

Petitioner's Demonstratives

Samsung Electronics Co., Ltd., and Samsung
Electronics America, Inc.,

Petitioner

v.

Apex Beam Technologies LLC,

Patent Owner

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

Samsung Exhibit 1042

Samsung v. Apex - IPR2023-00598

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Topics

- Instituted grounds
- High-level explanation of technology
- Established *prima facie* case of obviousness
- Disputed issues

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Instituted Grounds

- All claims of the '767 patent are challenged:
 - Claims 1-5: user equipment method
 - Claims 6-10: base station method
 - Claims 11-15: user equipment device
 - Claims 16-20: base station device

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1, 4–6, 9–11, 14–16, 19, 20	103 ¹	You, Liu
2, 3, 7, 8, 12, 13, 17, 18	103	You, Liu, Mallick

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State of the Art — Paging Process

In existing LTE systems, transmission opportunities of paging are defined through a Paging Frame (PF) and a Paging Occasion (PO) uniformly. The PF is a radio frame which is likely to transmit a paging message, and the PO is used for determining a subframe which is likely to transmit a paging message in the PF. The radio frame in LTE has a

(’767 patent, 1:45-50.)

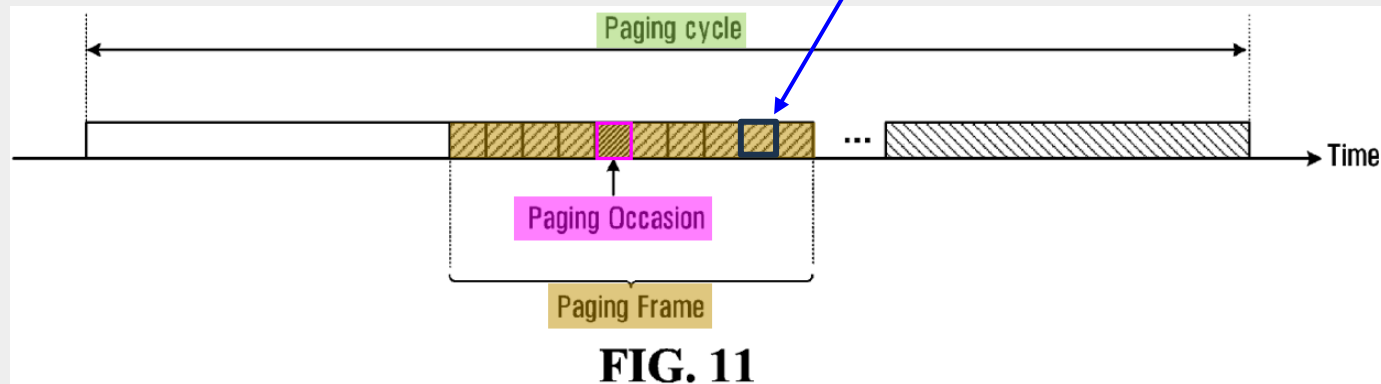


FIG. 11

(Weng (Ex. 1013), Fig. 11.)

State of the Art — 4G/LTE: Fixed Frame Structure

a paging message in the PF. The radio frame in LTE has a fixed time length of 10 milliseconds, and the subframe has a fixed time length of 1 millisecond. Since an LTE network generally employs a single numerology or the numerology basically does not change in a long time in the network, the definition of the possible time of paging using the PF and PO having a fixed time length can simplify the design of system, under the premise of guaranteeing the paging capacity and not increasing the power consumption of UE. Under the 5G ('767 patent, 1:50-58.)

[0178] Each frame is 10 ms long.

[0179] Within each frame, there are 10 equal-length subframes with two slots in each subframe.

[0180] Within each slot, there are 7 OFDM symbols with the normal CP case or 6 OFDM symbols with the extended CP case.

(Weng (Ex. 1013), [0178]-[0180]; Bims Decl. (Ex. 1002), ¶46.)

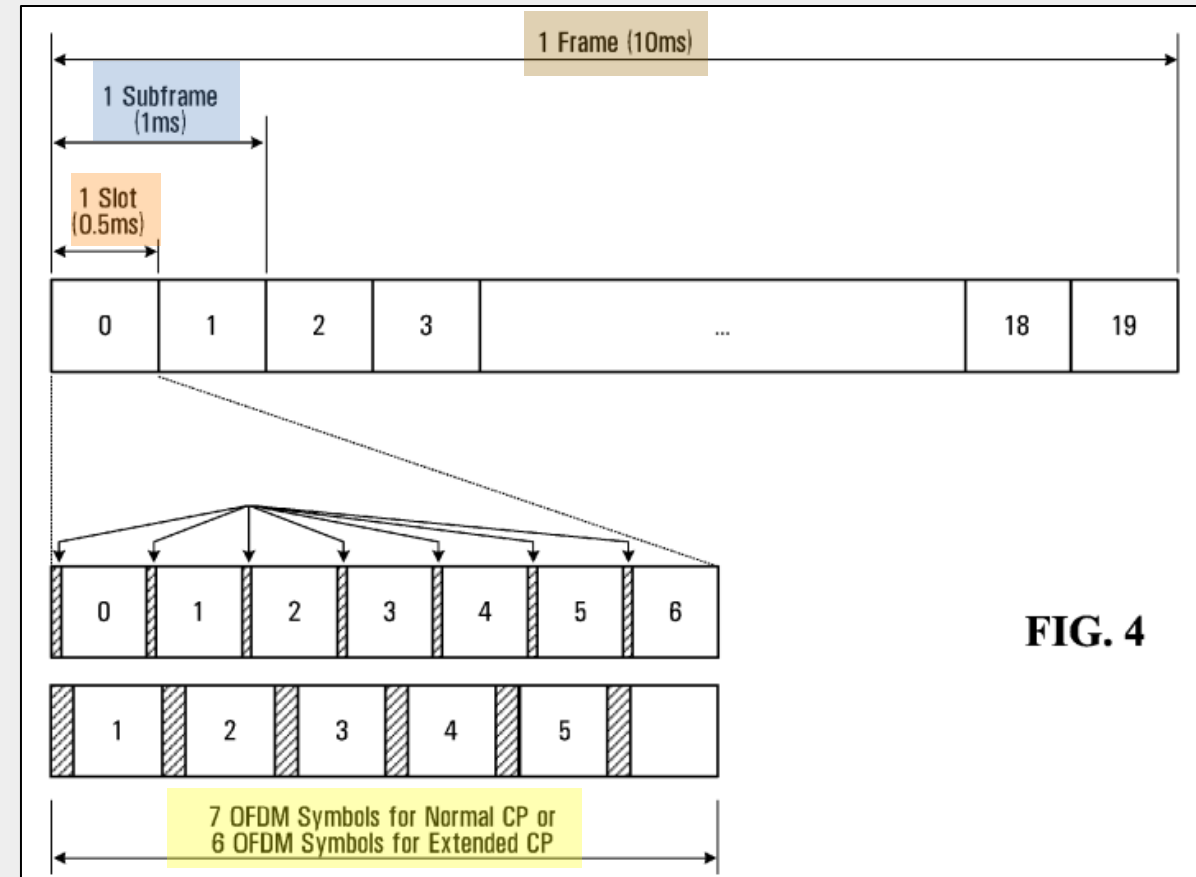


FIG. 4

(Weng (Ex. 1013), Fig. 4.)

State of the Art — 5G/NR: Multiple Numerologies & Flexible Frame Structure

[0045] In NR system, different numerologies might be used, whereas different numerologies might use different transmission parameters, for example different subcarrier spacings. The different subcarrier spacings mean different symbol lengths. For example, for 15 kHz subcarrier spacing, its symbol will have a time length four times as that for 60 kHz subcarrier spacing, as illustrated in Fig. 2. Thus, the numerology to be used can be used to define a symbol.

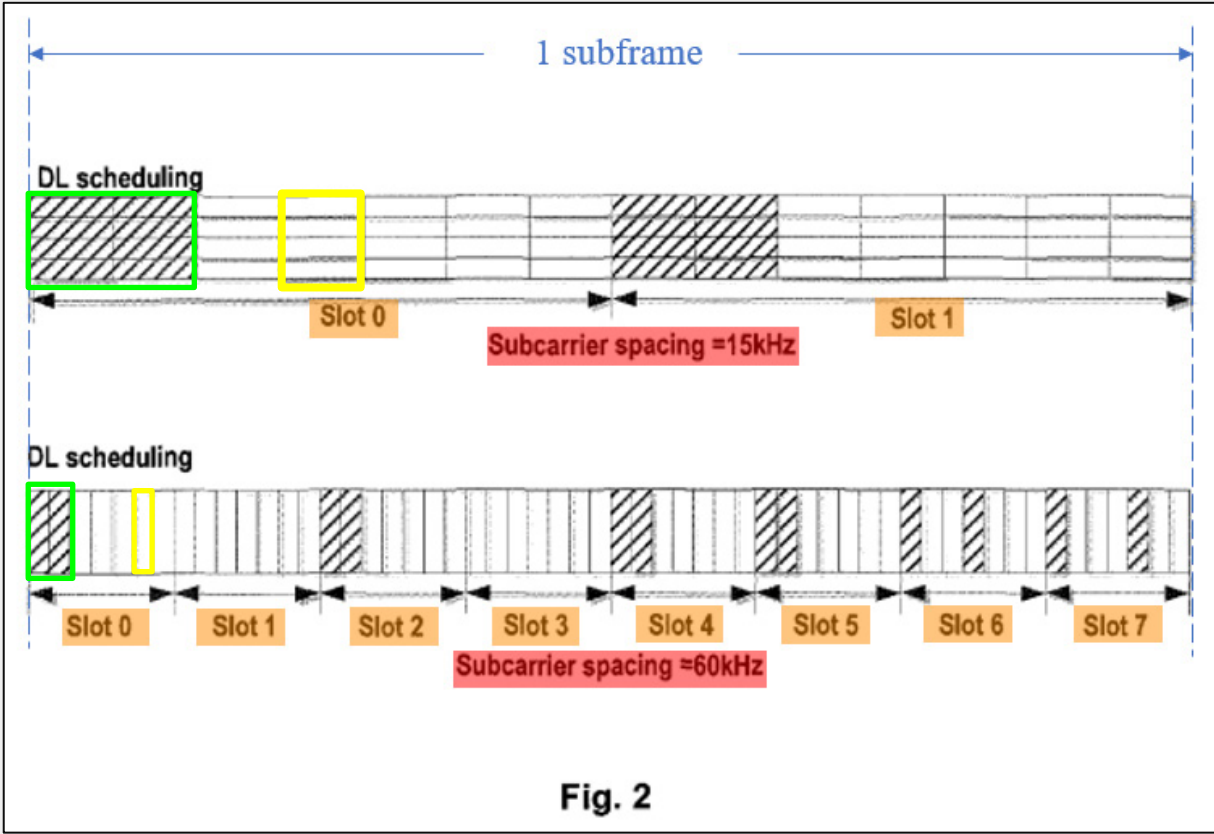
(Liu, [0045].)

[0003] Especially, in the NR network, different numerologies will coexist in the same carrier and a mini-slot will be introduced to carry Ultra-reliable low latency communication (URLLC) traffic. As a result, DCI monitoring may be performed per symbol based on the specific numerology. Thus, a terminal device like user equipment (UE) needs to know when to monitor the DCI for scheduling related operations.

(Liu, [0003].)

In order to be applied to various different application scenarios flexibly, future wireless communication systems, especially 5G NR, will support various numerologies. The various numerologies refer to various subcarrier spacings, various symbol time lengths, various Cyclic Prefix (CP) lengths, etc. In order to simplify the design of systems and

(’767 patent, 1:32-37.)



(Liu, Fig. 2.)

Exemplary '767 Claim: Monitor Paging Scheduling Information

1. A method in a User Equipment (UE) for paging, comprising:

monitoring a first signaling in X time intervals; and

receiving a first radio signal;

wherein X is a positive integer; the first signaling is used for determining scheduling information for the first radio signal;

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};

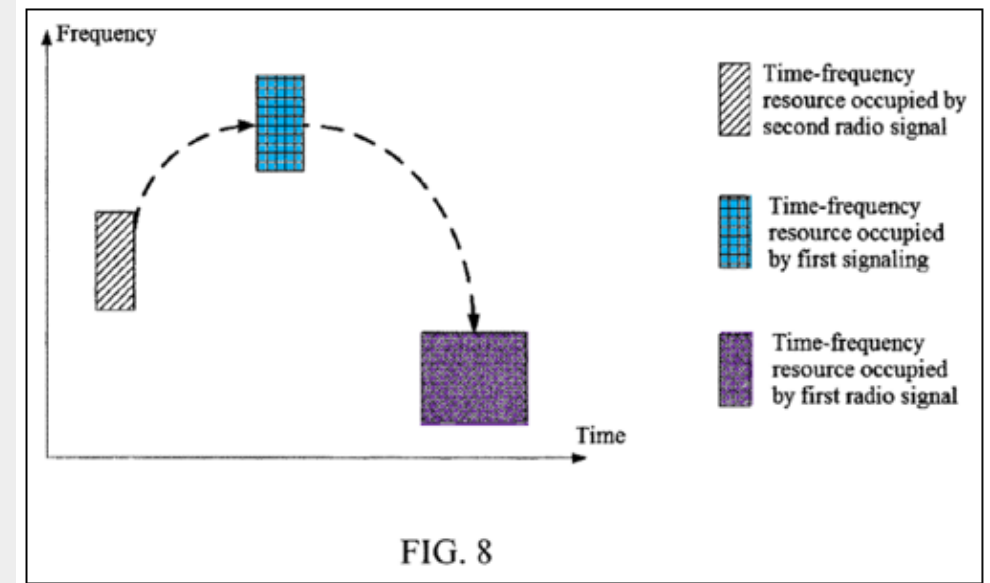
the first radio signal carries a paging message;

the frequency domain resource used for transmitting the first signaling belongs to a first subband;

the first subband comprises a positive integer number of consecutive subcarriers in frequency domain; and

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.

('767 patent, 23:2-20.)



In embodiment 8, the first signaling is used for determining scheduling information for the first radio signal. The scheduling information includes at least one of {occupied time-frequency resource, adopted MCS, subcarrier spacing of subcarriers in occupied frequency domain resource}. The

('767 patent, 19:63-67, Fig. 8.)

Exemplary '767 Claim: Determine Monitoring Occasions

1. A method in a User Equipment (UE) for paging, comprising:
monitoring a first signaling in **X time intervals**; and
receiving a first radio signal;

wherein **X** is a positive integer; the first signaling is used for
determining scheduling information for the first radio
signal;

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};

the first radio signal carries a paging message;

the frequency domain resource used for transmitting the first
signaling belongs to a first subband;

the first subband comprises a positive integer number of
consecutive subcarriers in frequency domain; and

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**.

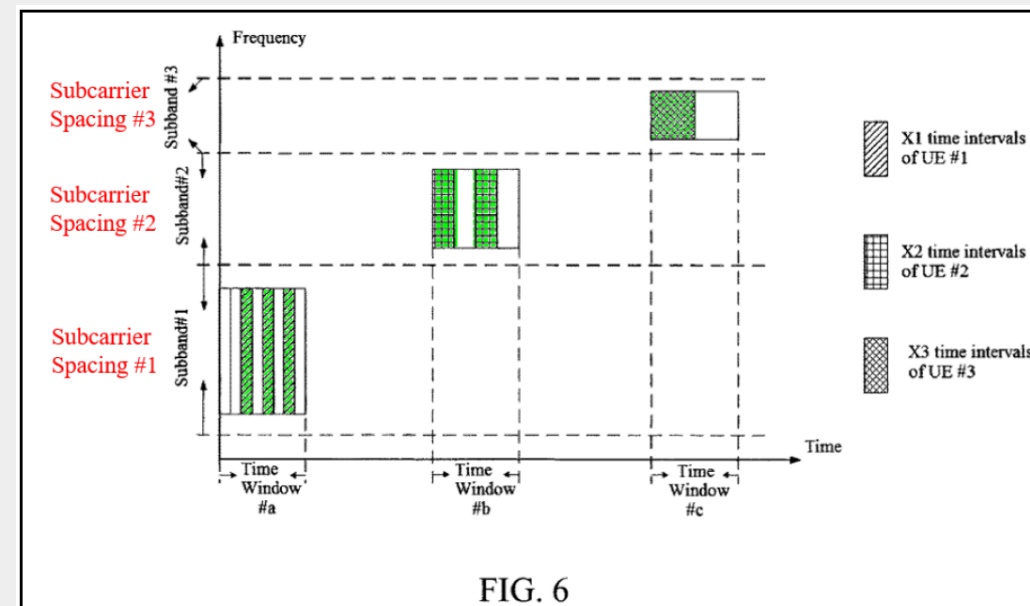
('767 patent, 23:2-20.)

especially 5G NR, will support various numerologies. The
various numerologies refer to various subcarrier spacings,
various symbol time lengths, various Cyclic Prefix (CP)
lengths, etc. In order to simplify the design of systems and

('767 patent, 1:34-37.)

In order to solve the above design problem of paging
when multiple numerologies are employed in the 5G NR, the
present disclosure provides a solution, which determines the
transmission opportunities of paging according to the
numerology employed by the paging, thereby guaranteeing

('767 patent, 2:1-5.)



('767 patent, Fig. 6.)

Topics

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You Discloses 4G/LTE Paging Ready for Improvement

[196] Under the assumption that a **paging occasion** is a time region for **M-PDCCH** monitoring for paging message scheduling, a UE can monitor a common search space (CSS) within a **paging occasion** to check **paging message** transmission. Depending on duration of **paging occasion** and period of CSS starting subframe, there can be **multiple CSS monitoring opportunities** within a **paging occasion** as shown in FIG. 8. The period and offset of CSS starting subframe location can be configured by eNB. In this case, offset k_{offset} of the CSS starting subframe may mean a difference from a reference subframe n (e.g., subframe 0) to a subframe $n+k_{\text{offset}}$ in which the CSS starting subframe is first applied.

(*You*, [196].)

101. In my opinion, *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. '767 patent, Abstract, 1:15-89, 3:7-14. In particular, *You* discloses methods of configuring "**M-PDCCH CSS for paging scheduling**," each CSS being "**within an interval where a UE monitors [the] M-PDCCH.**" *You*, [185], [188]-[189]. This is just like the '767 patent's disclosure about monitoring the "**first signaling**" (i.e., paging scheduling information) in "**X time intervals.**" '767 patent, Abstract, 2:20-32.

(Bims Decl. (Ex. 1002), ¶101.)



(*You*, Fig. 8.)

5G/NR Was Still Being Developed

7 Q When was 5G developed?
8 A It's been evolving since around
9 2015, I believe, and I think some of the
10 documents were released around 2018.
11 Q When you say "released," does that
12 mean that they were, you know, finalized at
13 that point?
14 A They were published -- there were
15 documents that were published at that point
16 in terms of finalized. That's a -- that's a
17 fairly precise term, and so I'd have to go
18 back and look at that.
19 Q Do you recall when the technical
20 specifications for 5G were finalized?
21 A Not off the top of my head. I
22 wasn't asked to opine on that.
23 Q Were they finalized before or after
24 the priority date of the '767 patent?
25 MR. PYMENTO: Objection.
1 A As far as I can tell, they were
2 published -- many of the documents were
3 published after the priority date of the
4 '767, but again, I'd have to go back and look
5 at that to be sure to answer that correctly.

(Gomez Tr. (Ex.1041), 19:7-20:5.)

This disclosure claims the priority benefit of Chinese Patent Application 201710255811.X, filed on Apr. 19, 2017, all of which is incorporated herein by reference.

('767 patent, 1:7-9.)

Related Art

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In order to be applied to various different application scenarios flexibly, future wireless communication systems, especially 5G NR, will support various numerologies. The

('767 patent, 1:20, 1:32-34.)

[0003] Especially, in the NR network, different numerologies will coexist in the same carrier and a mini-slot will be introduced to carry Ultra-reliable low latency communication (URLLC) traffic. As a result, DCI monitoring may be performed per symbol based on the specific numerology. Thus, a terminal device like user equipment (UE) needs to know when to monitor the DCI for scheduling related operations.

(Liu, [0003].)

Liu Addresses the Same 5G/NR Challenge as the '767 Patent

102. In my opinion, *Liu* attempts to solve the same problem as the '767 patent. (Bims Decl. (Ex. 1002), ¶102.)

'767 Patent

not increasing the power consumption of UE. Under the 5G NR, a network supports different numerologies, thus, a given time length, for example, 1 millisecond, probably includes multiple basic scheduling units (for example, slot). If the legacy design of the current paging opportunity is employed, the UE would detect the paging message different times for different numerologies within the 1 millisecond. Therefore, ('767 patent, 1:58-64.)

Liu

[0003] Especially, in the NR network, different numerologies will coexist in the same carrier and a mini-slot will be introduced to carry Ultra-reliable low latency communication (URLLC) traffic. As a result, DCI monitoring may be performed per (*Liu*, [0003].)

[0005] However, with the current DCI monitoring solution in LTE, it cannot support the DCI monitoring occasion change due to numerology and scheduling unit size. (*Liu*, [0005].)

Liu Provides the Same Solution as the '767 Patent

103. And, in my opinion, *Liu* provides the same solution as the '767 patent.

(Bims Decl. (Ex. 1002), ¶103.)

'767 Patent

In order to solve the above design problem of paging when multiple numerologies are employed in the 5G NR, the present disclosure provides a solution, which determines the transmission opportunities of paging according to the numerology employed by the paging, thereby guaranteeing that the UE has a small difference in the complexity and power consumption of monitoring the paging message under different numerologies and that the paging capacity basically remains the same. It should be noted the embodiments of the

('767 patent, 2:1-9.)

Liu

[0040] As mentioned hereinbefore, none of the prior arts can support the DCI monitoring occasion change due to numerology and scheduling unit size. Thus, in the present disclosure, there is proposed a new DCI transmission and receiving solution. In the proposed solution, a DCI configuration parameter can be first transmitted to the terminal device, and then the DCI is transmitted to the terminal device. Thus, the terminal device may monitor the DCI based on the received DCI configuration parameter, which means a flexible DCI monitoring solution and thus can support the DCI monitoring occasion change due to numerology and scheduling unit size.

(*Liu*, [0040].)

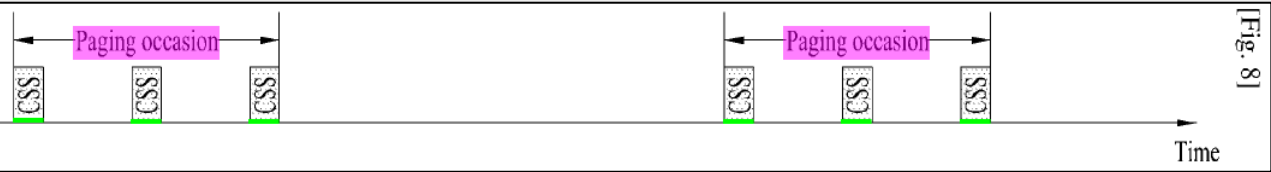
[0044] In an embodiment of the present disclosure, the DCI configuration parameter comprises at least one of: a numerology to be used; a valid duration for the DCI configuration parameter; a duration for a single DCI; and DCI occurrence occasions.

(*Liu*, [0044].)

Claim 1: “monitoring a first signaling in X time intervals”

You

In the following embodiments, each search space within an interval where a UE monitors M-PDCCH (CSS and/or USS) may be configured over one or more (consecutive or non-consecutive) downlink subframes. That is, a search space for (You, [185].)



(You, Fig. 8.)

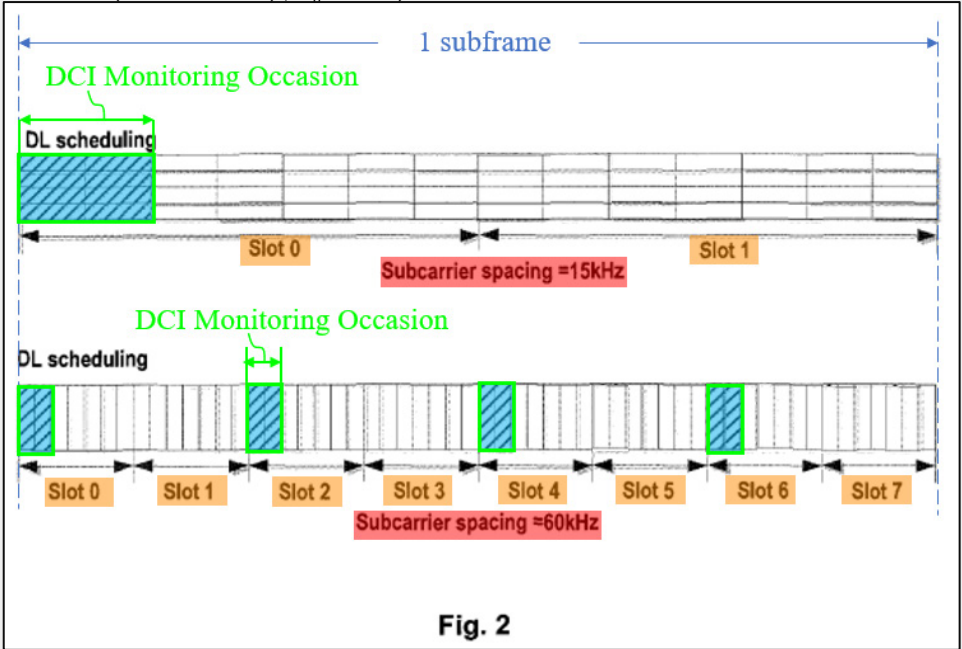
Liu

[0048] DCI occurrence occasions indicate occasions at which DCI occurs in frames. In an embodiment of the present disclosure, the DCI occurrence occasions can be at a slot level, at subframe level (multi-slot), or at symbol level, as illustrated in Figs. 3A to 3C respectively. (Liu, [0048].)

You + Liu

127. Moreover, as discussed in Section IX.A.3, Liu discloses a method for a UE to monitor DCI in one or more DCI monitoring occasions at 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]. Therefore, You in view of Liu also teaches limitation [1a].

(Bims Decl. (Ex. 1002), ¶127.)



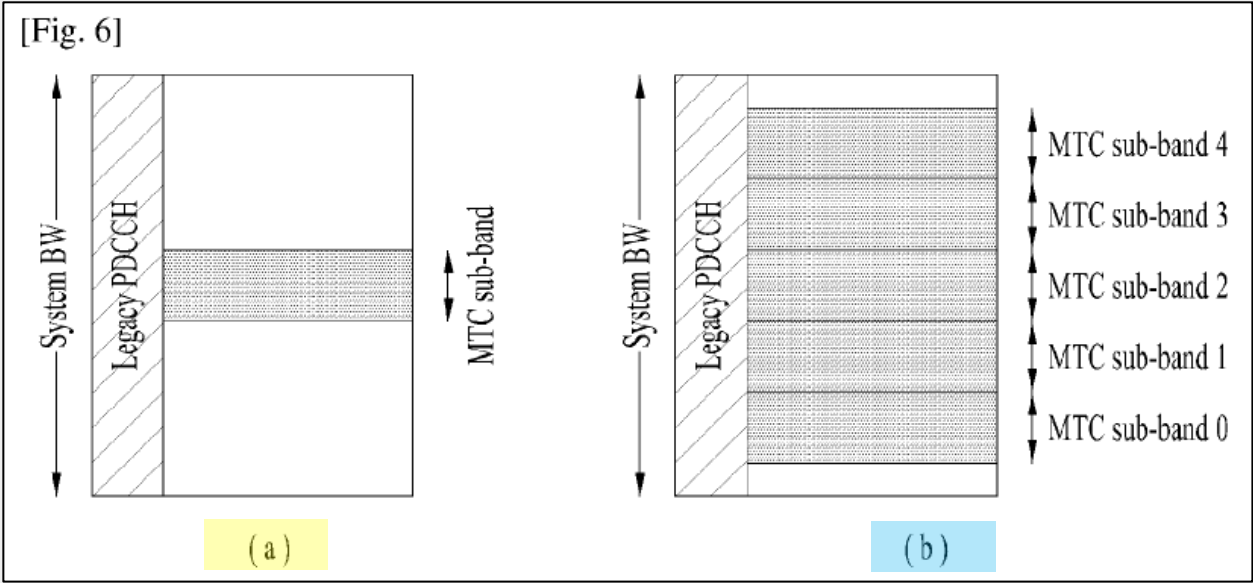
(Liu, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

Claim 1: “first subband”

FIG. 6 illustrates an example of signals band for MTC.

As one method for reducing the cost of the MTC UE, an operation of the MTC UE may be performed at a reduced UE downlink and uplink bandwidth of 1.4 MHz, for example, regardless of an operating system bandwidth of a cell. At this time, a sub-band (narrowband) for operating the MTC UE may always be located at the center (e.g., 6 center PRBs) of a cell as shown in FIG. 6(a), or several subbands for MTC may be provided for one subframe to multiplex MTC UEs as shown in FIG. 6(b), whereby the UEs may use their respective subbands different from each other or the UEs use the same subband not the subband of 6 center PRBs.

(You, [175]-[176].)



(You, Figs. 6(a) and 6(b).)

Claim 1: “determining the X time intervals”

1. Determine duration of each one of the “X time intervals.”

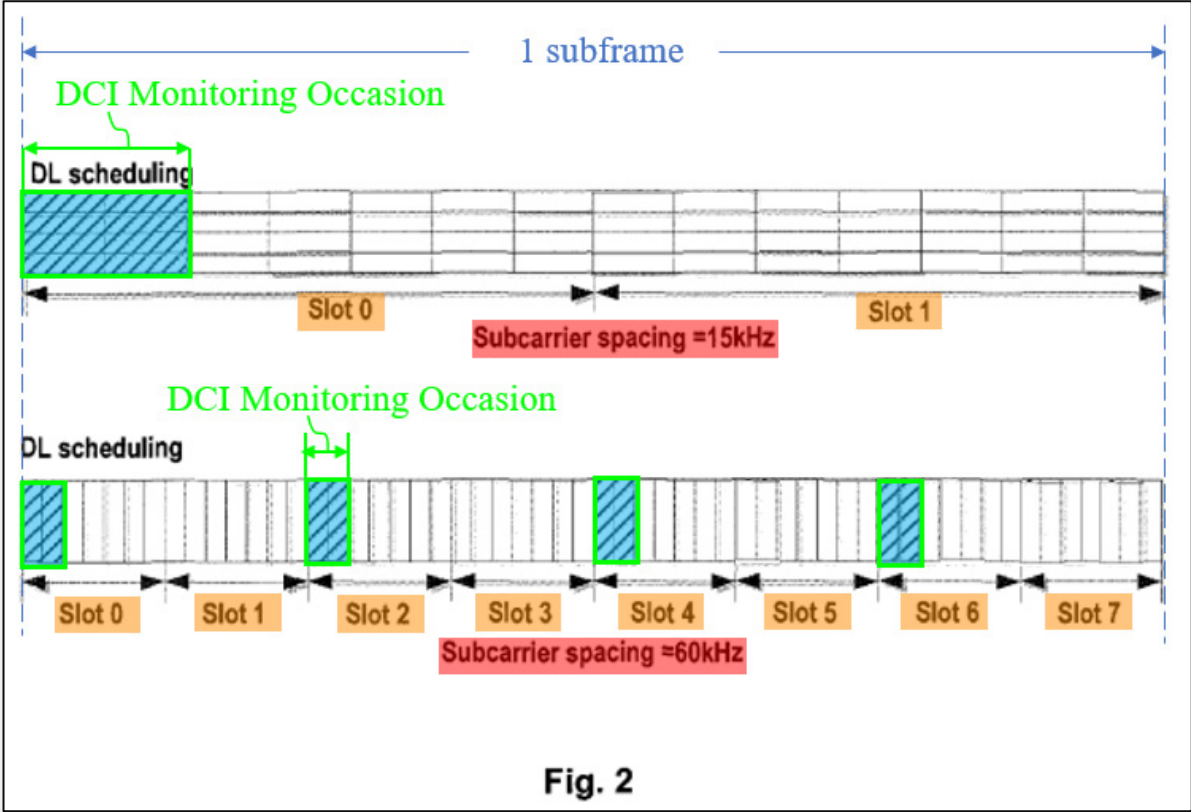
[0047] The duration for a single DCI indicates the length of the DCI, it can be a number of symbols. Thus, parameter may indicate the length of DCI. It is also possible to use a predetermined length and in such a case, this parameter can be omitted. (*Liu*, [0047].)

[0045] In NR system, different numerologies might be used, whereas different numerologies might use different transmission parameters, for example different subcarrier spacings. The different subcarrier spacings mean different symbol lengths. For example, for 15 kHz subcarrier spacing, its symbol will have a time length four times as that for 60 kHz subcarrier spacing, as illustrated in Fig. 2. Thus, the numerology to be used can be used to define a symbol. (*Liu*, [0045].)

Claim 1: “determining the X time intervals”

2. Determine time-domain locations of the “X time intervals.”

144. To further illustrate the concept, I modified *Liu*’s Figure 2 in the drawings below to show double-slot periodicity and zero offset: under the 15 kHz subcarrier spacing, a DCI monitoring occasion is in slot 0; whereas under the 60 kHz subcarrier spacing, DCI monitoring occasions are in slots 0, 2, 4, 6. *Liu*, Fig. 2. As shown, in my opinion, a POSA would have understood that the time-domain locations (i.e., slot locations) of the DCI monitoring occasions depend on the subcarrier spacing, and the UE uses the subcarrier spacing to determine which slots contain the DCI monitoring occasions (claimed “X time intervals”). Thus, in my opinion, a POSA would have understood that the UE would use the subcarrier spacing to determine the time-domain locations (slot locations) of the DCI monitoring occasions (claimed “X time intervals”).



(*Liu*, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

(Bims Decl. (Ex. 1002), ¶144.)

Claim 1: “determining the X time intervals”

3. Determine the number “X” of the “X time interval.”

number of DCI monitoring occasions in a DCI search space. Particularly, Liu discloses that “the DCI monitoring will be performed periodically, for example, every a predetermined number of slots” Liu, [0049]. 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]. 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, in my opinion, a POSA would have understood that the subcarrier spacing must be used to determine the number of DCI monitoring occasions.

(Bims Decl. (Ex. 1002) ¶146.)

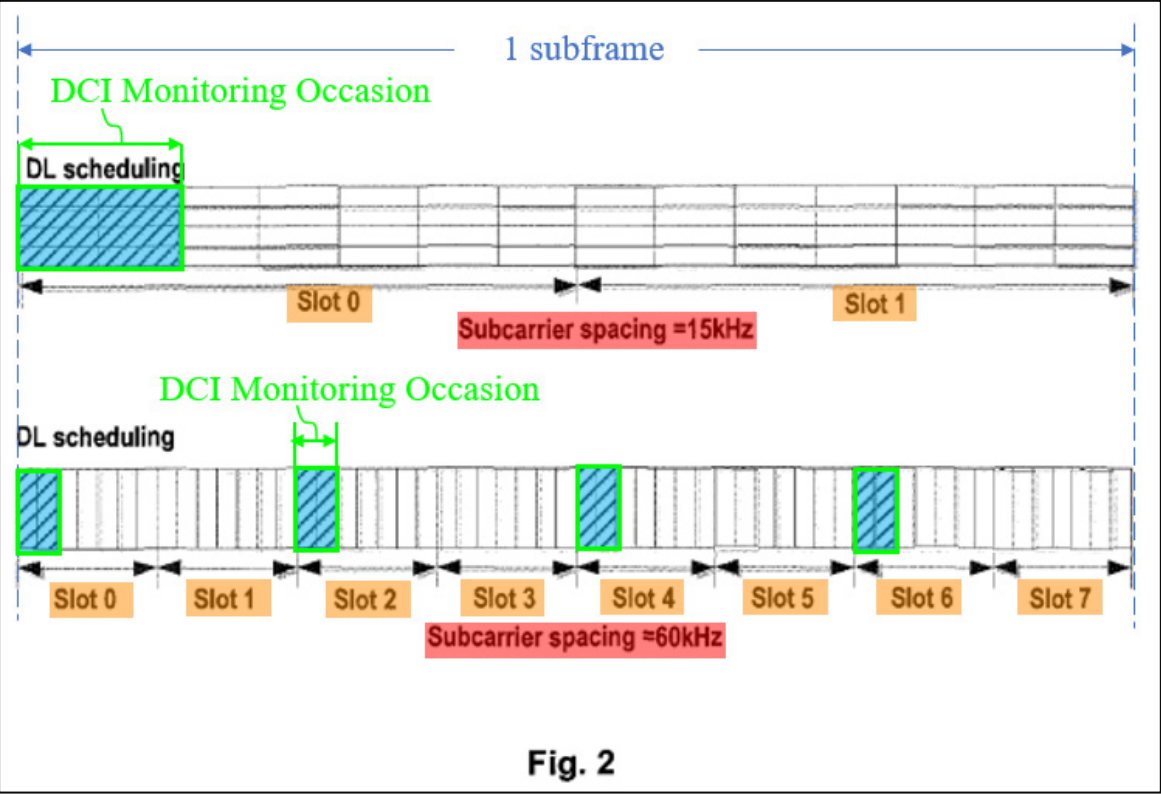


Fig. 2

(Liu, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

Claim 4: receive second radio signal for determining subband location or subcarrier spacing

- Both *You* and *Liu* disclose “receiving a second radio signal.”

You

CSS for paging (i.e., CSS_paging)

It is a CSS for paging monitoring in RRC_IDLE state. Since UEs in different CE levels monitor the same CSS for paging scheduling, it should be designed to cover all the CE levels. CSS_paging are configured by SIB. In other words, the configuration of CSS_paging may be transmitted through SIB. The UE may identify the configuration of CSS_paging by reading SIB. The UE may monitor M-PDCCH candidates of CSS within subframe(s) and/or narrowband(s) according to the CSS_paging configuration.

(*You*, [234]-[235].)

Liu

[0088] As illustrated in Fig. 11, the method starts from step 11, in which the terminal device like UE receiving a DCI configuration parameter. The DCI configuration parameter indicates the time-frequency resources for the following DCI.

[0089] In an embodiment of the present disclosure, the DCI configuration parameter may comprise at least one of: numerology to be used; a valid duration for the DCI configuration parameters; a duration for a single DCI; DCI occurrence occasions.

[0090] In another embodiment of the present disclosure, the DCI configuration parameter may comprise at least one of: a frequency domain resource unit; and a frequency hopping pattern.

(*Liu*, [0088]-[0090].)

Claim 4: receive second radio signal for determining subband location or subcarrier spacing

- It would have been obvious to modify *You*'s SIB message for reconfiguring CSS_paging, to include *Liu*'s DCI configuration parameter.

Motivation to Combine

have been motivated to combine the teachings of *You* and *Liu*. 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 DCI monitoring occasion change caused by numerology change. *Liu*, Abstract, [0019], [0040], [0095]; 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 Decl. (Ex. 1002), ¶150.)

Reasonable Expectation of Success

Moreover, a POSA would have had a reasonable expectation for the modification because it requires no more than combining prior art elements (*You*'s SIB message for reconfiguring CSS_paging and *Liu*'s DCI configuration parameter for reconfiguring DCI 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. (Bims Decl. (Ex. 1002), ¶150.)

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Disputed Issues

- Motivation to combine the cited 4G and 5G references
 - 4G references: *You, Mallick*
 - 5G reference: *Liu*
- “X time intervals” / “determining the X time intervals” (claim 1)
 - Claim construction of “time intervals”
 - Comparison to prior art
- “First subband” (claim 1)
- “Second radio signal” (claim 4)
- Expert qualifications

Disputed Issues

- Motivation to combine the cited 4G and 5G references
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- “First subband” (claim 1)
- “Second radio signal” (claim 4)
- Expert qualifications

Apex Fails to Confront Samsung’s Rationale for Combination

Apex

4G / LTE system with a 5G / NR system. Ex. 2004, ¶ 36. 4G and 5G systems, while similar in some ways since 5G is a progression from 4G, also have various and substantial differences which make combination not possible. *Id.* A person of ordinary skill in the art would not make the changes alleged by Petitioner, which include regressing to 4G / LTE again (*see infra* Sections VII.B.5 and VII.B.7, which only rely on You, a 4G / LTE system) because those differences were already considered by standard setting organizations, such as 3GPP, at the time of transitioning to 5G. *Id.*

.

subframe carries 2 slots, so 20 slots comprise a complete frame. *Id.* 5G / NR systems have subframes as a numerology independent time reference while a slot is the typical dynamic scheduling unit. *Id.* The difference between scheduling units (subframes in 4G / LTE systems versus slots in 5G / NR systems) is demonstrated below despite that 5G retained the same division of frames into subframes, indicating that any motivation to “combine” was already acted upon:

(POR 14-15.)

Dr. Bims

transmitted) are configured in the scheduling units (slots). *Liu* discloses that a subcarrier spacing change from 15 kHz to 60 kHz would cause the scheduling unit size (e.g., the slot size) to change. This further causes the M-PDCCH/DCI monitoring occasions to change. However, with the traditional blind decoding, the UE does not know when and how the subcarrier spacing and/or scheduling unit size would change. Thus, the UE would have to search the M-PDCCH/DCI monitoring occasions corresponding to *all* the supported subcarrier spacings (e.g., 15 kHz and 60 kHz), to look for the transmission of M-PDCCH/DCI. This would cause a significant drain to the UE’s battery power. To solve this problem, *Liu* proposes transmitting to the

(Bims Decl. (Ex. 1002), ¶ 113.)

Apex Fails to Confront Samsung’s Rationale for Combination

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.....
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(POR 14-15.)

27 Petition 28-32; POR 14-15; Pet. Reply 15-21; Bims Decl. (Ex. 1002), ¶111; *Liu*, [0002]-[0005], [0040].

Liu

[0002] New radio access system, which is called as new RAT (NR) system or network for short, is the next generation communication system. In Radio Access

[0004] In current LTE system, DCI monitoring is performed per subframe or per slot if the UE is in on duration of the discontinuous reception (DRX) active state. The DRX periodicity can be configured by higher layers.

[0005] However, with the current DCI monitoring solution in LTE, it cannot support the DCI monitoring occasion change due to numerology and scheduling unit size.

[0040] As mentioned hereinbefore, none of the prior arts can support the DCI monitoring occasion change due to numerology and scheduling unit size. Thus, in the present disclosure, there is proposed a new DCI transmission and receiving solution.
(*Liu*, [0002], [0004], [0005], [0040].)

Dr. Bims

supra, Section VI.C. Accordingly, in my opinion, a POSA would have been motivated to apply *Liu*’s teachings to modify *You*’s M-PDCCH/DCI monitoring scheme, so that it can support communications among massive number of machines. *See e.g.*, *Xiong*, [0021] (“With respect to massive

(Bims Decl. (Ex. 1002), ¶111.)
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Apex Fails to Confront Samsung's Rationale for Combination

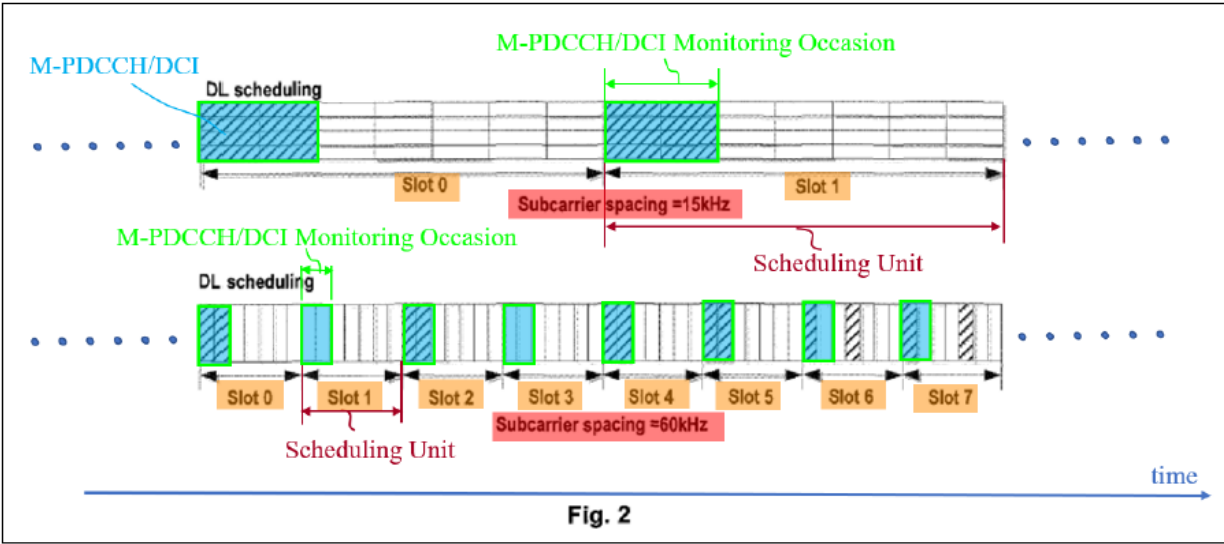
Apex

Liu is a 5G / NR system. See Ex. 1006, [0002]-[0003]; Ex. 2004, ¶ 45. Like the '767 Patent, Liu criticizes the faults of You / Mallick and other conventional 4G / LTE systems, namely that, in 4G / LTE systems, "DCI monitoring is performed per subframe or per slot" or some other fixed length with periodicity and that LTE "cannot support the DCI monitoring occasion change due to numerology and scheduling unit size." Ex. 1006, [0004]-[0005]; Ex. 2004, ¶ 45. Because You and Mallick are 4G / LTE systems, they are inapposite to the claims and disclosure of the '767 Patent, and a person of ordinary skill in the art would not be motivated to combine You or Mallick with the 5G / NR system of Liu. Ex. 2004, ¶ 45.

(POR 18.)

Dr. Bims

UE's battery power. To solve this problem, Liu proposes transmitting to the UE a DCI configuration parameter, to indicate the change of the subcarrier spacing. Liu, Abstract, [0019], [0057], [0095]. This way, the UE can know the scheduling unit (e.g., slot) corresponding to the new subcarrier spacing, and only search the PDCCH/DCI monitoring occasions configured in the new scheduling units (e.g., slots corresponding to the new subcarrier spacing). Id. Therefore, a POSA would have appreciated that Liu's solution



(Bims Decl. (Ex. 1002), ¶ 113.)

Apex Fails to Confront Samsung’s Rationale for Combination

Apex

4G / LTE system with a 5G / NR system. Ex. 2004, ¶ 36. 4G and 5G systems, while similar in some ways since 5G is a progression from 4G, also have various and substantial differences which make combination not possible. *Id.* A person of ordinary skill in the art would not make the changes alleged by Petitioner, which include regressing to 4G / LTE again (*see infra* Sections VII.B.5 and VII.B.7, which only rely on You, a 4G / LTE system) because those differences were already considered by standard setting organizations, such as 3GPP, at the time of transitioning to 5G. *Id.*

(POR 14-15.)

Dr. Bims

112. 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. Both *You* and *Liu* pertain to 3GPP systems and refer to and publications. Thus, in my opinion, as part of the natural transition to 5G for *You*’s MTC, a POSA would have been prompted by *Liu*’s teachings to modify *You*’s technique to meet the requirements of the emerging 5G/NR system.

(Bims Decl. (Ex. 1002), ¶112.)

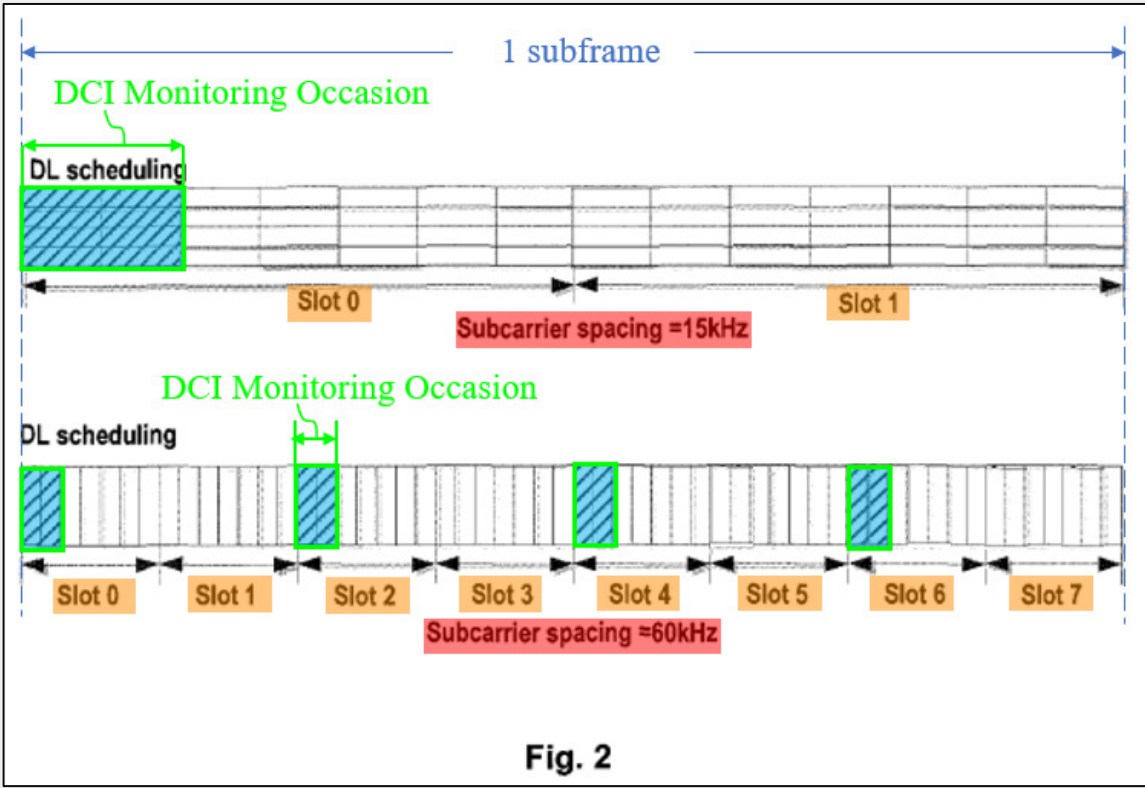
Apex Fails to Confront Samsung's Rationale for Combination

Dr. Bims

spacing). *Id.* Therefore, a POSA would have appreciated that *Liu*'s solution can "mitigate or at least alleviate" the uncertainty in PDCCH/DCI monitoring occasions due to 5G/NR's flexible numerology. *Liu*, [0010] ("To (Bims Decl. (Ex. 1002) ¶113.)

120. Moreover, in my opinion, a POSA would also have 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 scheduling unit size," and to make the M-PDCCH/DCI monitoring occasions predictable by a UE. *Liu*, Abstract, [0019]. Thus, the are scheduled to contain an X time interval. Moreover, the modification requires less time and battery power to locate the time-frequency resources for receiving the M-PDCCH/DCI, the UE operation is less likely to experience interruption or crash.

(Bims Decl. (Ex. 1002), ¶120.)



(*Liu*, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

Apex Fails to Confront Samsung’s Rationale for Combination

Apex

The proper inquiry is whether there is a motivation to combine where developers of 5G at the time of the invention had the ability to incorporate certain elements of 4G/LTE standard in the 5G/NR standard and made the decision not to do so because incorporating such elements from the 4G/LTE prior art (You and Mallick) to achieve Petitioner’s proposed combination would change the principle of operation of the 5G/NR prior art (Liu). *In re Ratti*, 270 F.2d 810, 813 (C.C.P.A. 1959) (reversing a rejection of obviousness where the seal construction taught in the primary reference required rigidity for operation, whereas the seal in the claimed invention required resiliency such that the “suggested combination of references would require a . . . change in the basic principles under which the [primary reference] construction was designed to operate.”); POR at 14-17 (“those differences (Sur-reply 12.)

Dr. Bims

117. In my opinion, a simple substitution of *Liu*’s DCI configuration parameter for *You*’s CSS_paging configuration parameters would yield a slot-level M-PDCCH monitoring occasions within a paging occasion. Specifically, *You*
-
122. Additionally, although *You*’s UE monitors the paging M-PDCCH/DCI at the subframe level while *Liu* “DCI occurrence occasions” can be at slot level, multi-slot level, or even symbol level, such difference does not require any modification to the UE’s fundamental design. Rather, *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 symbol level. *Liu*, [0049] (describing the “periodicity” can be flexibly configured at “symbols, slots, or frames”). For example, since a slot is comprised of a plurality of

(Bims Decl. (Ex. 1002), ¶117, ¶122.)

Apex Fails to Confront Samsung's Rationale for Combination

Apex

The proper inquiry is whether there is a motivation to combine where developers of 5G at the time of the invention had the ability to incorporate certain elements of 4G/LTE standard in the 5G/NR standard and made the decision not to do so because incorporating such elements from the 4G/LTE prior art (You and Mallick) to achieve Petitioner's proposed combination would change the principle of operation of the 5G/NR prior art (Liu). *In re Ratti*, 270 F.2d 810, 813 (C.C.P.A. 1959) (reversing a rejection of obviousness where the seal construction taught in the primary reference required rigidity for operation, whereas the seal in the claimed invention required resiliency such that the "suggested combination of references would require a . . . change in the basic principles under which the [primary reference] construction was designed to operate."); POR at 14-17 ("those differences (Sur-reply 12.)

Dr. Bims

121. A POSA would also have a reasonable expectation of success for the resulted combination because it merely requires combining prior elements according to known methods. Particularly, *You* discloses that the paging M-PDCCH search space is specified by a set of CSS_paging parameters. *You*, [250] (Table 13). *You* discloses that a base station can transmit the CSS_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 obvious to incorporate *Liu*'s DCI configuration parameter in *You*'s CSS_paging parameters and transmit them to the UE via an SIB, RRC, or DCI message. These messages are old, routine communication methods used in the art to communicate control data.

(Bims Decl. (Ex. 1002), ¶121.)

Disputed Issues

- Motivation to combine the cited 4G and 5G references
 - 4G references: *You, Mallick*
 - 5G reference: *Liu*
- “X time intervals” / “determining the X time intervals” (claim 1)
 - Claim construction of “time intervals”
 - Comparison to prior art
- “First subband” (claim 1)
- “Second radio signal” (claim 4)
- Expert qualifications

Construction of the Claim Term “Time Intervals”

Claim Term	Samsung’s Construction	Apex’s POPR	Apex’s POR
“time intervals” (all claims)	plain and ordinary meaning	not disputed	<i>variable</i> ranges of time — “the length of each time interval is variable, and not necessarily following a pattern”

Apex's "Variable" Construction Improperly Excludes Embodiments

- Apex's construction excludes three out of the four embodiments cited by the Patent Owner Response.

In one embodiment, any two of the X time intervals have an equal time length.

In one embodiment, two of the X time times have different time lengths.

(’767 patent, 2:48-51; *see also id.*, 19:1-4.)

In one embodiment, any one of the X time intervals comprises M Orthogonal Frequency Division Multiplexing (OFDM) symbols, M is a positive integer smaller than 14.

In one embodiment, any one of the X time intervals comprises M OFDM symbols, M is a positive integer smaller than 7.

(’767 patent, 2:58-63; *see also id.*, 19:11-15.)

Other, Uncited Embodiments Also Contradict Apex's "Variable" Construction

'767 Patent

In one embodiment, any one of the X time intervals is a slot.

('767 patent, 2:52-53.)

Apex's POR

Second, Petitioner incorrectly argues that Liu discloses this limitation because Liu describes "monitor[ing] one or more DCI monitoring occasions at the slot level." Pet. at 38; Ex. 2004, ¶ 48. However, this is inapposite to the claimed "X time intervals" because the '767 Patent explains prior art 5G / NR systems which utilize different numerologies to compute smaller scheduling units such as slots within 1ms subframes in which to detect the paging message. *Id.* These slots are also fixed ranges of time, which cannot be X time intervals:

(POR 20.)

Other, Uncited Embodiments Contradict Apex’s “Variable” Construction

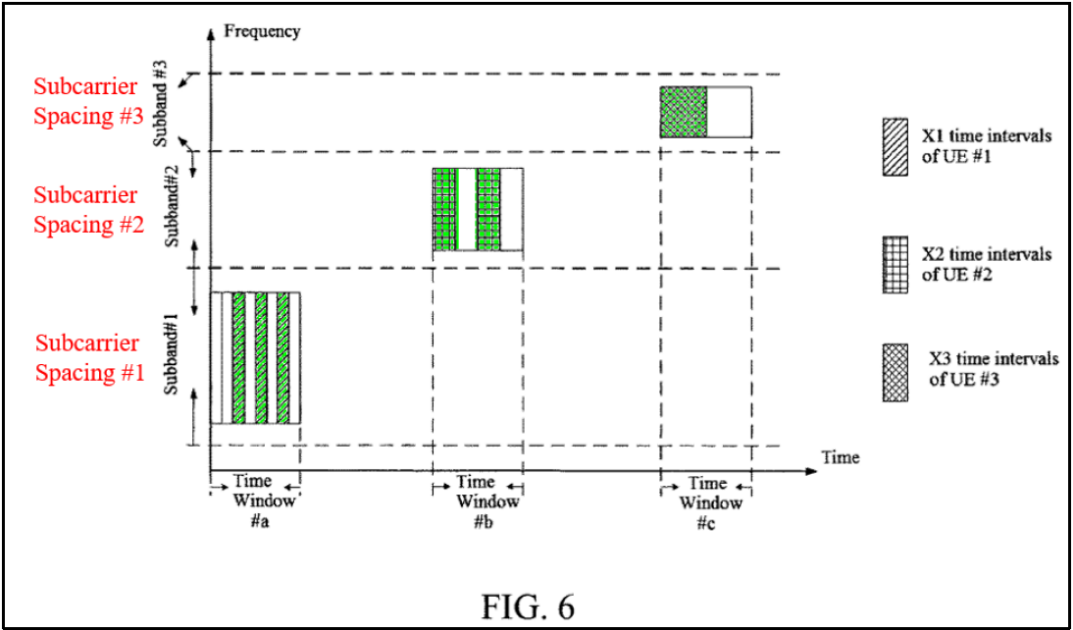
’767 Patent

In one embodiment, any two of the X time intervals have an equal time length, and the time length of each one of the X time intervals is correlated to the subcarrier spacing of subcarriers included in the first subband.

(’767 patent, 2:54-57, 9:7-10.)

In one embodiment, in two of the Q subbands, the subcarriers have an equal subcarrier spacing.

(’767 patent, 18:36-37.)



(’767 patent, Fig. 6.)

Apex’s Expert

19 Q Does the time length of one of the
20 X time intervals have to change for it to be
21 considered a variable range of time?
22 A Well, variable --
23 MR. PYMENTO: Objection to form.
24 A -- means that it changes over time.
25 Q So your definition of -- of
1 variable excludes the situation where all of
2 the X time intervals are the same time
3 length?
4 MR. PYMENTO: Objection to the
5 form.
6 A So variable ranges of time mean
7 that the ranges can change over time. That's
8 all it means.

(Gomez Tr. (Ex.1041), 69:19-70:8.)

Apex's Expert Contradicts Apex's "Variable" Construction

18 Do you see where it says, "In one
19 embodiment, any two of the X time intervals
20 have an equal time length"?
21 **A Yes.**
22 Q And then, in the next sentence, it
23 says, "In one embodiment, two of the X time
24 intervals have different time lengths"?
25 **A So these are embodiments. These**
1 **are examples of what could occur.**
2 I do see that, but like I said,
3 there's all these other embodiments above and
4 below that.

(Gomez Tr. (Ex.1041), 44:18-45:4.)

11 Q Do you agree that the '767 patent
12 discloses an embodiment where all of the X
13 time intervals have an equal time length?
14 **A That's just one embodiment. That's**
15 **not the inventive quality -- necessarily the**
16 **only inventive quality of the '767 patent,**
17 **but that's what it says here, yes.**

(Gomez Tr. (Ex.1041), 46:11-17.)

21 Q So there's nothing in Claim 1 that
22 excludes the ability for the X time intervals
23 to all be the same time length?
24 **A I don't think there's --**
25 MR. PYMENTO: Objection to the
1 form. Asked and answered.
2 **A It's not even contemplating that.**
3 **It's just simply saying, "Monitoring a first**
4 **signaling in X time intervals."**
5 Q Right?
6 It doesn't specify, one way or the
7 other, right?
8 **A Nowhere in the patent does it. So**
9 **the X time intervals could be different**
10 **lengths or they could be the same length.**
11 **Again, I haven't opined on --**
12 MR. PYMENTO: Objection to the
13 form.
14 **A -- that specifically. All it's**
15 **saying in the patent is that it's monitoring**
16 **the first signaling in X time intervals.**

(Gomez Tr. (Ex.1041), 63:21-64:16.)

Apex's Construction Is Optional, Thus Irrelevant to the Outcome

time interval is variable, and not necessarily following a pattern. Ex. 2004, ¶ 37. As shown below, some time intervals among the X time intervals **can be** equal in time / symbol length or could have different time / symbol lengths, regardless of the length of slots, subframes, or frames:

(POR 11.)

'767 Patent, 2:48-51, 2:58-63, 19:1-4, 19:11-15; Ex. 2004, ¶ 37. Based on the reading of the aforementioned portions of the '767 Patent, a person of ordinary skill in the art would also understand that each time interval **need not be** equally spaced between each other since the lengths of the X time intervals within a slot (or across slots), subframe (or across subframes), or frame (or across frames) are of different lengths. *Id.* The diversity of lengths among the X time intervals means that time

(POR 11-12.)



“As a matter of linguistic precision, optional elements do not narrow the claim because they can always be omitted.”

In re Johnston, 435 F.3d 1381, 1384 (Fed. Cir. 2006); *see* Pet. Reply 8.

added); Ex. 2004, ¶ 46. However, You's subframes (*i.e.*, fixed ranges of time) are not X time intervals, which are variable ranges of time, meaning that the length of the time intervals are **not necessarily** equal and the time intervals are **not necessarily** periodic in time, as described in Section IV. Ex. 2004, ¶ 46.

(POR 19.)

Id. at 2:1-9; Ex. 2004, ¶ 48. While Liu may describe slot-level monitoring of DCI, Liu does not disclose either the number (X) of time intervals or the duration of each of the X time intervals, which **could be** variable (*i.e.*, different duration for each interval, and the one paragraph that Petitioner dedicates to Liu points to no such disclosure. *See* Pet. at 38; Ex. 2004, ¶ 48.

(POR 21.)

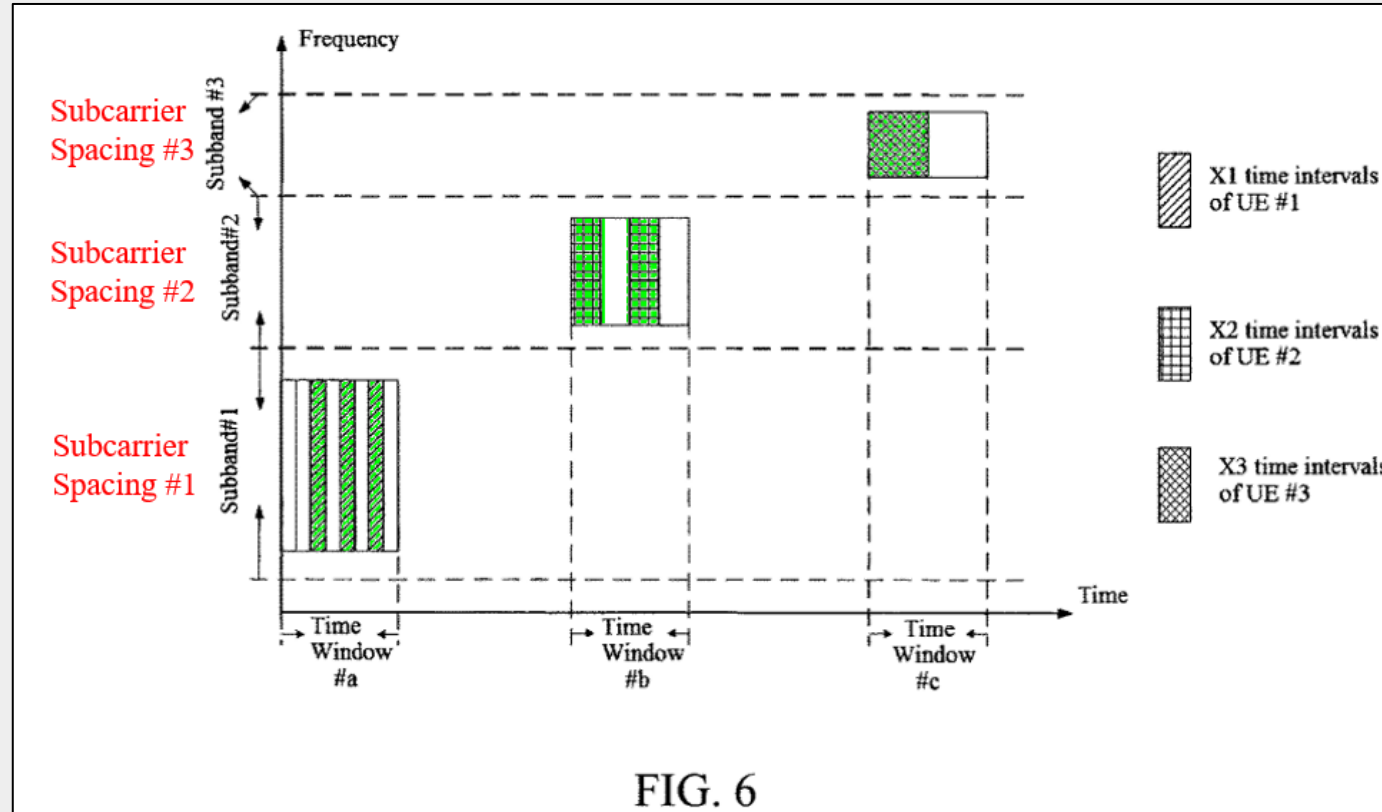
Liu Discloses *Variable* Time Intervals in the Same Way as '767 Patent



“We hold that where a patent owner in an IPR first proposes a claim construction in a patent owner response, a petitioner must be given the opportunity in its reply to argue and present evidence of anticipation or obviousness under the new construction, at least where it relies on the same embodiments for each invalidity ground as were relied on in the petition.”

Axonics, Inc. v. Medtronic, Inc., 75 F.4th 1374, 1384 (Fed. Cir. 2023).

Liu Discloses Variable Time Intervals in the Same Way as '767 Patent



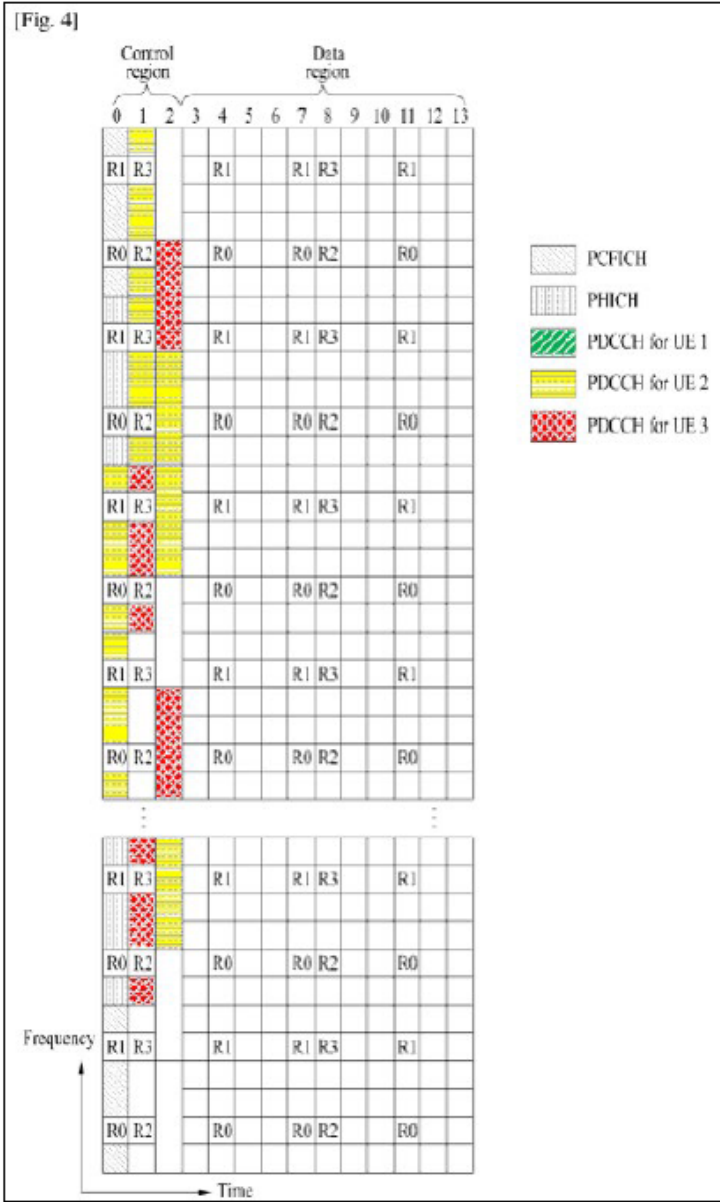
('767 patent, Fig. 6.)

Monitoring = *Blind* Decoding

control region of a previous subframe. A UE can monitor a PDCCH search space to determine whether the DCI for the UE is actually transmitted on any of the PDCCH candidates. *You*, [121]. “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]. 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 Decl. (Ex. 1002), ¶61.)



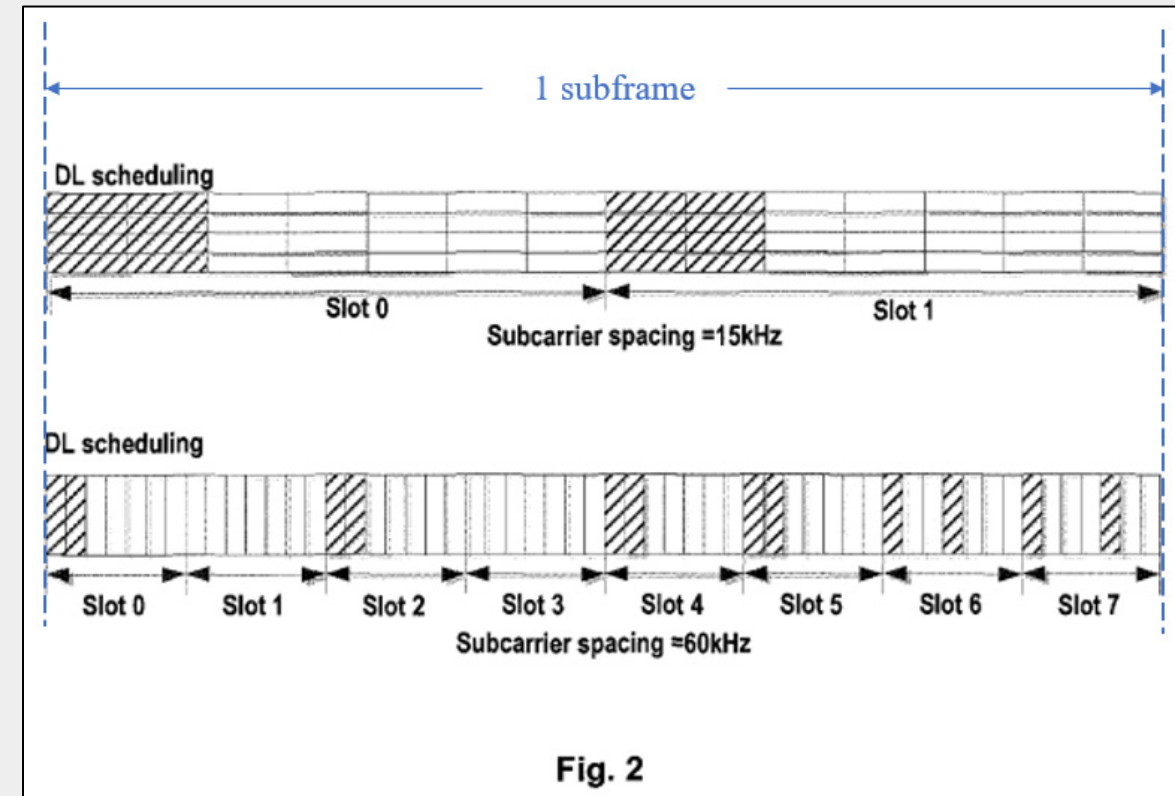
You, Fig. 4.

(Bims Decl. (Ex. 1002), ¶57.)

Liu Discloses *Variable* Time Intervals in the Same Way as '767 Patent

104. Specifically, *Liu* explains that the 5G/NR system supports different numerologies, which “use different transmission parameters, for example 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 subcarrier 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*, Sections VI.B.4, VI.C. Thus, the symbol and slot durations depend on the subcarrier spacing. *Liu*, [0005], [0019], [0040].

(Bims Decl. (Ex. 1002), ¶104.)



(Bims Decl. (Ex. 1002), ¶104; *Liu*, Fig. 2.)

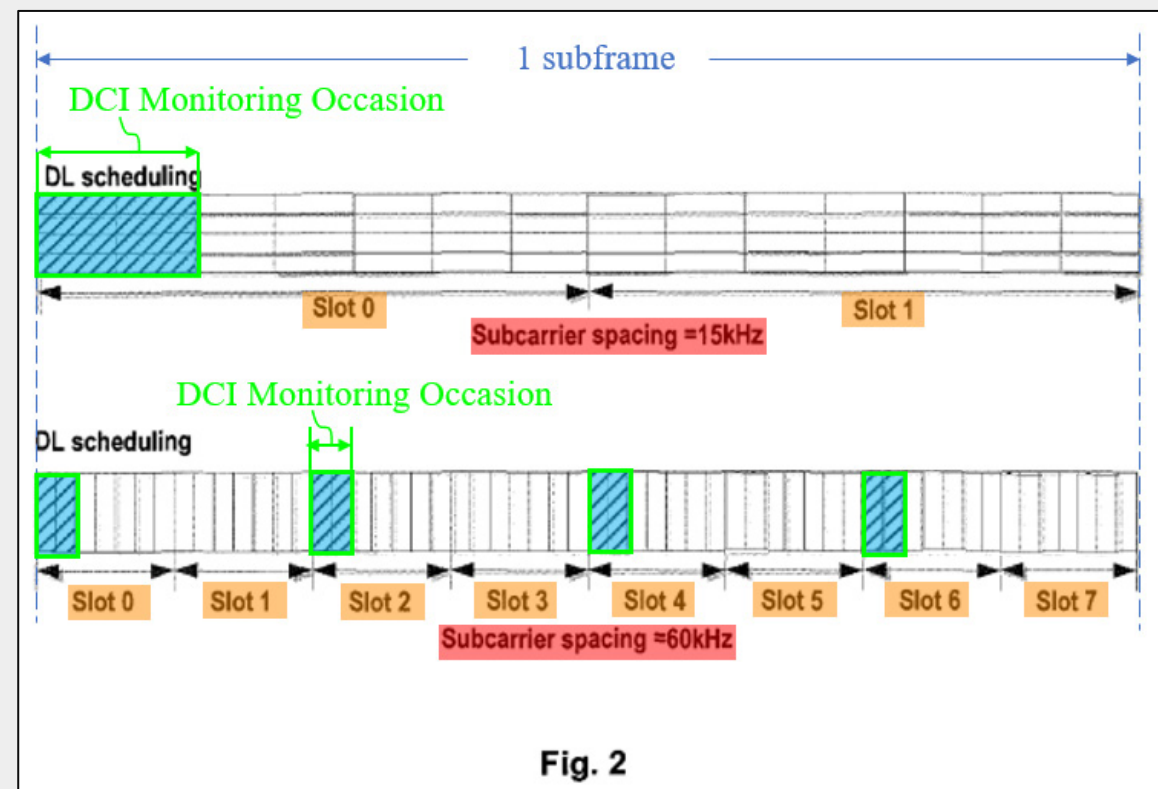
4G UE Does Not Know the Monitoring Occasion Change Caused by Numerology Change

113. Moreover, a POSA would have appreciated that *Liu*'s M-PDCCH/DCI transmission/monitoring method is advantageous because it reduces the UE's burden in monitoring the paging scheduling information in *You* (i.e., searching the transmission occasions of the M-PDCCH/DCI). As discussed in Section VI.B.6, "monitoring" means blind decoding the M-PDCCH/DCI 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 paging M-PDCCH/DCI are located. *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. For

(Bims Decl. (Ex. 1002), ¶113.)

[0005] However, with the current DCI monitoring solution in LTE, it cannot support the DCI monitoring occasion change due to numerology and scheduling unit size.

(*Liu*, [0005].)

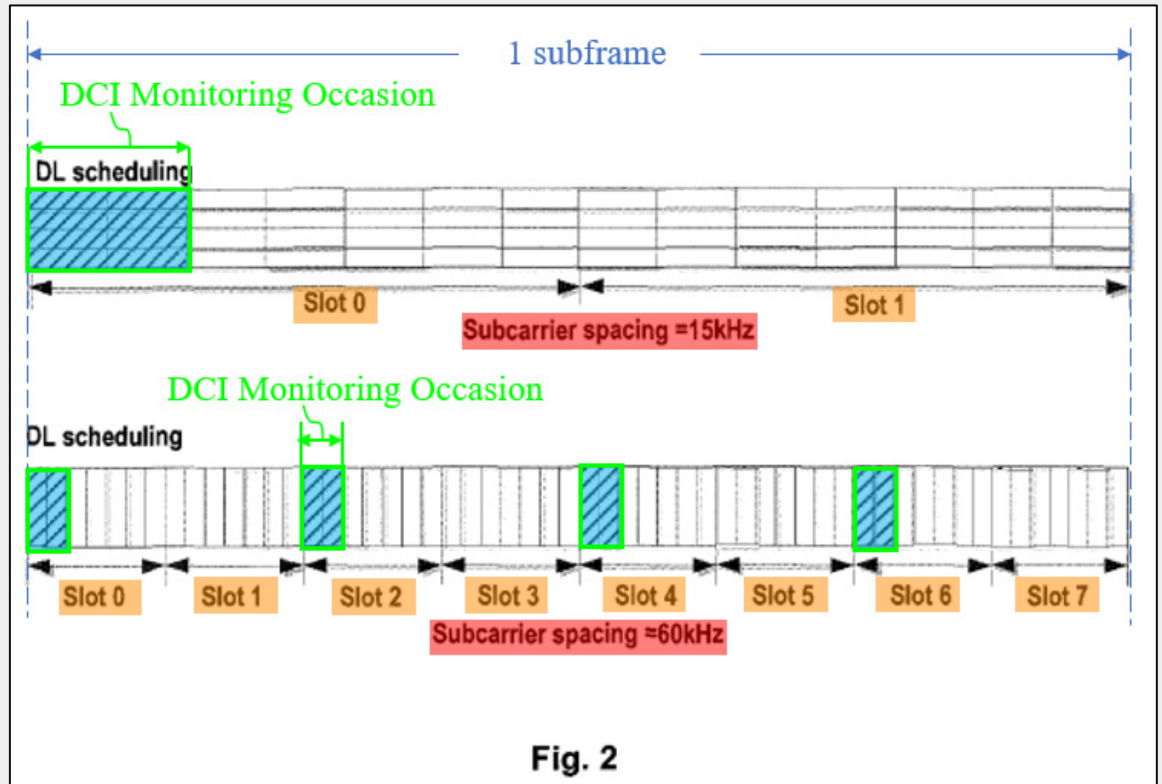


(*Liu*, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

4G UE Does Not Know the Monitoring Occasion Change Caused by Numerology Change

performed. *Liu*, Abstract, [0005], [0019], [0040], [0095], Fig. 2. For example, as shown in Figure 2 below, M-PDCCH/DCI may occur at slot level (e.g., per slot), so a scheduling unit is a slot and the M-PDCCH/DCI monitoring occasions (i.e., the time intervals in which the M-PDCCH/DCI is transmitted) are configured in the scheduling units (slots). *Liu* discloses that a subcarrier spacing change from 15 kHz to 60 kHz would cause the scheduling unit size (e.g., the slot size) to change. This further causes the M-PDCCH/DCI monitoring occasions to change. However, with the traditional blind decoding, the UE does not know when and how the subcarrier spacing and/or scheduling unit size would change. Thus, the UE would have to search the M-PDCCH/DCI monitoring occasions corresponding to all the supported subcarrier spacings (e.g., 15 kHz and 60 kHz), to look for the transmission of M-PDCCH/DCI. This would cause a significant drain to the UE's battery power. To solve this problem, *Liu* proposes transmitting to the

(Bims Decl. (Ex. 1002), ¶113.)



(*Liu*, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

Liu Discloses *Variable* Time Intervals in the Same Way as '767 Patent

[0040] As mentioned hereinbefore, none of the prior arts can support the DCI monitoring occasion change due to numerology and scheduling unit size. Thus, in the present disclosure, there is proposed a new DCI transmission and receiving solution. In the proposed solution, a DCI configuration parameter can be first transmitted to the terminal device, and then the DCI is transmitted to the terminal device. Thus, the terminal device may monitor the DCI based on the received DCI configuration parameter, which means a flexible DCI monitoring solution and thus can support the DCI monitoring occasion change due to numerology and scheduling unit size.

(*Liu*, [0040].)

[0057] Reference is made back to Fig. 1, in step 102, the DCI can be transmitted to the terminal device. With the DCI configuration parameter, the terminal device 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].)

[0019] With embodiments of the present disclosure, a DCI configuration parameter can be first transmitted to the terminal device, and then the DCI is transmitted to the terminal device. Thus, the terminal device may monitor the transmitted DCI based on the received DCI configuration parameter, which means a flexible DCI monitoring solution and thus can support the DCI monitoring occasion change due to numerology and scheduling unit size.

(*Liu*, [0019].)

[0095] Next, in step 1102, DCI is received within time-frequency resources indicated by the DCI configuration parameter at the terminal device. That is to say, at the terminal device, the terminal device may perform DCI monitoring based on the DCI configuration parameter, which means a flexible DCI monitoring solution and thus can support the DCI monitoring occasion change due to numerology and scheduling unit size.

(*Liu*, [0095].)

Liu Discloses *Variable* Time Intervals in the Same Way as '767 Patent

118. Also, in my opinion, a POSA would have known how to use *Liu*'s DCI configuration parameter to determine the resulting M-PDCCH/DCI monitoring occasions. Specifically, the DCI configuration information regarding the “numerology” (subcarrier spacing) and “DCI occurrence occasions” (periodicity, offset from the starting point) can be used by the UE to determine the locations of the M-PDCCH/DCI monitoring occasions in the time domain. *Liu*, [0045], [0048]-[0049]. The “duration for a single DCI” can be used by the UE to determine the duration of each M-PDCCH/DCI monitoring occasion. *Id.*, [0047]. The “valid duration for the DCI configuration parameter” can be used by the UE to determine the total duration of the paging occasion. *Id.*, [0046]. And the “frequency domain resource unit” and “frequency hopping pattern” can be used by the UE to determine the subband location and bandwidth for monitoring the M-PDCCH/DCI. *Id.*, [0054]-[0055].

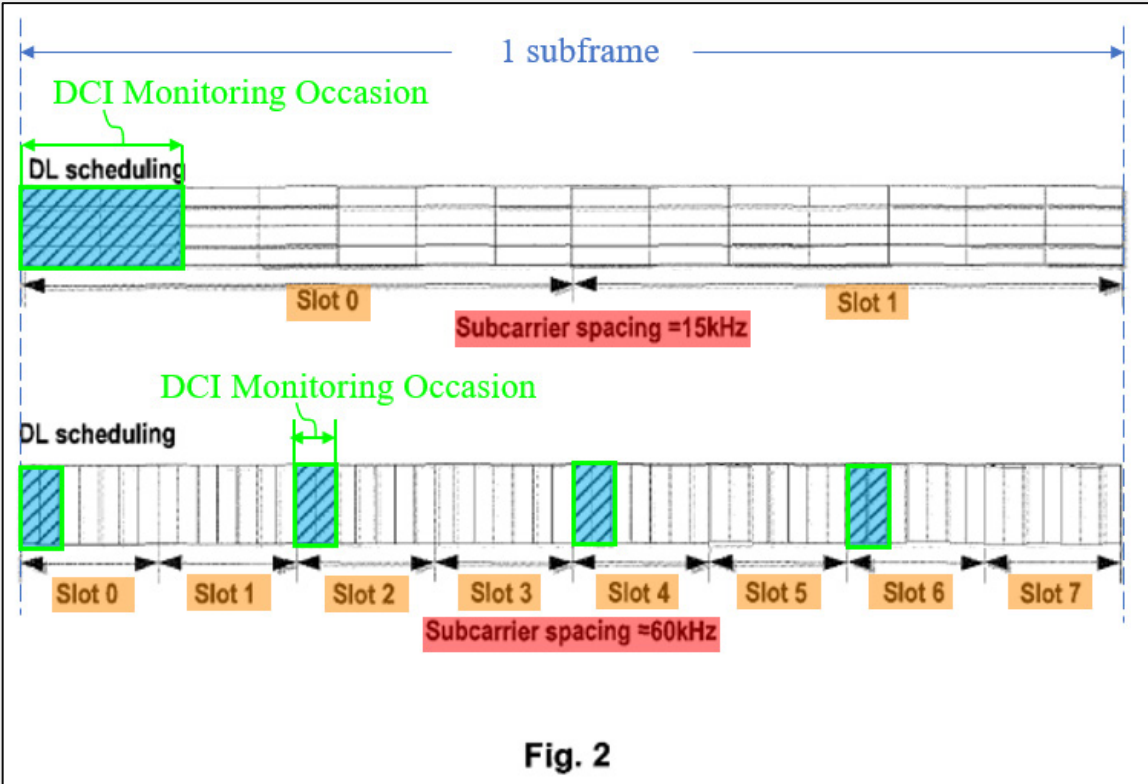
(Bims Decl. (Ex. 1002), ¶118.)

Liu Discloses Variable Time Intervals in the Same Way as '767 Patent

143. *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]. 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. *Id.*, [0045]. 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 of a subframe and a frame. It follows that the DCI monitoring occasions in the slots have different time-domain locations of a subframe and a frame.

(Bims Decl. (Ex. 1002), ¶143.)



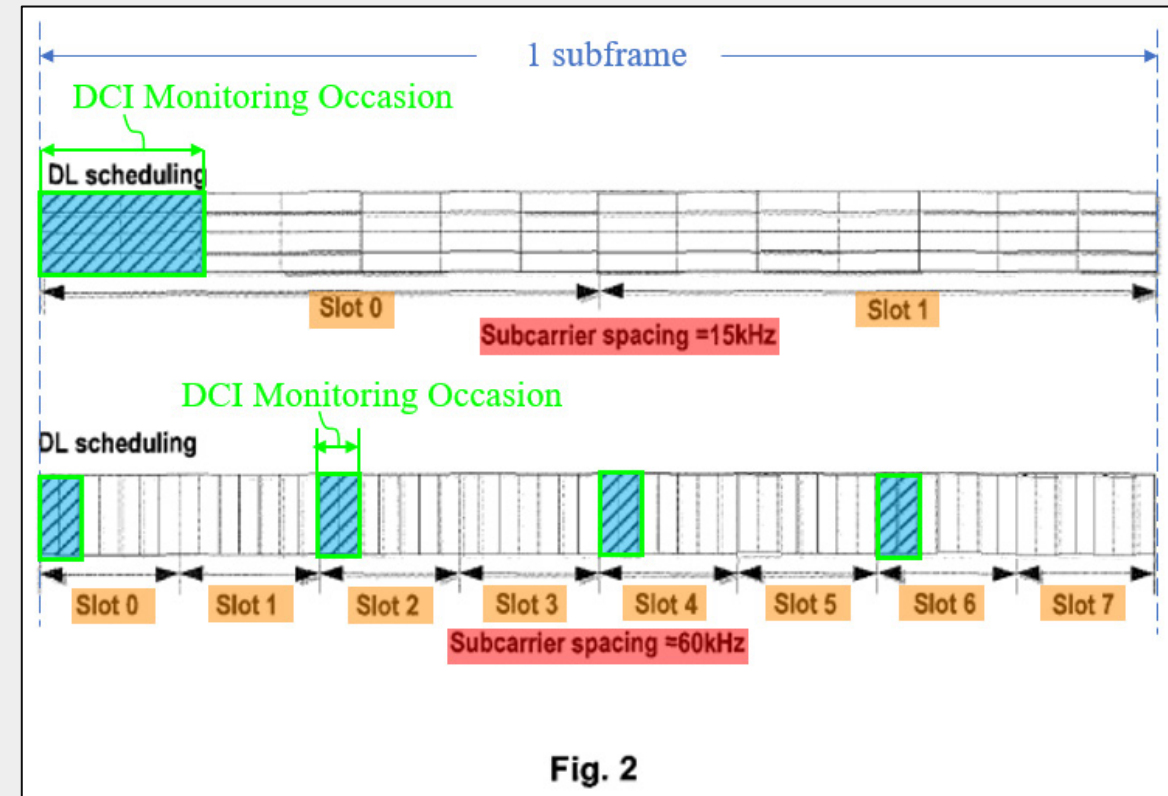
(*Liu*, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

DEMONSTRATIVE EXHIBIT – NOT EVIDENCE

Liu Discloses *Variable* Time Intervals in the Same Way as '767 Patent

[0045], [0047]-[0049], Fig. 2. 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 the system latency. This is particularly useful in *You*'s coverage enhancement mode, which requires multiple repetitions of the M-PDCCH/DCI transmission. In my opinion, a POSA would have expected the resulting combination to work well in a 5G/NR system because, by using *Liu*'s method, the UE can precisely determine the time-domain locations, durations, and number of the M-PDCCH/DCI monitoring occasions at the slot level, despite the duration of a slot and the number of slots in a subframe change with the subcarrier spacing.

(Bims Decl. (Ex. 1002) ¶147.)



(*Liu*, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

Both *You* and *Liu* Disclose “X Is A Positive Integer”

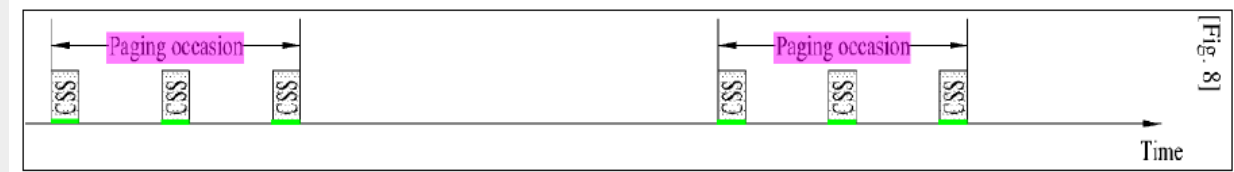
d. [1c]: “wherein **X** is a positive integer;”

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

(Bims Decl. (Ex. 1002), ¶129.)

On this preliminary record, *You* supports Petitioner’s contentions. As noted above, *You* discloses repeating transmission of the M-PDCCH signal for coverage enhancement over a number of consecutive downlink subframes. Ex. 1005 ¶¶ 182–183.

(Institution Decision 17.)



Id., Fig. 8.

(Bims Decl. (Ex. 1002), ¶125.)

a PDCCH”); Moreover, *You*’s one or more downlink subframes in a paging occasion disclose the claimed “X time intervals” because each subframe is a time interval. *Supra*, Section VI.B.3.

(Bims Decl. (Ex. 1002), ¶126.)

Moreover, as discussed in Section IX.A.3, *Liu* discloses a method for a UE to monitor DCI in one or more DCI monitoring occasions at 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]. Therefore, *You* in view of *Liu* also teaches limitation [1a].

(Bims Decl. (Ex. 1002), ¶127.)

Disputed Issues

- Motivation to combine the cited 4G and 5G references
 - 4G references: *You, Mallick*
 - 5G reference: *Liu*
- “X time intervals” / “determining the X time intervals” (claim 1)
 - Claim construction of “time intervals”
 - Comparison to prior art
- “First subband” (claim 1)
- “Second radio signal” (claim 4)
- Expert qualifications

Construction of “First Subband” No Longer Disputed

Petitioner argues that we need not interpret any claim terms for purposes of this Decision. Pet. 20–21.

Patent Owner argues that “the term ‘subband’ should be construed as ‘one of a plurality of subsets of a frequency band.’” Prelim. Resp. 4. Patent Owner argues that the specification of the ’767 patent defines “subband” in this manner. *Id.* at 4–7.

We do not see an explicit definition of “subband” in the ’767 patent as asserted by Patent Owner. However, we agree on this record that the ordinary and customary meaning of “subband” as used in the ’767 patent is a subset of the available frequency band. *See, e.g.*, Ex. 1001, 2:28–29 (“The first subband includes a positive integer number of consecutive subcarriers in frequency domain.”), Fig. 6 (illustrating three subbands); *see also* Ex. 1005 ¶ 176 (describing a subband as a narrowband of frequency available in a cell); Ex. 1002 ¶ 68 (describing 5G systems as dividing “an available bandwidth . . . between four subbands ‘BW’ with 7.5, 15, 30, and 60 kHz subcarrier spacings, respectively”); Pet. 42 (mapping You’s “reduced UE downlink and uplink bandwidth” to the recited subband).

(Institution Decision 11.)

To the extent Patent Owner argues that the recited “first subband” requires one or more additional subbands, we disagree. We see no language in claim 1 that requires the use of a second subband. Moreover, even if we (Institution Decision 19.)

IV. CLAIM CONSTRUCTION

During the Institution phase, the Board correctly “agree[d] on this record that the ordinary and customary meaning of ‘subband’ as used in the ’767 patent is a subset of the available frequency band.” Decision, Paper No. 10 at 11. The Board (POR 8.)

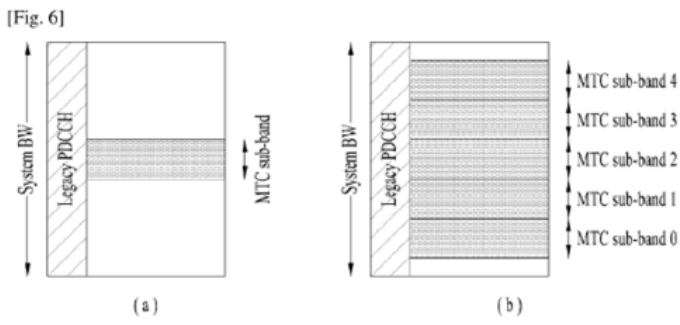
Apex’s New Argument About the “First Subband” Is Wrong

Apex 

5. The Combination of You and Liu Does Not Render Obvious “*the frequency domain resource used for transmitting the first signaling belongs to a first subband*” as Required by Claim 1

.....

Petitioner only relies on You and specifically Fig. 6 of You for this limitation. Pet. at 42; Ex. 2004, ¶ 55. But the specification of Fig. 6 only makes clear the allegedly disclosed subband corresponds *to a singular subframe* in which M-PDCCH is monitored, as shown below:



Ex. 1005, Fig. 6; Ex. 2004, ¶ 55.

(POR 24-25.)

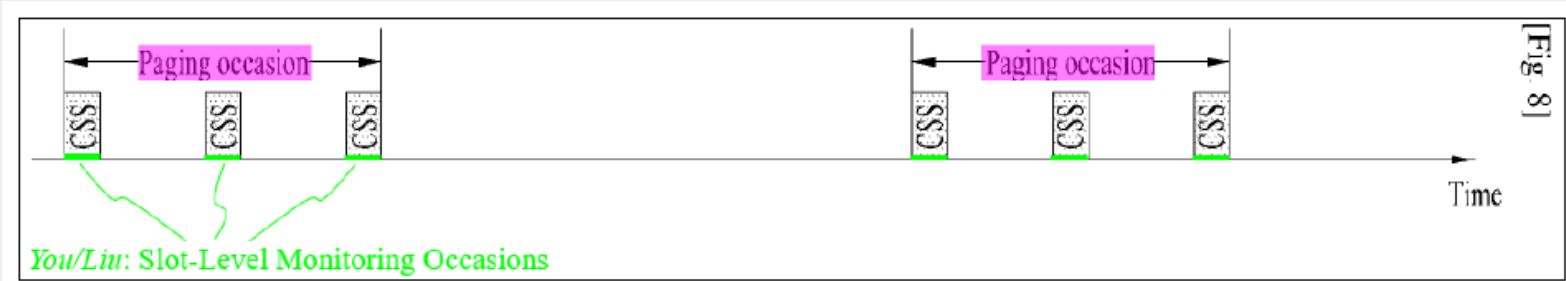
You/Liu’s Slot-Level Monitoring Can Be Done in A Single Sub-Frame

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

.....

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].

(Petition 37-38.)



You, Fig. 8.

(Petition 34.)

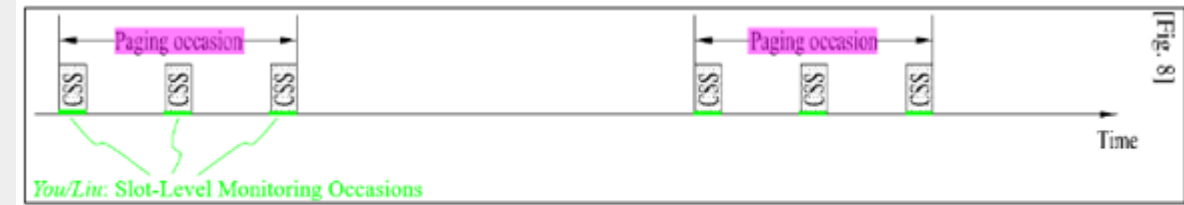
You/Liu's Slot-Level Monitoring Can Be Done in A Single Sub-Frame

- 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

(Bims Decl. (Ex. 1002), ¶117.)

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 Decl. (Ex. 1002), ¶200.)



You, Fig. 8.

(Bims Decl. (Ex. 1002), ¶200.)

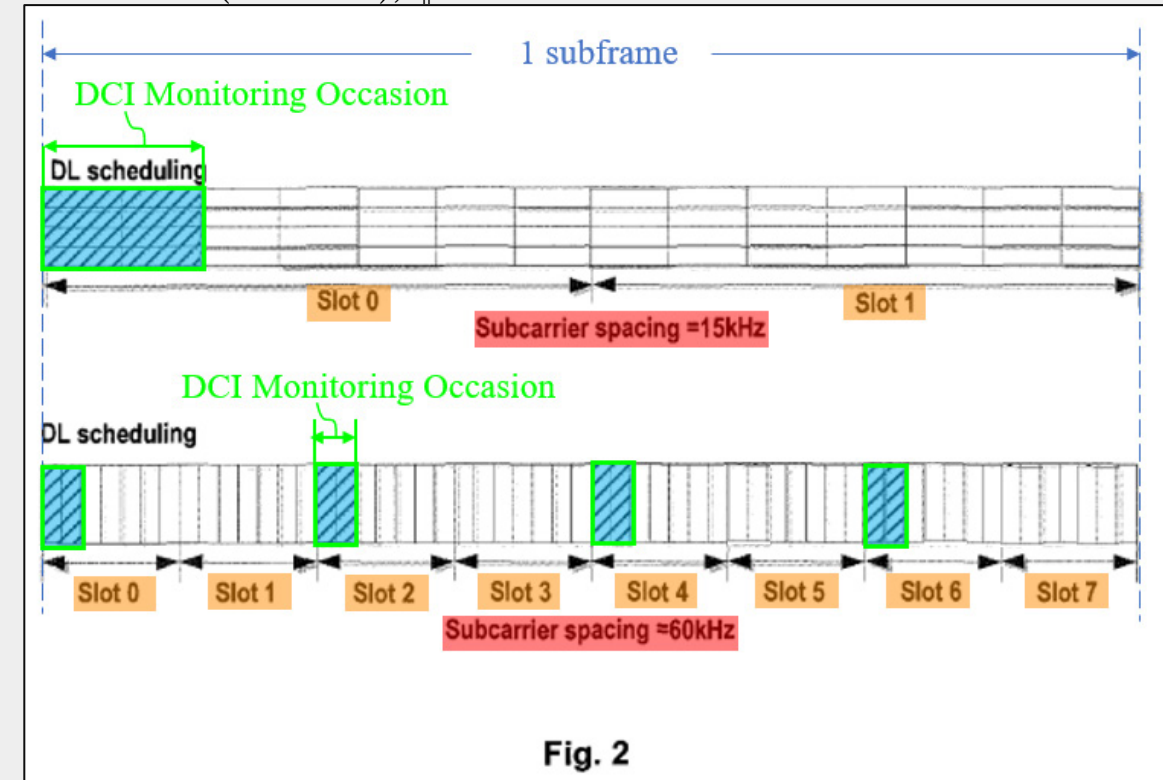


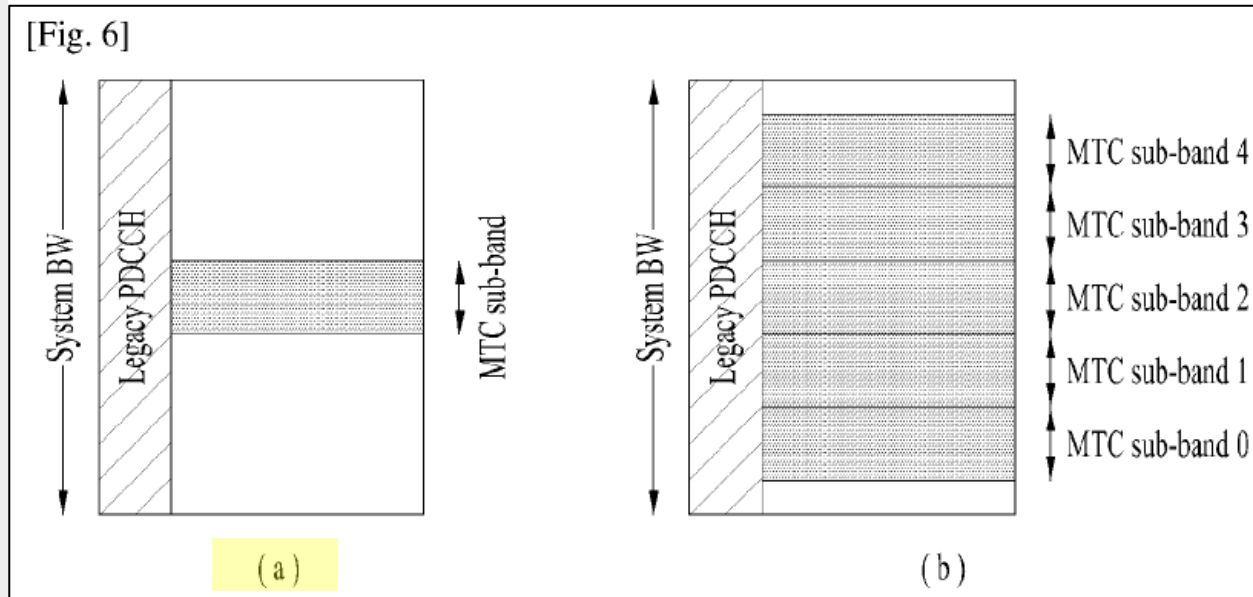
Fig. 2

(*Liu*, Fig. 2 (modified); Bims Decl. (Ex. 1002), ¶144.)

You Discloses the Monitoring Subband Can Exist In Multiple Sub-Frames

FIG. 6 illustrates an example of signals band for MTC.

As one method for reducing the cost of the MTC UE, an operation of the MTC UE may be performed at a reduced UE downlink and uplink bandwidth of 1.4 MHz, for example, regardless of an operating system bandwidth of a cell. At this time, a sub-band (narrowband) for operating the MTC UE may always be located at the center (e.g., 6 center PRBs) of a cell as shown in FIG. 6(a), or several subbands for MTC may be provided for one subframe to multiplex MTC UEs as shown in FIG. 6(b), whereby the UEs may use their respective subbands different from each other or the UEs use the same subband not the subband of 6 center PRBs.



(You, [175]-[176], Figs. 6(a) and 6(b).)

You Discloses the Monitoring Subband Can Exist In Multiple Sub-Frames

transmissions such as “the PDCCH, the PDSCH, etc.” *Id.*, [173]-[174]. To solve this problem, *You* “proposes that the eNB 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 non-consecutive] downlink subframes.” *Id.*, [177], [185].

(Bims Decl. (Ex. 1002), ¶97 (quoting *You*, [185]).)

In case of coverage enhancement (CE), M-PDCCH may be transmitted by being repeated once or multiple times. Therefore, a search space where M-PDCCH (hereinafter, paging M-PDCCH) will be monitored may be configured repeatedly over a plurality of downlink subframes, and a UE may attempt repeated reception of M-PDCCH within search spaces within the plurality of downlink subframes. If CE having a repetition level greater than 1 is applied, for example, each CSS shown in FIG. 8 may be a plurality of consecutive subframes that may have repetitions of M-PDCCH. If CE having a repetition level greater than 1 is applied, as another example, a plurality of CSSs within the same paging occasion shown in FIG. 8 may be CSSs for repetitions of the same M-PDCCH. If CE having a repetition level greater than 1 is applied, as still another example, a plurality of CSSs over a plurality of paging occasions shown in FIG. 8 may be CSSs for repetitions of the same M-PDCCH.

(*You*, [187].)

Disputed Issues

- Motivation to combine the cited 4G and 5G references
 - 4G references: *You, Mallick*
 - 5G reference: *Liu*
- “X time intervals” / “determining the X time intervals” (claim 1)
 - Claim construction of “time intervals”
 - Comparison to prior art
- “First subband” (claim 1)
- “Second radio signal” (claim 4)
- Expert qualifications

Claim 4: “Second Radio Signal [] Used for Determining at Least One of {Location of the First Subband . . . , Subcarrier Spacing . . . }

Apex

While Petitioner relies on the combination of *You* and *Liu* for the entirety of the claim limitation, Petitioner only relies on *You*’s SIB to disclose “the second radio signal” aspect. Pet. at 51-54; Ex. 2004, ¶ 59. However, a person of ordinary skill in the art would understand that *You* is a 4G / LTE system so its SIB would not determine at least one of {location of the first subband in frequency domain, subcarrier spacing of subcarriers included in the first subband, which are 5G / NR numerology metrics. *Id.* *You*’s SIB merely “includes parameters needed to determine if a specific cell is suitable for cell selection, as well as information about time-domain scheduling of the other SIBs.” Ex. 1005, [70]-[71]; Ex. 2004, ¶ 59. (POR 29.)

“Samsung’s combination of *You* and *Liu*.” Petitioner is clear that the portion of the combination used to disclose the claimed “second radio signal” is from *You*. Pet. at 51-54. And Patent Owner correctly addressed this disclosure in *You* and the cites (Sur-reply 20.)

Samsung

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

Second, *Liu* discloses that the UE can receive information for reconfiguring the time-frequency resources for monitoring DCI. Bims, ¶149. Specifically, *Liu*

“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.

(Petition 51-52.)

Claim 4: “Second Radio Signal [] Used for Determining at Least One of {Location of the First Subband . . . , Subcarrier Spacing . . . }

Apex

Since Petitioner fails to show how the combination of *You* and *Liu* discloses, teaches, or suggests “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,” it therefore cannot disclose, teach, or suggest “receiving a second radio signal 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}.” See *supra* Section VII.B.6; Ex. 2004, ¶ 58.

.

Additionally, as described in Section VII.A, there is no motivation to combine a 4G / LTE system with a 5G / NR system. *Id.*

Therefore, Claim 4 is not rendered obvious by the combination of *You* and *Liu*.

(POR 28-29.)

Samsung

It would have been obvious to modify *You*’s SIB message for reconfiguring CSS_paging to include *Liu*’s DCI configuration parameter. Bims, ¶150.

.

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.

(Petition 52-53.)

53, none of which are addressed by Apex. Given that the DCI configuration parameter includes “a numerology to be used” and a “frequency domain resource unit”; 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”), the combination results in what is claimed.

Petition 52-54.

(Pet. Reply 24.)

Disputed Issues

- Motivation to combine the cited 4G and 5G references
 - 4G references: *You, Mallick*
 - 5G reference: *Liu*
- “X time intervals” / “determining the X time intervals” (claim 1)
 - Claim construction of “time intervals”
 - Comparison to prior art
- “First subband” (claim 1)
- “Second radio signal” (claim 4)
- Expert qualifications

Level of Ordinary Skill Is Agreed and Adopted

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. (Petition 22.)

V. LEVEL OF ORDINARY SKILL IN THE ART

Patent Owner utilizes Petitioner's proposed level of skill in the art—a person of ordinary skill in the art ("POSITA") 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. Pet. at 22; Ex. 2004, ¶ 27. Someone with less or different technical education but more relevant practical experience, or more relevant education but less practical experience, could also be considered a POSITA. *Id.* (POR 12.)

We find Petitioner's definition to be consistent with the patent and prior art of record, and adopt it as our own for purposes of this Decision. *See, e.g., In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (approving the determination of the level of ordinary skill in the art by appeal to the references of record). (Institution Decision 10.)

Law Regarding Experts



“To offer expert testimony from the perspective of a skilled artisan in a patent case—like for claim construction, validity, or infringement—a witness must at least have ordinary skill in the art. Without that skill, the witness’ opinions are neither relevant nor reliable.”

Kyocera Senco Indus. Tools Inc. v. Int’l Trade Comm’n, 22 F.4th 1369, 1376-77 (Fed. Cir. 2022); see Pet. Reply 25-26.

Expert Qualifications

Dr. Bims (Samsung) ✓

9. I received a B.S. in Computer and Systems Engineering from Rensselaer Polytechnic Institute in 1985. I received an M.S. in Electrical Engineering in 1988 and a Ph.D. in Electrical Engineering in 1993, both from Stanford University. As a graduate student, I studied the principle of Digital Communications theory, including data modulation and demodulation, signal constellations and lattices, channel estimation, equalization, filtering, precoding, synchronization, and trellis coding. My Ph.D. thesis addressed the application of trellis coding and precoding to a digital modulation system, and was titled “Trellis Coding for Multi-Level, Partial Response Continuous Phase Modulation with Precoding.”

(Bims Decl. (Ex. 1002), ¶9.)

Mr. Gomez (Apex) ✗

2. I received my Bachelor’s degree in Electrical Engineering from Yale University in 1983.

(Gomez Decl. (Ex. 2004), ¶2.)

Curriculum Vitae of Miguel Gomez

2178 Sirah Ct., Livermore CA 94550
miguel@rockslideanalytics.com
ph. 415.793.4103

Education

Year	College or University	Degree
1983	Yale University	BSEE

(Gomez Decl. (Ex. 2004), Ex. A at 2.)

Expert Qualifications

Dr. Bims (Samsung) ✓

10. After receiving my Ph.D. in 1993, I worked for Glenayre Technologies – Wireless Access Group, where I worked on applications for wireless communication, including inventing, designing, and building a patented two-way pager test system and co-developing a wireless application protocol.
- • • • •
13. In 2001, I developed a business plan for building network infrastructure for Institute of Electrical and Electronics Engineers (“IEEE”) 802.11 standard (“Wi-Fi”) enterprise networks, and then later that year founded AirFlow Networks, Inc. where I invented and received eleven patents on a distributed antenna system design for wireless networks, based on the 802.11 wireless local area network specification.
14. I am currently the President of Protocomm Systems, LLC and Bims Laboratories, LLC, both of which I founded. As the President of Bims Laboratories, I perform technical research in wireless technology standards, such as UMTS, LTE/4G, 5G, Wi-Fi, Bluetooth, and other network communication protocols. I am named as an inventor of twenty-three telecommunications related patents.

(Bims Decl.
(Ex. 1002),
¶10, ¶¶13-14.)

Mr. Gomez (Apex) ✗

1. The details of my education, work experience, and research are summarized in my curriculum vitae (“CV”) which is attached to this Report as **Exhibit A**. I have summarized some of the relevant information about my experience and qualifications below.
2. I received my Bachelor’s degree in Electrical Engineering from Yale University in 1983.
3. I am a co-inventor on the following patents: U.S. Patent No. 7,814,204 “Method of and system for analyzing the content of resource requests”, U.S. Patent No. 7,447,777 “Switching System”, U.S. Patent No. 7,321,926 “Method and system for allocating resources to resource requests”, U.S. Patent No. 8,412,838 “Method and system for analyzing the content of resource requests”, and U.S. Patent No. 7,298,746 “Method and system for reassembling and parsing packets in a network environment.”
4. In summary, I have more than 35 years of experience as an Electrical Engineer with a broad background in integrated circuit design, storage, power conversion, telephony and telecommunications.
- (Gomez Decl. (Ex. 2004), ¶¶1-4.)

Expert Qualifications

Dr. Bims (Samsung) ✓



07/1992 - 12/1998 **Glenayre Technologies-Wireless Access Group • San Jose, California**

Position: *Member of Technical Staff; Sr. Member of Technical Staff; Manager of NOC Systems*

Employee #6 at the company, which was acquired by Glenayre Technologies, Nov 1997. Designed and built a 4-channel ReFLEX50 pager demonstration in 1 week. Participated in early field trials and feasibility studies, culminating in a Pioneer's Preference license award from the FCC to SkyTel Corporation for Narrowband PCS development.

(Bims Decl. (Ex. 1002), A-2.)

12/2001 - 05/2004 **AirFlow Networks, Inc. LLC • Sunnyvale, California**

Position: *CEO/CTO & Founder*

As the sole founder of the company, created the original business plan, raised venture capital, and hired the core engineering team. Grew the company to 32 people and shipped products for revenue in the US and overseas. Fifteen patents on the core technology have issued. These patents, which relate to wireless network infrastructure based on the 802.11 specification, have been sold to Broadcom.

(Bims Decl. (Ex. 1002), A-1.)

2/2014 – Present **Access Network Protocol Development**

Position: *Technical Lead Developer*

Developing a C++17-based DES of SDRs for wired and wireless network protocols, that includes IMT-2020 channel models. Implementations of the IEEE 802 and LTE protocol families, plus PTP, PPoE, IPv6, digital cable, Bluetooth, DSL, frame relay and many other managed node models for smart grid and vertical IoT applications. Used for technical analysis of emerging wireless standards amendments.

(Bims Decl. (Ex. 1002), A-3.)

Mr. Gomez (Apex) ✗



From: August 2006

To: March 30, 2009

Organization: ActSolar Inc.

Title: VP Engineering and System Architect

Summary: Mr. Gomez has designed and built a 400 watt power inverter which takes an input voltage of 30 volts DC and converts it to 240 VAC. Included in the design is an energy compensation circuit that recovers up to 40% of power normally lost due to power factor correction issues. Included as part of the inverter system was rooftop data collection for power and temperature with wireless connections to cloud management services.

(Gomez Decl. (Ex. 2004), Ex. A, 3.)

From: February 1997

To: December 1999

Organization: Philips Semiconductor

Title: Consultant

Summary:

- Developed the certification environment which was used by Philips Semiconductor and Microsoft to verify operation of Philips' Poseidon handheld chipset running Windows CE. This included board development, FPGA coding and simulation as well as porting Windows CE.
- Supported development of Philip's version of the Mips 4000 along with several of the peripheral devices that made up the system on a chip and the bus interconnect.
- Miguel Gomez also developed the ASIC logic and board level hardware for a 56Kbs software modem while at Philips.

(Gomez Decl. (Ex. 2004), Ex. A, 5.)

Expert Qualifications

Mr. Gomez (Apex) ❌

17 Which of those engineering
18 experiences involved wireless networking?
19 **A. There was quite a few that involved**
20 **wireless networking. The Philips environment**
21 **required wireless local area networking, as well**
22 **as working with Microsoft, to understand their**
23 **early smartphone implementations that they were**
24 **coming out with on CE.**
25 **Also the ActSolar required**
1 **transmission of data from the rooftops down to**
2 **the -- down to the receivers. And so we were**
3 **using a protocol called Zigbee. I think it was**
4 **802.11.15 was the underlying technology to that**
5 **-- to that -- to Zigbee. And so, you know, I**
6 **built a number of radio systems over the years**
7 **related to transmitting various types of data.**
8 **Q. Are there any others besides those**
9 **that you just called out?**
10 **A. Those are the two primary ones that I**
11 **-- that I recall.**

(Gomez Tr. (Ex. 1040), 47:17-48:11.)

2 **Q. Did any of the engineering**
3 **experiences listed on your CV involve 4G**
4 **cellular network communications?**
5 **A. From the engineering experiences,**
6 **most of the work was done either on the -- on**
7 **the 2G or the local area network protocols like**
8 **802.11a and some of the other protocols that had**
9 **to do with technology similar to 4G.**
10 **Q. But none of them directly involved**
11 **4G?**
12 **A. (Witness indicating.)**
13 **MR. PYMENTO: Objection.**
14 **THE STENOGRAPHER: I didn't get an**
15 **answer. I'm sorry.**
16 **THE WITNESS: Like I said, the**
17 **technologies included some of the same**
18 **elements of the 4G, like, you know, the**
19 **OFDM -- OF -- the orthogonal**
20 **frequency-division multiplexing.**
21 **(Stenographer clarification.)**
22 **THE WITNESS: Orthogonal**
23 **frequency-division multiplexing.**
24 **Some of the same technologies.**

1 **BY MR. HIGH:**
2 **Q. But none of them directly involved**
3 **4G?**
4 **MR. PYMENTO: Objection.**
5 **THE WITNESS: No.**
6 **BY MR. HIGH:**
7 **Q. Did any of the engineering**
8 **experiences involve 5G?**
9 **A. No.**

(Gomez Tr. (Ex. 1040), 50:2-51:9.)

Expert Qualifications

Mr. Gomez (Apex) ❌

2 Q In LTE was the term "user
3 equipment" limited to cell phones?

4 A I haven't opined on whether or not
5 it was limited to -- to cell phones in my
6 report.

7 Q Do you know the answer?

8 MR. PYMENTO: Objection to the
9 form.

10 A In my experience, much of this
11 technology has been applied to lots of
12 different forms, but I don't have a specific
13 answer for you, sitting here.

(Gomez Tr. (Ex. 1041), 25:2-13.)

16 In LTE, do you know how the devices
17 that could support 7.5 kHz determined what
18 the subcarrier spacing they should apply is?

19 MR. PYMENTO: Objection to the form
20 and scope.

21 A Yeah, again, I haven't opined in my
22 report on any characteristics of LTE
23 supporting 7.5 kHz.

24 Q And just to be clear, do you know
25 the answer?

1 MR. PYMENTO: Same objection.

2 A You know, I don't have an opinion.
3 I haven't studied it. I'd have to go back
4 and just make sure I get a correct answer for
5 you.

(Gomez Tr. (Ex. 1041), 25:16-26:5.)

15 Q And LTE, when you switch from a
16 normal cyclic prefix to an extended cyclic
17 prefix, how does the number of symbols
18 change?

19 A It reduces them. I just don't
20 recall, off the top of my head, how it -- how
21 many it reduces it by, but I think it's the
22 same.

(Gomez Tr. (Ex. 1041), 29:15-22.)

23 Q In LTE, how does switching from a
24 15 kHz subcarrier spacing to a 7 and a half
25 kHz subcarrier spacing affect the frame
1 structure?

2 A That I haven't studied, and I would
3 have to go back and look at that to give you
4 an accurate answer.

(Gomez Tr. (Ex. 1041), 29:23-30:4.)

16 Q And with a subcarrier spacing of 15
17 kHz, is the symbol length the same in both
18 LTE and 5G?

19 A Well, the slots are different, so I
20 believe the symbol is -- the symbol length
21 varies depending on the numerology in 5G.
22 And I just don't recall whether they're
23 exactly the same in -- in 15 kHz because the
24 slot numbers are different.

(Gomez Tr. (Ex. 1041), 34:16-24.)

14 Q Did LTE support extended cyclic
15 prefixes?

16 A That, I don't recall. I believe
17 they did, but I have to go back and check.

(Gomez Tr. (Ex. 1041) 28:14-17.)

23 Q In LTE, are you familiar with the
24 concept of a control region?

25 A Yes.

1 Q What is a control region?

2 A Well, it's a region which controls
3 information that's being transmitted.

4 Q Is it a region of a subframe?

5 A Again, I have to go back and look
6 at that for LTE. I don't recall if it's a
7 subframe or a slot.

8 Q Does the control region have a
9 particular number of symbols?

10 MR. PYMENTO: Objection to form.

11 A I don't recall that, off the top of
12 my head.

13 Q Do you recall whether the number of
14 symbols in a control region can change in
15 LTE?

16 A I haven't looked at LTE with regard
17 to this subject, so I have to go back and
18 look at it.

19 Q Was the control region where a
20 PDCCH was delivered for LTE?

21 A Again, I have to go back and look
22 at that to give you an accurate answer.

(Gomez Tr. (Ex. 1041), 39:23-40:22.)

Expert Qualifications

Mr. Gomez (Apex)

22 Q In LTE, did base stations and UEs
23 communicate using higher level signaling?

24 MR. PYMENTO: Same objection.

25 A **I'd have to go back and look at
1 that. I believe they did, but I just want to
2 make sure I give a correct answer.**

3 Q Did LTE use RRC signaling to
4 communicate?

5 A **I'd have to go back and look at
6 that.**

7 Q In 5G, do base stations and UEs
8 communicate using higher level signaling?

9 MR. PYMENTO: Objection to form.

10 A **When you say "higher level
11 signaling," what do you mean by that?**

12 Q Does that concept -- does that term
13 mean anything to you as a person of ordinary
14 skill in the art?

15 A **Yes, it does, but I just want to
16 make sure I understand how you're using it.**

17 Q What do you understand it to mean?

18 A **Well, it's a signaling that's done
19 at a higher control level.**

20 Q Does that occur in communications
21 between base stations and UEs in 5G?

22 MR. PYMENTO: Objection to form.

23 A **Yes, it does.**

24 Q Did that kind of signaling occur
25 between base stations in UEs in LTE?

1 MR. PYMENTO: Objection to the
2 form.

3 A **Like I said, I'd have to go back
4 and look at that.**

5 Q Is RRC an example of higher level
6 signaling?

7 A **Again, I'm just trying to
8 understand how you used the term "higher
9 level signaling."**

10 Q I'll use it in the way that you
11 understand it and in the way you provided it
12 in your definition.

13 A **Well, I haven't opined on that in
14 my report, so I'd like to understand how
15 you're using it.**

16 Q I'm using it the way you just
17 defined it.

18 A **I don't believe I gave a definition
19 for it.**

20 Q Higher level signaling, you said
21 it's signaling that's done at a higher
22 control level.

23 A **Okay.**

24 Q Is RRC an example of higher level
25 signaling under that definition?

1 A **I haven't given an opinion on that
2 in my report. You know, this is outside the
3 scope of the report, so to the extent that it
4 is a signaling, it could be a higher level
5 signaling.**

(Gomez Tr. (Ex. 1041),
41:22-44:5.)