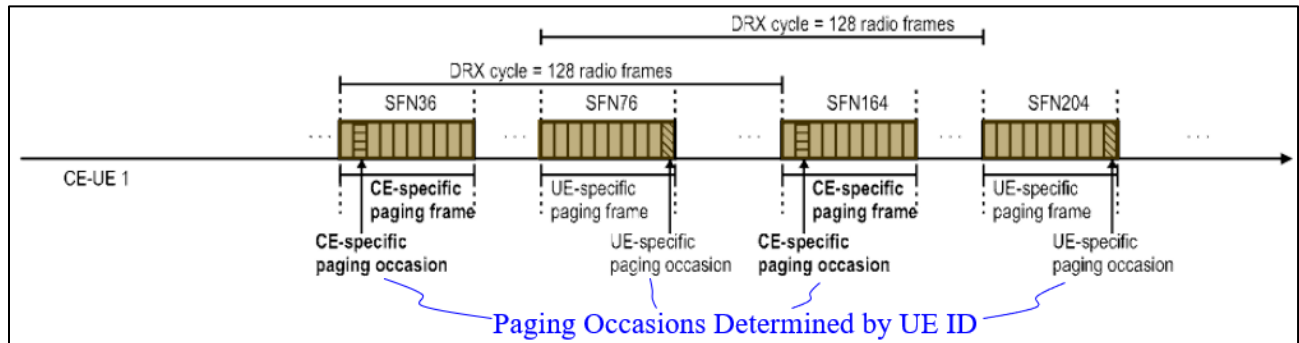


Bims, ¶205.

- f. [2f]: “a **feature ID** of a monitor of the **first signaling** is used for determining the **X time intervals** in the **Y time intervals**.”

You in view of *Liu* and *Mallick* teaches this limitation. Bims, ¶¶206-207. As discussed for limitation [1a], You discloses a UE for “monitoring a **first signaling**,” as claimed. You, [185]-[187], [199]. Moreover, *Mallick* discloses the claimed “**feature ID** of a monitor of the **first signaling**” by disclosing a **UE ID** (e.g., a UE-specific ID associated with a non-CE-UE or CE-UE, or a CE-specific ID

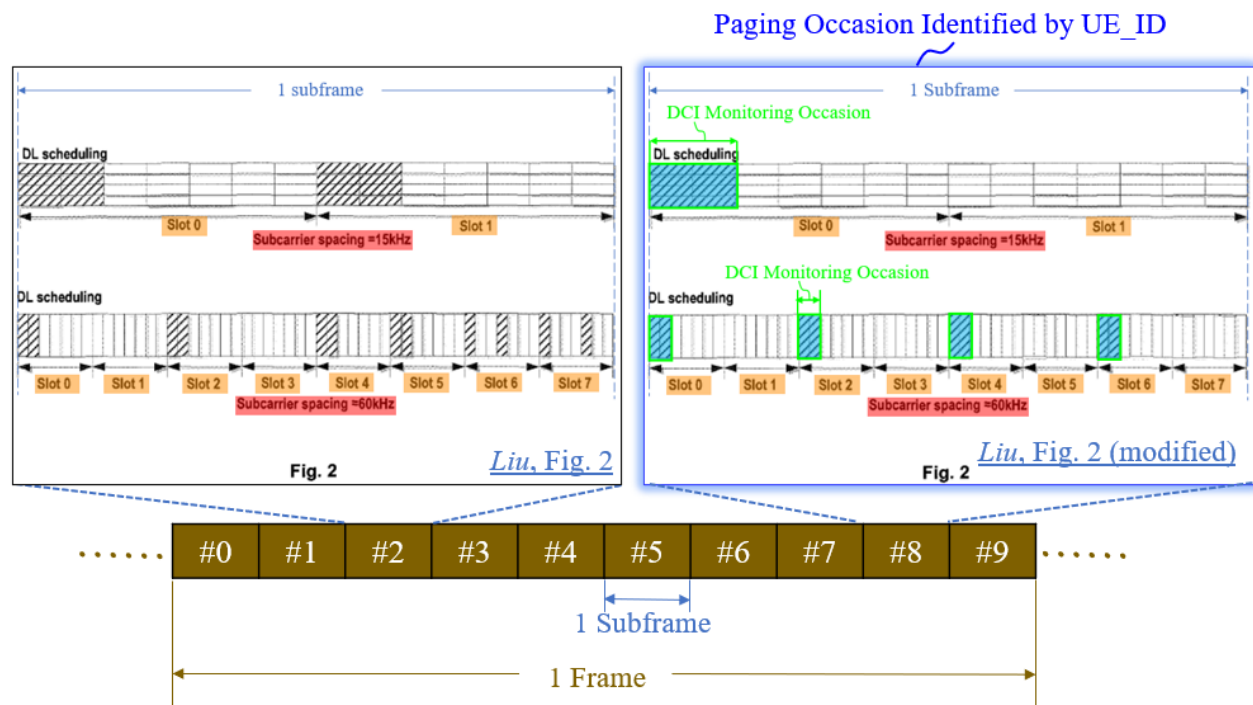
associated with a CE-UE) that is used for determining a paging occasion in a **paging frame**. *Mallick*, [0027], [0170].



Id., Fig. 5 (excerpt).

As discussed for limitation [2c], *You/Liu* teaches that the **paging frame** is divided into **Y slots**; and as discussed for limitation [2a], *You/Liu* teaches that the **M-PDCCH monitoring occasions** belong to the paging occasion. Thus, the location (i.e., subframe number) of the paging occasion in the **paging frame** specifies which one(s) of the **Y slots** contain the **M-PDCCH monitoring occasions**. *Bims*, ¶207. Moreover, as discussed in §VI.B.2, it would have been obvious for a POSA to apply *Mallick*'s teachings to *You/Liu* to determine the location of the paging occasion in the **paging frame** based on the **UE ID**. *Id.*; *Mallick*, [0027] (determining paging occasion index " $i_s = \text{floor}(\text{UE_ID}/N) \bmod N_s$ "). This combination is illustrated below—the **UE ID** is used to determine the paging occasion (i.e., location of the **M-PDCCH monitoring occasions** (e.g., subframe 8))

and thus the **M-PDCCH monitoring occasions** in the **Y slots** of the **paging frame** (containing the **Y slots**, including in other subframes (e.g., subframe 2)).



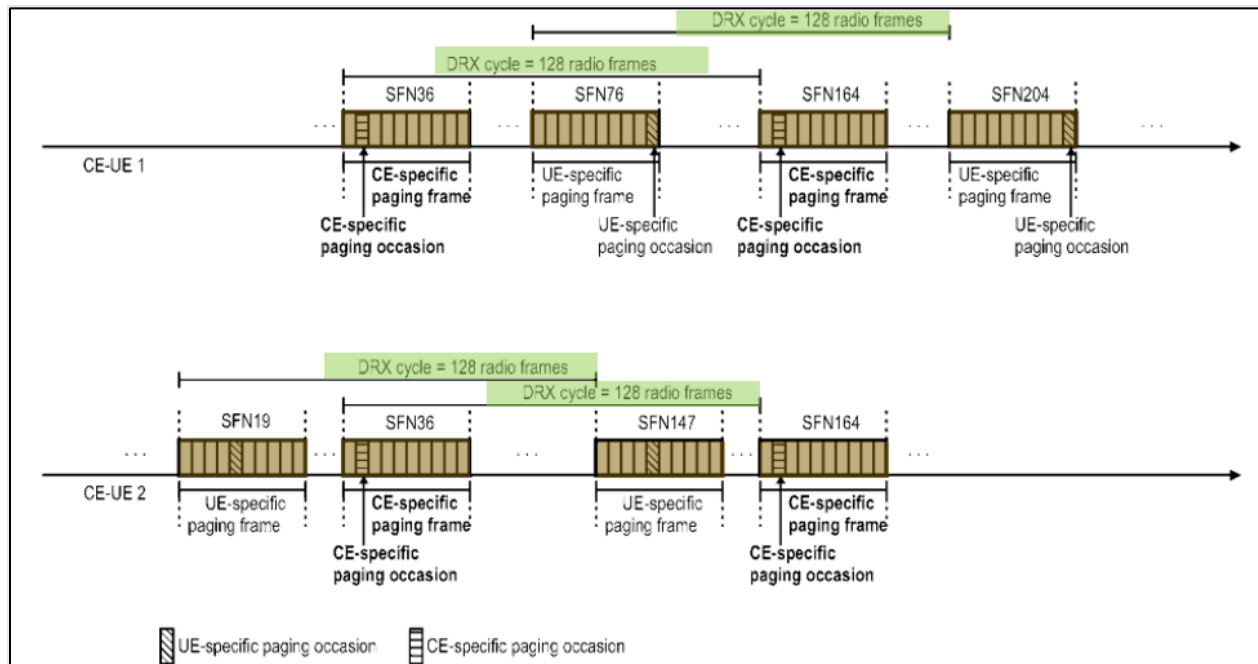
Bims, ¶207.

4. Claim 3

- a. [3a]: “The method according to claim 2, wherein the **first time window** belongs to one of **Z time windows**, Z being an integer greater than 1;”

You in view of *Liu* and *Mallick* teaches claim 2 and this additional limitation. Bims, ¶¶208-211. As discussed for limitation [2a], *You* in view of *Liu* alone or further in view of *Mallick* teaches that the **X time intervals** belong to a **paging frame**. *Mallick* further discloses that the **paging frame** belongs to a **DRX**

cycle, which contains a “default” integer number (e.g., 32, 64, 128 or 256) of radio frames. *Mallick*, [0038]; see also *id.*, [0019] (Table 1), [0022], Fig. 5.



Id., Fig. 5.

Because a radio frame is a time window with a certain duration, *Mallick*'s DRX cycle discloses the claimed “Z time windows,” with each radio frame in the DRX cycle constituting one of the claimed “Z time windows.” Bims, ¶209.

Moreover, *You* and *Mallick* each disclose that the paging frame is a radio frame. *You*, [191]; *Mallick*, [0024], [0134]. It follows that the paging frame is one of the radio frames in the DRX cycle. Bims, ¶210.

Finally, for the reasons discussed in §VI.B.2, it would have been obvious to apply *Mallick*'s teachings to *You/Liu*. Bims, ¶211. Moreover, a POSA would have

appreciated that a default setting is widely applicable, and thus would have had a reasonable expectation of success for using one of *Mallick*'s default paging cycles in *You/Liu. Id.*

b. [3b]: “Z is predefined, or Z is configurable;”

You in view of *Liu* and *Mallick* teaches this limitation. Bims, ¶212. *Mallick* discloses that the “[p]aging DRX cycle[] is the Discontinuous Reception (DRX) cycle configured in the UE (using NAS signalling) or the default DRX cycle broadcast in the System Information Block (SIB).” *Mallick*, [0038]; *see also id.*, [0017]. Thus, the DRX cycle can be a default (i.e., predefined) cycle for a cell and broadcast by an SIB message, or the DRX cycle can be a configurable cycle that is UE-specific and configured by upper-layer signaling (e.g., NAS). Bims, ¶212. Finally, for the reasons discussed in §VI.B.2, it would have been obvious to apply *Mallick*'s teachings to *You/Liu. Id.*

c. [3c]: “any two of the Z time windows have an equal time length; and”

You discloses this limitation by disclosing that each radio frame in the DRX cycle has a fixed duration of 10 ms. *You*, [52]; Bims, ¶213. For the reasons discussed in §§VI.B.2 and VI.B.3.b, *Liu*'s solution for 5G/NR does not change the existing frame durations in the DRX cycle.

- d. [3d]: “the **feature ID** of the monitor of the **first signaling** is used for determining the **first time window** in the **Z time windows**.”

You in view of *Liu* and *Mallick* teaches this limitation. Bims, ¶214. As discussed for limitation [2f], *Mallick* discloses the claimed “**feature ID**” by disclosing a **UE ID** that is used for determining a paging occasion in a **paging frame**. *Mallick* further discloses that the same **UE ID** can be used to determine the **paging frame** itself. Compare *Mallick*, [0025], with ’767 patent, 5:15-19 (using substantially the same formula to determine “the **paging frame number (SFN)**” based on the “**UE_ID**”); *Mallick*, [0170]. Moreover, as discussed in §VI.B.2, it would have been obvious to apply *Mallick*’s teachings to *You/Liu*. Bims, ¶214.

5. Claims 7 and 8

Aside from their dependency on claim 6, claims 7 and 8 are substantially similar to claims 2 and 3, respectively, and thus are taught by *You* in view of *Liu* and *Mallick* for the reasons discussed for claims 6, 2, and 3. Bims, ¶¶215-216.

6. Claims 12 and 13

Aside from their dependency on claim 11, claims 12 and 13 are substantially similar to claims 2 and 3, respectively, and thus are taught by *You* in view of *Liu* and *Mallick* for the reasons discussed for claims 11, 2, and 3. Bims, ¶¶217-218.

7. Claims 17 and 18

Aside from their dependency on claim 16, claims 17 and 18 are substantially similar to claims 2 and 3, respectively, and thus are taught by *You* in view of *Liu* and *Mallick* for the reasons discussed for claims 16, 2, and 3. Bims, ¶¶219-220.

VII. DISCRETIONARY DENIAL IS NOT WARRANTED

A. Denial of Institution Is Not Warranted Under *Fintiv*

Fintiv and the Office’s interim guidelines dated June 21, 2022 (“Interim Procedures”) require institution. Factor 6 requires institution because Petitioner presents a compelling unpatentability challenge; Factors 3 and 4 favor institution; and Factors 1, 2, and 5 are, at worst, neutral.

Factor 3 favors institution because Petitioner acted diligently and almost no parallel investment has occurred. Patent Owner served infringement contentions only last month. Ex. 1033. Fact discovery opened only this month, and will not close until February 2024, with expert discovery closing March 2024. Ex. 1032, 3. The parties will not begin claim construction until August 2023 and the hearing will not take place until December 2023. *Id.*

Factor 4 favors institution because this Petition challenges claims 6-10 and 16-20, which are not involved in the litigation. Moreover, Petitioner has not served invalidity contentions, so no overlap currently exists. Petitioner reserves the right to submit a stipulation after serving invalidity contentions.

Regarding Factors 1, 2, and 5, Patent Owner filed its Complaint against Petitioner on June 1, 2022. Ex. 1029. No stay has been requested, trial is currently scheduled for June 24, 2024, and the median time-to-trial in the Eastern District of Texas is 24.5 months, so trial is projected to occur, at the earliest, in June or July 2024. Ex. 1032, 1; Ex. 1031, 35. An FWD is anticipated in August 2024, about one month after trial ends. In these circumstances, Factors 1, 2, and 5 are at worst neutral. *Protect Animals with Satellites v. OnPoint Sys.*, IPR2021-01483, Paper 11 at 12-13, 17 (Mar. 4, 2022). Indeed, the Board has instituted with far more time between trial and FWD. *See NetNut v. Bright Data*, IPR2021-01492, Paper 12 at 9-16 (Mar. 21, 2022) (instituting IPR without stipulation and copending trial date six months before FWD); *Protect Animals*, IPR2021-01483, Paper 11 at 18-19 (same with trial date one month before FWD); Interim Procedures, 8.

Denial of institution is not warranted under *Fintiv*.

B. Denial of Institution Is Not Warranted Under 35 U.S.C. §325(d)

No other proceedings involving the '767 patent are currently pending or have been brought before the Patent Office. Additionally, none of the asserted prior art references (*You*, *Liu*, and *Mallick*) were before the Examiner during prosecution. Thus, the same or substantially the same prior art or arguments have not been previously presented to the Patent Office and denial of institution is not warranted under §325(d).

VIII. MANDATORY NOTICES

A. Real Party-in-Interest

The real parties-in-interest are Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc.

B. Related Matters

Apex asserted the '767 patent in the following litigations: *Apex Beam Technologies LLC v. Samsung Electronics Co., Ltd. et al.*, Case No. 2:22-cv-00188-JRG (E.D. Tex.); *Apex Beam Technologies LLC v. ZTE Corporation*, Case No. 2:22-cv-00031-JRG-RSP (E.D. Tex.); *Apex Beam Technologies LLC v. OnePlus Technology (Shenzhen) Co., Ltd.*, Case No. 2:22-cv-00032-JRG (E.D. Tex.); and *Apex Beam Technologies LLC v. TCT Mobile International Limited et al.*, Case No. 2:21-cv-00438-JRG (E.D. Tex.).

The '767 patent is related to U.S. Patent Nos. 10,966,178 and 11,457,426, and pending U.S. Patent Application No. 17/950,726.

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Please address all correspondence to counsel at the address above. Petitioner consents to electronic service by email at the above email addresses.

IX. GROUNDS FOR STANDING

Petitioner certifies that the '767 patent is available for IPR and that Petitioner is not barred or estopped from requesting IPR challenging the patent claims on the grounds identified herein.

X. CONCLUSION

For the reasons above, Petitioner requests institution of IPR and cancellation of each challenged claim. The Office may charge any required fees to Deposit Account No. 06-0916.

Dated: February 28, 2023

By: /Joshua L. Goldberg/
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CLAIMS APPENDIX

1. **[1pre]** A method in a User Equipment (UE) for paging, comprising:
 - [1a]** monitoring a first signaling in X time intervals; and
 - [1b]** receiving a first radio signal;
 - [1c]** wherein X is a positive integer;
 - [1d]** the first signaling is used for determining scheduling information for the first radio signal;
 - [1e]** the scheduling information comprises at least one of {occupied time-frequency resource, adopted Modulation Coding Scheme (MCS), subcarrier spacing of subcarriers in occupied frequency domain resource};
 - [1f]** the first radio signal carries a paging message;
 - [1g]** the frequency domain resource used for transmitting the first signaling belongs to a first subband;
 - [1h]** the first subband comprises a positive integer number of consecutive subcarriers in frequency domain; and
 - [1i]** at least one of {location of the first subband in frequency domain, subcarrier spacing of subcarriers included in the first subband} is used for determining the X time intervals.

2. **[2a]** The method according to claim 1, wherein
any one of the X time intervals belongs to a first time window in time
domain;
[2b] the time length of the first time window is predefined;
[2c] the first time window is divided into Y time intervals;
[2d] the X time intervals are X time intervals of the Y time intervals, Y
being a positive integer not smaller than X;
[2e] the subcarrier spacing of subcarriers included in the first subband is
used for determining Y; and
[2f] a feature ID of a monitor of the first signaling is used for determining
the X time intervals in the Y time intervals.
3. **[3a]** The method according to claim 2, wherein
the first time window belongs to one of Z time windows, Z being an integer
greater than 1;
[3b] Z is predefined, or Z is configurable;
[3c] any two of the Z time windows have an equal time length; and
[3d] the feature ID of the monitor of the first signaling is used for
determining the first time window in the Z time windows.

4. **[4a]** The method according to claim 1, further comprising:
receiving a second radio signal;
[4b] wherein the second radio signal is used for determining at least one of
{location of the first subband in frequency domain, subcarrier spacing
of subcarriers included in the first subband}.
5. **[5a]** The method according to claim 1, further comprising:
receiving a second signaling;
[5b] wherein the second signaling is used for determining Q subbands, Q
being a positive integer;
[5c] the first subband belongs to one of the Q subbands;
[5d] any one of the Q subbands comprises a positive integer number of
consecutive subcarriers; and
[5e] the feature ID of the monitor of the first signaling is used for
determining the first subband in the Q subbands.
6. **[6pre]** A method in a base station for paging, comprising:
[6a] transmitting a first signaling in a positive integer number of time
intervals of X time intervals; and
[6b] transmitting a first radio signal;

- [6c] wherein X is a positive integer;
- [6d] the first signaling is used for determining scheduling information for the first radio signal;
- [6e] the scheduling information comprises at least one of {occupied time-frequency resource, adopted MCS, subcarrier spacing of subcarriers in occupied frequency domain resource};
- [6f] the first radio signal carries a paging message;
- [6g] the frequency domain resource used for transmitting the first signaling belongs to a first subband;
- [6h] the first subband comprises a positive integer number of consecutive subcarriers in frequency domain; and
- [6i] at least one of {location of the first subband in frequency domain, subcarrier spacing of subcarriers included in the first subband} is used for determining the X time intervals.

- 7. [7a] The method according to claim 6, wherein any one of the X time intervals belongs to a first time window in time domain;
- [7b] the time length of the first time window is predefined;
- [7c] the first time window is divided into Y time intervals;

[7d] the X time intervals are X time intervals of the Y time intervals, Y

being a positive integer not smaller than X;

[7e] the subcarrier spacing of subcarriers included in the first subband is

used for determining Y; and

[7f] a feature ID of a monitor of the first signaling is used for determining

the X time intervals in the Y time intervals.

8. **[8a]** The method according to claim 7, wherein

the first time window belongs to one of Z time windows, Z being an integer

greater than 1;

[8b] Z is predefined, or Z is configurable;

[8c] any two of the Z time windows have an equal time length; and

[8d] the feature ID of the monitor of the first signaling is used for

determining the first time window in the Z time windows.

9. **[9a]** The method according to claim 6, further comprising:

transmitting a second radio signal;

[9b] wherein the second radio signal is used for determining at least one of

{location of the first subband in frequency domain, subcarrier spacing
of subcarriers included in the first subband}.

10. [10a] The method according to claim 6, further comprising:
transmitting a second signaling;
[10b] wherein the second signaling is used for determining Q subbands, Q
being a positive integer;
[10c] the first subband belongs to one of the Q subbands;
[10d] any one of the Q subbands comprises a positive integer number of
consecutive subcarriers; and
[10e] the feature ID of the monitor of the first signaling is used for
determining the first subband in the Q subbands.
11. [11pre] A UE for paging, comprising:
[11a] a first receiver module, to monitor a first signaling in X time intervals;
and
[11b] a second receiver module, to receive a first radio signal;
[11c] wherein X is a positive integer;
[11d] the first signaling is used for determining scheduling information for
the first radio signal;

- [11e] the scheduling information comprises at least one of {occupied time-frequency resource, adopted MCS, subcarrier spacing of subcarriers in occupied frequency domain resource};
- [11f] the first radio signal carries a paging message;
- [11g] the frequency domain resource used for transmitting the first signaling belongs to a first subband;
- [11h] the first subband comprises a positive integer number of consecutive subcarriers in frequency domain; and
- [11i] at least one of {location of the first subband in frequency domain, subcarrier spacing of subcarriers included in the first subband} is used for determining the X time intervals.

12. [12a] The UE according to claim 11, wherein
any one of the X time intervals belongs to a first time window in time domain;
- [12b] the time length of the first time window is predefined;
 - [12c] the first time window is divided into Y time intervals;
 - [12d] the X time intervals are X time intervals of the Y time intervals, Y being a positive integer not smaller than X;

[12e] the subcarrier spacing of subcarriers included in the first subband is used for determining Y; and

[12f] a feature ID of a monitor of the first signaling is used for determining the X time intervals in the Y time intervals.

13. [13a] The UE according to claim 12, wherein the first time window belongs to one of Z time windows, Z being an integer greater than 1;

[13b] Z is predefined, or Z is configurable;

[13c] any two of the Z time windows have an equal time length; and

[13d] the feature ID of the monitor of the first signaling is used for determining the first time window in the Z time windows.

14. [14a] The UE according to claim 11, wherein the first receiver module further receives a second radio signal;

[14b] the second radio signal is for determining at least one of {location of the first subband in frequency domain, subcarrier spacing of subcarriers included in the first subband}.

15. [15a] The UE according to claim 11, wherein

the first receiver module further receives a second signaling;

[15b] the second signaling is for determining Q subbands, Q being a positive integer;

[15c] the first subband belongs to one of the Q subbands;

[15d] any one of the Q subbands comprises a positive integer number of consecutive subcarriers; and

[15e] the feature ID of the monitor of the first signaling is used for determining the first subband in the Q subbands.

16. [16pre] A base station for paging, comprising:

[16a] a first transmitter module, to transmit a first signaling in a positive integer number of time intervals of X time intervals; and

[16b] a second transmitter module, to transmit a first radio signal;

[16c] wherein X is a positive integer;

[16d] the first signaling is used for determining scheduling information for the first radio signal;

[16e] the scheduling information comprises at least one of {occupied time-frequency resource, adopted MCS, subcarrier spacing of subcarriers in occupied frequency domain resource};

[16f] the first radio signal carries a paging message;

- [16g] the frequency domain resource used for transmitting the first signaling belongs to a first subband;
- [16h] the first subband comprises a positive integer number of consecutive subcarriers in frequency domain; and
- [16i] at least one of {location of the first subband in frequency domain, subcarrier spacing of subcarriers included in the first subband} is used for determining the X time intervals.
17. [17a] The base station according to claim 16, wherein any one of the X time intervals belongs to a first time window in time domain;
- [17b] the time length of the first time window is predefined;
- [17c] the first time window is divided into Y time intervals;
- [17d] the X time intervals are X time intervals of the Y time intervals, Y being a positive integer not smaller than X;
- [17e] the subcarrier spacing of subcarriers included in the first subband is used for determining Y; and
- [17f] a feature ID of a monitor of the first signaling is used for determining the X time intervals in the Y time intervals.

18. **[18a]** The base station according to claim 17, wherein
the first time window belongs to one of Z time windows, Z being an integer
greater than 1;
[18b] Z is predefined, or Z is configurable;
[18c] any two of the Z time windows have an equal time length; and
[18d] the feature ID of the monitor of the first signaling is used for
determining the first time window in the Z time windows.
19. **[19a]** The base station according to claim 16, wherein
the first transmitter module further transmits a second radio signal;
[19b] the second radio signal is for determining at least one of {location of
the first subband in frequency domain, subcarrier spacing of
subcarriers included in the first subband}.
20. **[20a]** The base station according to claim 16, wherein
the first transmitter module further transmits a second signaling;
[20b] the second signaling is for determining Q subbands, Q being a positive
integer;
[20c] the first subband belongs to one of the Q subbands;

[20d] any one of the Q subbands comprises a positive integer number of consecutive subcarriers; and

[20e] the feature ID of the monitor of the first signaling is used for determining the first subband in the Q subbands.

CERTIFICATION OF WORD COUNT

Pursuant to 37 C.F.R. §42.24, Petitioner certifies that the word count of Petitioner's Petition for *Inter Partes* Review (exclusive of any table of contents, table of authorities, mandatory notices under §42.8, certificates of service and word count, and list of exhibits or claim listing) as measured by Microsoft Word is 13,988.

Dated: February 28, 2023

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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. §§42.6(e) and 42.105(a), the undersigned certifies that on February 28, 2023, a copy of the foregoing Petition for *Inter Partes* Review, the associated powers of attorney, and Exhibits 1001-1002, 1004-1037 were served by FedEx Priority Overnight on the correspondence address of record indicated in the Patent Office's public Patent Center system for U.S. Patent No. 10,462,767:

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