

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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In the Patent of: **Yang, Xiu Zheng**, Shulin (TW);  
**Ren-Jr Chen**, Hsinchu (TW);  
**Chang-Lung Hsiao**, Hsinchu (TW);  
**Pang-An Ting**, Fongyuan (TW)

U.S. Patent No: 8,265,096

Issue Date: September 11, 2012

Appl. Serial No.: 12/168,855

Filing Date: July 7, 2008

Title: METHOD FOR CONSTRUCTING FRAME STRUCTURES

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PTAB Case No. IPR2021-00734

Patent No. 8,265,096 B2

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**PETITION FOR *INTER PARTES* REVIEW  
OF U.S. PATENT NO. 8,265,096 B2**

**Claims 1-4 and 6-8**

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## EXHIBIT LIST

| Exhibit  | Description                                                                                                                                     |
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| Ex. 1001 | U.S. Patent No. 8,265,096 (“the ’096 patent”)                                                                                                   |
| Ex. 1002 | Declaration of Dr. Sumit Roy (“Roy”)                                                                                                            |
| Ex. 1003 | <i>Sand Revolution II, LLC v. Continental Intermodal Group-Trucking LLC</i> , Paper 24, IPR2019-01393 (PTAB June 16, 2020)                      |
| Ex. 1004 | Fourteenth Supplemental Order Regarding Court Operations Under Exigent Circumstances Created by the Covid 19 Pandemic (W.D. Tex. Mar. 17, 2020) |
| Ex. 1005 | Excerpts from JEFFREY G. ANDREWS ET AL., FUNDAMENTALS OF WiMAX (2007)                                                                           |
| Ex. 1006 | Five Criteria Statement for P802.16m PAR Proposal, IEEE 802.16-06/055r3 (Nov. 15, 2006)                                                         |
| Ex. 1007 | IEEE 802.16m System Requirements, IEEE 802.16m-07/002r4 (Oct. 19, 2007)                                                                         |
| Ex. 1008 | Listing of Challenged ’096 Patent Claims                                                                                                        |
| Ex. 1009 | U.S. Provisional App. No. 60/929,798                                                                                                            |
| Ex. 1010 | Excerpts from ’096 Patent File History                                                                                                          |
| Ex. 1011 | Claim Construction Order in <i>STC.UNM v. Apple Inc.</i> , No. 1-20-cv-00351 (W.D. Tex. Apr. 9, 2020), ECF No. 69 (“Markman Order”)             |
| Ex. 1012 | U.S. Pub. No. 2009/0067377 A1 (“Talukdar”)                                                                                                      |
| Ex. 1013 | U.S. Provisional Application No. 60/956,031 (“Talukdar Provisional”)                                                                            |
| Ex. 1014 | Canadian Patent Application No. 2 581 166 A1 (“Wang”)                                                                                           |
| Ex. 1015 | WIPO Handbook on Industrial Property Information and Documentation, “Examples and Kinds of Patent Documents” (May 2016)                         |
| Ex. 1016 | U.S. Pub. No. 2007/0155387 A1 (“Li”)                                                                                                            |
| Ex. 1017 | U.S. Pub. No. 2007/0104174 A1 (“Nystrom”)                                                                                                       |
| Ex. 1018 | U.S. Pub. No. 2008/0095195 (“Ahmadi”)                                                                                                           |
| Ex. 1019 | Excerpts from William Stallings, WIRELESS COMMUNICATIONS AND NETWORKS (2D ED. 2005)                                                             |
| Ex. 1020 | U.S. Patent No. 7,460,466 B2 (“Lee”)                                                                                                            |

| Exhibit  | Description                                                                                                                                                                                                                                                                                                                                                              |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Ex. 1021 | U.S. Patent No. 8,462,611 B2 (“Ma”)                                                                                                                                                                                                                                                                                                                                      |
| Ex. 1022 | Fixed, nomadic, portable and mobile applications for 802.16-2004 and 802.16e WiMAX networks (November 2005)                                                                                                                                                                                                                                                              |
| Ex. 1023 | Mohammad Azizul Hasan, Performance Evaluation of WiMAX/IEEE 802.16 OFDM Physical Layer (June 2007)                                                                                                                                                                                                                                                                       |
| Ex. 1024 | U.S. Patent No. 7,710,910 B2 (“Ode”)                                                                                                                                                                                                                                                                                                                                     |
| Ex. 1025 | IEEE 802.16m System Requirements, IEEE 802.16m-07/002r4 (Jan. 12, 2007)                                                                                                                                                                                                                                                                                                  |
| Ex. 1026 | U.S. Pub. No. 2004/0037215 A1 (“Hwang”)                                                                                                                                                                                                                                                                                                                                  |
| Ex. 1027 | Yasamin Mostofi, <i>ICI Mitigation for Pilot-Aided OFDM Mobile Systems</i> (IEEE, Vol. 4, No. 2, Mar. 2005)                                                                                                                                                                                                                                                              |
| Ex. 1028 | Scott McKeown, <i>District Court Trial Dates Tend to Slip After PTAB Discretionary Denials</i> , Patents Post Grant (available at: <a href="https://www.patentspostgrant.com/district-court-trial-dates-tend-to-slip-after-ptab-discretionary-denials/">https://www.patentspostgrant.com/district-court-trial-dates-tend-to-slip-after-ptab-discretionary-denials/</a> ) |

## I. INTRODUCTION

Petitioner ZyXEL Communications Corporation (“ZyXEL”) requests that the Board institute *inter partes* review (“IPR”) of claims 1-4 and 6-8 of U.S. Patent No. 8,265,096 (“the '096 patent”) (the “challenged claims”), because those claims were  
5 unpatentable over the prior art discussed in this Petition but not considered by the Examiner during the original prosecution.

The '096 patent describes methods for constructing a data transmission frame structure with sections formatted for two communication systems, one of which supports higher mobility than the other. The frame includes: a first section  
10 comprising data formatted for the first system; a second section comprising data formatted for the second, higher-mobility system; and a non-data section that describes some aspect of data in one of the sections. To support higher mobility, the second system has a shorter symbol period or denser pilot symbols than the first system.

15 During prosecution of the '096 patent application, the Examiner did not appreciate that every aspect of the claimed methods was known in the prior art. Motorola had previously filed a patent application that described frame structures with data sections formatted for different communication systems. *Four years* before the application for the '096 patent, Ericsson engineers had filed a patent application  
20 disclosing a system that used denser pilot symbols for higher-mobility users. And

two years before the application for the '096 patent, Intel engineers had filed a patent application disclosing a system that used a shortened symbol period for higher-mobility users.

The Patent Office did not have the benefit of considering these references during prosecution. As shown below, all limitations of the challenged claims were known and obvious before the '096 patent. IPR should therefore be instituted, and the challenged claims should be cancelled.

## **II. MANDATORY NOTICES**

### **A. Real Parties in Interest**

ZyXEL Communications Corporation files this Petition because UNM Rainforest Innovations ("UNM"), recorded with the Patent Office as the allegedly current assignee of the '096 patent, sued ZyXEL Communications Corporation for infringing the '096 patent. ZyXEL Communications Corporation has had sole control over this Petition and is the real party in interest for this Petition. No other party controls, funds, or has been involved with the preparation or filing of this Petition. ZyXEL Communications Inc. is a U.S. subsidiary of ZyXEL Communications Corporation that also sells Wi-Fi products. ZyXEL Communications Inc. has not been sued for infringing the '096 patent. ZyXEL Communications Inc. does not have control over any decisions made by ZyXEL Communications Corporation and had no input in the current petition. As such,

ZyXEL Communication Corp. does not believe that ZyXEL Communications Inc. qualifies as a real party in interest to this proceeding. But, in the interest of full disclosure, ZyXEL Communications Corporation<sup>1</sup> identifies ZyXEL Communications Inc. to the Board.

5           **B.     Related Matters**

UNM has asserted certain claims of the '096 patent in the following pending district-court lawsuits: *UNM Rainforest Innovations v. ASUSTek Computer, Inc.*, No. 6:20-cv-00142 (W.D. Tex.); *UNM Rainforest Innovations v. Dell Techs. Inc. et al.*, No. 6:20-cv-00468 (W.D. Tex.); *UNM Rainforest Innovations v. D-Link Corp.*,  
10 No. 6:20-cv-00143 (W.D. Tex.); *UNM Rainforest Innovations v. TP-Link Techs. Co.*, No. 6:19-cv-00262 (W.D. Tex.); and *UNM Rainforest Innovations v. ZyXEL Commc'ns Corp.*, No. 6:20-cv-00522 (W.D. Tex.).<sup>2</sup>

Third-party, Qualcomm Incorporated, has also filed IPR petitions challenging claims 1-4 and 6-8 of the '096 Patent.<sup>3</sup> *Qualcomm Incorporated v. UNM Rainforest*

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<sup>1</sup> Any reference to "ZyXEL" in this petition refers to ZyXEL Communications Corporation.

<sup>2</sup> UNM also asserted the '096 patent in *UNM Rainforest Innovations v. Apple Inc.*, No. 1:20-cv-00351 (W.D. Tex.) ("the *Apple* litigation"), which has been dismissed. See Dkt. #80 (Aug. 5, 2020).

<sup>3</sup> Third-party Intel Corp. also filed an IPR petition challenging the same claims in *Intel Corp. v. UBM Rainforest Innovations*, IPR2020-01576, Paper 2 (Sept. 14,

*Innovations*, IPR2021-00375, Paper 2 (Dec. 28, 2020) (“the Qualcomm IPR”). A motion for joinder with IPR2021-00375 accompanies this Petition.

Finally, original patentee Industrial Technology Research Institute (“ITRI”) filed a civil complaint on January 25, 2021 against both UNM and Sino Matrix Technology, Inc.(UNM’s assignee) in the Taiwan Hsinchu District Court seeking a declaratory judgment that ITRI is the owner of all rights in certain patents, including the '096 patent.

**C. Notice of Counsel and Service Information**

Petitioner’s counsel are:

| Lead Counsel                                                                                                                                                                                | Back-Up Counsel                                                                                                                                                                                                                                                                                                                                                          |
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2020), which was recently terminated before any institution decision or UNM’s preliminary response. *See id.*, Paper 8.

|  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Filed herewith is a Power of Attorney appointing the above-named counsel.

### III. REQUIREMENTS FOR *INTER PARTES* REVIEW

#### A. Standing

The '096 patent qualifies for IPR, and Petitioner is not barred from requesting review.

#### 5 B. Challenge Grounds

Claims 1-4 and 6-8 of the '096 patent were obvious on the following grounds:

| Ground | Basis for Obviousness                 | Challenged Claims |
|--------|---------------------------------------|-------------------|
| 1      | Talukdar (Ex. 1012) and Li (Ex. 1016) | 1-4, 6-7          |
| 2      | Talukdar and Nystrom (Ex. 1017)       | 8                 |

Talukdar, Li, Nystrom, and other references illustrate the state of the art at the time of the alleged invention. *See Ariosa Diagnostics v. Verinata Health, Inc.*, 805 F.3d 1359, 1365 (Fed. Cir. 2015) (“Art can legitimately serve to document the knowledge that skilled artisans would bring to bear in reading the prior art identified as producing obviousness.”) (citation omitted).

The Declaration of Dr. Sumit Roy<sup>4</sup> (Ex. 1002, “Roy”) and other evidence cited therein and in the Exhibit List further support this Petition.

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<sup>4</sup> Dr. Roy’s declaration is identical to his declaration in the Qualcomm IPR. *See* Roy ¶ 1.

**IV. THE BOARD SHOULD NOT DENY INSTITUTION FOR DISCRETIONARY REASONS**

Section 325 does not apply because the Qualcomm IPR, which raised prior art not cited or considered during prosecution to support entirely new arguments, and  
5 Petitioner's challenge is substantively identical to it. *See Celltrion, Inc. v. Genentech, Inc.*, IPR2018-01019, Paper 11 at 7, 11-13 (P.T.A.B. Oct. 30, 2018) (declining to exercise discretion under § 325 with respect to a "copycat" petition "for the same reasons stated in our Institution Decision in the [original] IPR," and further observing that "[Petitioner] filed a concurrent motion to join the [original] IPR,  
10 effectively obviating any concerns of serial harassment and unnecessary expenditure of resources.").

Section 314 likewise does not support denial. This is the first petition Petitioner filed challenging any claim of the '096 patent. *Cf. Apple Inc. v. Uniloc 2017 LLC*, IPR2020-00854, Paper 9 at 8 (P.T.A.B. Oct. 28, 2020) (exercising  
15 discretion under § 314 and denying institution with respect to follow-on petition where the petitioner had previously filed a petition that the Board declined to institute). Although Section 314 gives the Director discretion regarding IPR petitions, it does not appear to give the Director unfettered discretion to deny an otherwise meritorious petition. Further, although Petitioner is a defendant in one  
20 action, *UNM Rainforest Innovations v. ZyXEL Communications Corporation*, No. 6-20-cv-00522 (WDTX) (W.D. Tex.) ("the ZyXEL litigation"), the factors set out in

*Apple, Inc. v. Fintiv, Inc.*, Paper 11, IPR2020-00019 (PTAB Mar. 20, 2020) (precedential), favor proceeding with this Petition.

***Fintiv factor 1, likelihood of a stay.*** The district court has not granted a stay pending IPR in any of the parallel litigations, and Petitioner is not aware of grounds for one in those litigations. Absent specific evidence regarding a potential stay based upon an IPR, the Board “will not attempt to predict” how the court will proceed. *Sand Revolution II, LLC v. Cont’l Intermodal Group-Trucking LLC*, IPR2019-01393, Paper 24 at 7 (PTAB June 16, 2020) (informative) (Ex. 1016). This factor is neutral. *Id.*

***Fintiv factor 2, trial date proximity to Final Written Decision (FWD).*** The FWD will issue before the trial date in the *ZyXEL* case (April 4, 2022). The Court has not yet set a trial date in either the *D-Link* case or the *TP-Link* case, and, therefore trials in those cases are highly likely to be set later than the latest of the currently set trial dates in the other cases before the same court (April 4, 2022 in *ZyXEL*) that are further along procedurally, which means that the FWD should issue before trial in *D-Link* and *TP-Link*. Although the scheduled trial dates in the *Dell* case (November 8, 2021) and the *ASUSTek* case (January 3, 2022) are ostensibly before the expected FWD date, the Board has recognized that trial dates are often amended and continued, particularly as the calendared dates approach. *Sand Revolution*, Paper 24 at 9 (uncertainty of expected trial date weighed against exercising discretion to deny

institution). A trial date that is a year away is inherently uncertain. *Cf. In re Apple Inc.*, No. 2020-135, 2020 WL 6554063, at \*8 n.5 (Fed. Cir. Nov. 9, 2020) (noting, in the transfer analysis context, that the time to trial factor “frequently calls for speculation” because “scheduled trial dates are often subject to change”). Across all  
5 districts, the average trial delay is three months, and “[i]n the WDTX, **70% of trial dates initially relied upon by the PTAB to deny petitions have slid.**” Ex. 1028. The Western District of Texas did not conduct any trials for several months after the COVID-19 pandemic, and recently postponed civil jury trials through April 30, 2021. *See* Fourteenth Supplemental Order Regarding Court Operations Under the  
10 Exigent Circumstances Created by the COVID-19 Pandemic (W.D. Tex. Mar. 17, 2021) (Ex. 1007). The continuing uncertainty created by the pandemic and current backup of cases, including criminal cases that will take priority over civil cases when trials resume, creates significant uncertainty about trial dates in later cases. This factor is, therefore, at worst, neutral.

15 ***Fintiv factor 3, investment in the parallel proceedings.*** The “Investment in the Parallel Proceeding by the Court and the Parties” (*Fintiv* at 10) weighs heavily against denial. The *ZyXel* litigation is at an early stage. The Court has summarily denied ZyXEL’s motion to dismiss for lack of standing, which did not concern the validity or infringement of the ‘096 patent. Analogously, in *Dish Network LLC v. Broadband iTV*, IPR2020-01267, the PTAB instituted IPR where, in a parallel case,  
20

the Court had denied a motion to dismiss under 35 U.S.C § 101 and did not provide analysis of challenged claims or subject matter eligibility. *Id.*, Paper 15 at p. 19. In addition, the Court has set a *Markman* hearing for May 13, 2021, and neither the claim construction process nor fact discovery has begun yet. The court issued a three-page *Markman* order (Ex. 1005) in the prior *Apple* litigation that had no substantive analysis. *Sand Revolution* at 10-11 (two-page *Markman* Order did not demonstrate a high level of investment of time and resources). The parties in *Dell* and *ASUSTek* have stipulated to the Court's previous claim constructions on all terms of the '096 patent and have adopted positions identical to those advanced by the parties in the *Apple* case. *Dell* ECF No. 49, pp. 2-3; *ASUSTek* ECF No. 27, pp. 2-3. The Court has not conducted *Markman* hearings in any other cases regarding the '096 patent and largely has been dealing with procedural motions unrelated to matters of claim construction, validity, or infringement of the '096 patent. Petitioner filed this Petition expeditiously, substantially before the one-year bar date. *Fintiv* at 11. This factor weighs against discretionary denial.

***Fintiv factor 4, overlap of issues.*** The invalidity grounds, arguments, and evidence presented in this Petition will be different than those presented in the litigations. This Petition challenges claims (claims 2 and 13), which are not asserted in any of the litigations. Further, ZyXEL will stipulate in the *ZyXEL* litigation, prior to any trial, that if the Board institutes IPR of the challenged claims in this Petition,

ZyXEL will not pursue invalidity of the challenged claims on the same grounds or even the same references at issue in this Petition. This mitigates concerns of duplicated efforts and conflicting decisions. See *VMware, Inc. v. Intellectual Ventures I LLC*, IPR2020-00470, Paper 13 at 20 (PTAB Aug. 18, 2020) (finding  
5 similar stipulation “mitigates any concerns of duplicative efforts between the district court and the Board, as well as concerns of potentially conflicting decisions”). This factor weighs against discretionary denial.

***Fintiv factor 5, whether petitioner and defendant are the same.*** This factor weighs against discretionary denial. Even though the petitioner is the same party as  
10 the defendant in the *ZyXEL* litigation, this petition is substantively identical to Qualcomm IPR where the petitioner is not a defendant in any of the litigations. *Fintiv*, IPR2020-00019, Paper 11 at 13 (considering “whether the petitioner and the defendant in the parallel proceeding are the same party”). This factor therefore weighs against denial.

***Fintiv factor 6.*** The “other circumstances that impact the Board’s exercise of  
15 discretion, including the merits” (*Fintiv*, IPR2020-00019, Paper 11 at 6, 14-15) heavily favor institution, because the grounds raised are particularly strong: the prior art demonstrates unpatentability based on references not considered by the Examiner that would have been combined by skilled artisans as asserted. Finally, this Petition  
20 is substantively identical to the Qualcomm IPR, and does not raise any grounds for

invalidity that are not raised there. These circumstances weigh against discretionary denial.

The *Fintiv* factors, viewed holistically, demonstrate that instituting review would promote efficiency and integrity of the system. *Fintiv*, IPR2020-00019, Paper 5 11 at 6. Discretionary denial under § 314 is not appropriate.

## V. OVERVIEW OF THE '096 PATENT

From the 1990s into the early 2000s, the popularity of wireless cellular communication systems and wired broadband communication systems grew exponentially. Both systems were widely adopted, but they were distinct.

### 10 A. Background: History of Broadband Wireless and the IEEE 802.16 WiMAX Standards

From the 1990s into the early 2000s, the popularity of wireless cellular communication systems and wired broadband communication systems grew exponentially. Both systems were widely adopted, but they were distinct.

15 Cellular wireless systems typically included a number of mobile stations (*e.g.*, cellular telephones) and fixed base stations that communicated wirelessly with the mobile stations. Roy ¶ 52. Base stations received communications from mobile stations and helped route the communications to intended destinations, which could be telephones on the public wired telephone network or other mobile stations on a  
20 network like the Internet. Cellular wireless systems allowed users to stay connected even while moving and were used primarily for voice calls and low-bitrate

applications. Roy ¶ 54. Broadband systems, on the other hand, typically involved user equipment with more computational power (*e.g.*, personal computers) connected over a wireline medium to the Internet or a local network. *Id.* Broadband systems provided users with significantly higher bandwidth than wireless systems and facilitated data-heavy applications like Internet browsing, file downloading, and media streaming.

In 1998, the Institute of Electrical and Electronics Engineers (IEEE) formed the 802.16 group, which sought to combine broadband-level service with wireless techniques in the “WiMAX” standard. Roy ¶ 63. The group released a first 802.16 standard in 2001 and established the WiMAX Forum to promote certification efforts. *Id.* ¶¶ 63-65. In 2003, the group amended the standard to add support for multipath environments, where the signal arriving at a receiver contained reflected radio waves arriving via different paths. *Id.* ¶¶ 63-64. The air interface for 802.16 was based on orthogonal frequency division multiplexing (OFDM) techniques, which allowed a transmission to be sent over a large frequency bandwidth divided into multiple overlapping but orthogonal sub-carrier frequencies (often called “subcarriers”). *Id.* ¶¶ 71-73. At the time, OFDM was the dominant technique for handling broadband multipath scenarios. *Id.* ¶ 71.

But broadband wireless still could not provide the high-throughput data rates of traditional broadband services. Roy ¶ 54, 58. The 802.16 group understood that

adoption of broadband wireless would depend largely on their ability to differentiate it based on features such as portability and mobility, which traditional broadband could not offer. *Id.* The group thus began work on revisions to the 802.16 standard that were focused on providing mobility support. *Id.*

5           The first 802.16 revision that included mobility support was published in 2005 as 802.16(e). Roy ¶ 64. The 802.16(e) revision defined a mobile system profile (called “Mobile WiMAX”) that used OFDM to support user equipment moving at up to vehicular speeds. *Id.* The 802.16(e) revision also used orthogonal frequency division multiple access (OFDMA)—a technique that allowed sub-carrier  
10 frequencies to be allocated among multiple users—to scale the data rate based on the available channel bandwidth. Roy ¶¶ 75-76.

          The 802.16(e) revision specified a default frame structure for data transmissions:

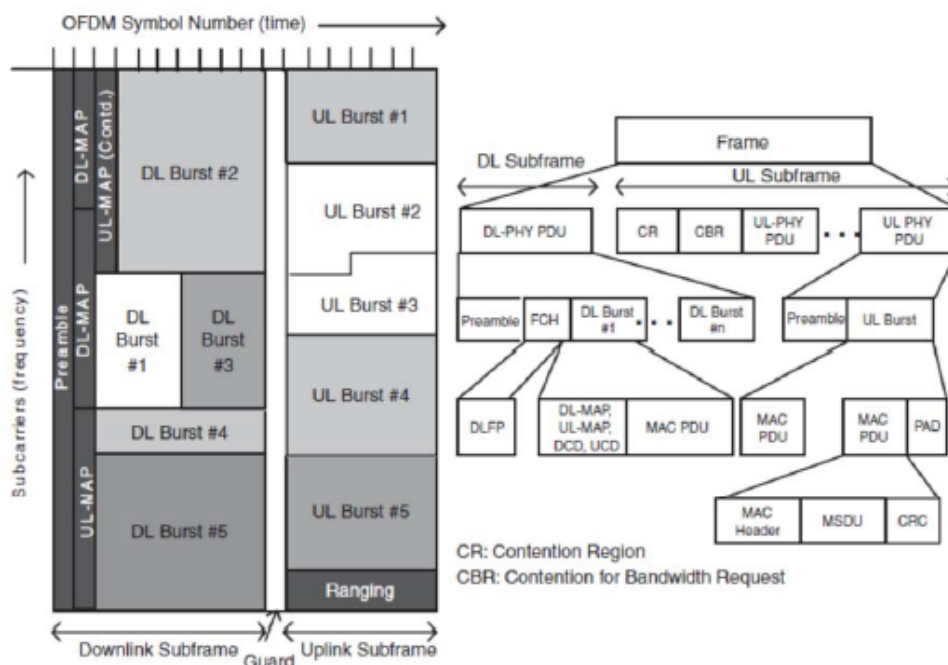


Figure 2.1 A sample TDD frame structure for mobile WiMAX

Ex. 1005 (“Fundamentals of WiMAX”) at 45; Roy ¶ 68. As shown above, an 802.16 frame included *downlink* (DL) subframes, which were used for communications from the base station to mobile stations, and *uplink* (UL) subframes, which were used for communications from mobile stations to the base station. *Id.* ¶¶ 68-69. The downlink subframe began with a preamble that included information used for time and frequency synchronization and channel estimation. *Id.* A frame control header (FCH) and downlink and uplink MAP messages (DL-MAP, UL-MAP) followed. *Id.* The FCH provided frame configuration information such as the length of the MAP messages, the modulation and coding schemes used for the frame data, and the usable subcarriers. *Id.* The DL-MAP and UL-MAP messages specified which data

regions within the frame were allocated to which users, as well as data modulation and coding schemes. *Id.*

Mobility support created implementation challenges, particularly for OFDM systems. Faster-moving user devices experienced frequently-changing channel conditions, Doppler spreads, and higher levels of interference between OFDM subcarriers. Roy ¶ 81. Wireless systems typically used “pilot” symbols—symbols with a known value and format, transmitted at known intervals—to perform channel estimation, which helped compensate for these issues. *Id.* But devices traveling at vehicular speeds did not always receive pilot symbols frequently enough for channel estimation purposes.

In 2006, the 802.16 group began developing another mobility-focused revision, 802.16(m), which supported higher data rates for mobility scenarios and improved the levels and quality of service of cell coverage. Roy ¶ 66. During development, the 802.16 group specified that 802.16(m) would also support legacy 802.16(e) systems. *Id.* The 802.16(m) revision was released in 2011. *Id.*

Thus, by the mid-2000s—well before the '096 patent—providing mobility support in broadband wireless systems was a known goal. The IEEE had identified mobility as a key objective for broadband wireless systems in the 802.16(e) standard, which it released in 2005. The 802.16(m) standard, begun in 2006, extended mobility support in a manner consistent with cellular standards. Implementation-level details

were left to equipment manufacturers and telecommunications providers to develop more fully.

**B. The '096 Patent Discloses Constructing a Frame Structure to Provide Compatibility between 802.16 Systems with Mobility Support**

Consistent with these industry efforts, the named inventors of the '096 patent described a frame structure for 802.16 systems that provided enhanced mobility support. The '096 patent recognizes the default frame structure defined by the 802.16 standard as prior art:

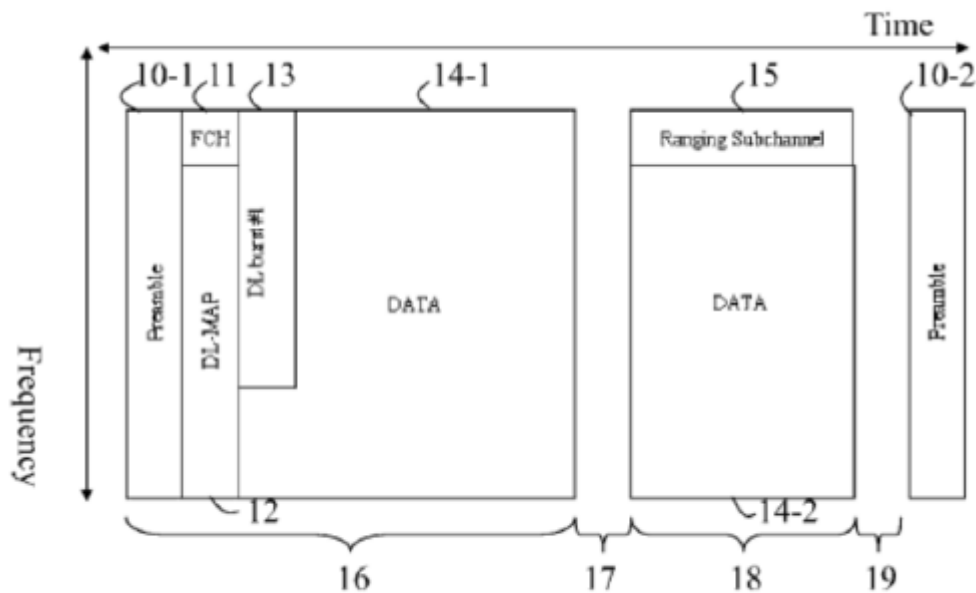


FIG. 1 (Prior Art)

'096 patent, Fig. 1; *id.* at 1:28-31, 1:36-37. As discussed above (*supra* at 11-13), an 802.16 frame included a downlink subframe and an uplink subframe (subframes 16 and 18, respectively, in Figure 1). '096 patent at 1:37-39. The downlink subframe

included sections for user data (DATA 14-1) and non-data information (preamble 10-1, FCH 11, and DL-MAP 12). *Id.* at 1:46-49.

The '096 patent observes that 802.16(m), which was under development when the '096 patent application was filed, would require “full backward compatibility with the legacy system defined in the IEEE Standard 802.16e” and provide “higher speed tolerance” than 802.16(e). *Id.* at 1:30-35; *supra*, § IV(A). The patent proposes an amended frame structure that addresses these compatibility and mobility requirements.

To address backward compatibility, the patent calls for splitting the downlink and uplink subframes into two zones: a first zone containing data formatted for a first system (*e.g.*, a user device compliant with 802.16(e)), and a second zone containing data formatted for a second system (*e.g.*, an 802.16(m) device):



*Id.*, Fig. 3 (downlink Zones 1 and 2 (30-1, 30-2), uplink Zones 1 and 2 (34-1, 34-2)); *id.* at 4:21-67. The frame retains the standard non-data portions of the 802.16 format, including the preamble, FCH, and DL-MAP. *Id.*, Fig. 3 (preamble 10-11, FCH 11, DL-MAP 12); *id.* at 4:40-46, 4:57-67; Roy ¶ 84.

5           To address mobility support, the '096 patent describes creating a zone for the second system with a modified symbol structure. '096 patent, Fig. 4 & 5:1-16. The patent observes that shortening the duration of symbols could improve mobility scenarios, because “a shorter symbol period may be more robust to inter-symbol interference” experienced by faster-moving devices. *Id.* at 5:16-17. Alternatively,  
10       increasing the density of pilot symbols could improve mobility support because “denser pilot symbols may achieve better channel estimation accuracy.” *Id.* at 5:17-18. The patent thus proposes incorporating either scheme into the new system zone: “zones ... for the new system ... under higher mobility ... may have a shorter symbol period or more pilot symbols placed therein” than the zones for the older system. *Id.*  
15       at 5:8-14; *id.*, Figure 7 & 7:38-8:6.

### **C.     The Challenged Claims of the '096 Patent**

The challenged claims of the '096 patent cover methods for constructing frame structures. Independent claim 1 recites as follows (with labels added):

20           1[pre]. A method of constructing a frame structure for data transmission, the method comprising:

1[a] generating a first section comprising data configured in a first format compatible with a first communication system using symbols;

1[b] generating a second section following the first section, the second section comprising data configured in a second format compatible with a second communication system using symbols, wherein the first communication system's symbols and the second communication system's symbols co-exist in one transmission scheme

1[c] and wherein: the second format is compatible with the second communication system configured to support higher mobility than the first communication system, wherein each symbol in the second communication system has a shorter symbol period than that in the first communication system;

1[d] generating at least one non-data section containing information describing an aspect of data in at least one of the first section and the second section; and

1[e] combining the first section, the second section and the at least one non-data section to form the frame structure.

Independent claim 8 is identical to claim 1, except that it replaces limitation 1[c] with “and wherein the second communication system has pilot symbols that are denser than those in the first communication system.” Claims 2-4 and 6-7 depend from claim 1 and specify further limitations relating to the nature and location of

information within the frame structure. Exhibit 1008 provides a full listing of the challenged claims.

**D. Priority Date and Prosecution History of the '096 Patent**

The application for the '096 patent was filed on July 7, 2008. It identified two  
5 provisional applications filed on July 12, 2007, and September 17, 2007. The July  
12 provisional, App. No. 60/929,798, consisted of a nine-page slide deck. Ex. 1009.  
This provisional did not contain any disclosure relating to a second communication  
system that had a shorter symbol period or denser pilot symbols. *Id.*; Roy ¶¶ 86-88.  
Each of the claims challenged in this Petition requires a frame section comprising  
10 data configured for a system “wherein each symbol ... has a shorter symbol period  
than that in the first communication system” (claims 1-4, 6-7) or that “has pilot  
symbols that are denser than those in the first communication system” (claim 8).  
*Infra*, § IV(C). Thus, the July 12 provisional did not contain written description  
support for the challenged claims, and September 17, 2007, is their earliest possible  
15 priority date. Petitioner reserves the right to assert a different actual priority date.

During prosecution of the application that issued as the '096 patent, the  
Examiner issued multiple office actions rejecting the challenged claims over  
different prior art combinations. The applicants ultimately amended various  
independent claims to recite that “the first communication system and the second  
20 communication system co-exist in one transmission scheme.” Ex. 1010 at 28, 41.

The applicants identified the support for this amendment as being “paragraph [0025] of Applicants’ published specification” (*id.* at 41), which disclosed that “the present invention may allow data of an old orthogonal frequency division multiple access (OFDMA) system (hereinafter a legacy system) and data of a new OFDMA system  
5 ***to co-exist in an OFDMA frame*** by changing a frame structure of the OFDMA frame” (*id.* at 5, [0025])<sup>5</sup>; Roy ¶¶ 89-90.

Following this amendment, the applicants held a telephonic interview in which the Examiner suggested amending the added claim language to recite that “the first and second systems’ *symbols* co-exist in one transmission scheme (as opposed  
10 to the first and second *systems* co-existing in one transmission scheme).” Ex. 1010 at 44. The Examiner made this amendment and subsequently allowed the claims. *Id.* at 52-54.

The Examiner did not consider any of the art relied upon in this Petition during prosecution of the '096 patent. As shown below, the Talukdar reference disclosed a  
15 frame structure in which the symbols of different systems co-existed in one transmission scheme. Ex. 1012 (“Talukdar”), [0051] (“FIG. 7 is a hybrid frame 700 ... designed to serve both 802.16(e) and 802.16(m) data traffic in the same 5 msec interval.”). The Li and Nystrom prior art references similarly disclosed different

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<sup>5</sup> Unless noted otherwise, all emphasis is added.

symbols of different communication systems co-existing in one transmission scheme and further disclosed communication systems configured to support higher mobility that used symbols with “a shorter symbol period” and “[denser] pilot symbols.” Ex. 1016 (“Li”), [0037] (“[T]he communications system ... may employ two OFDM  
5 symbol durations ... one set assigned to the slow and fast subscribers respectively. In an embodiment, the communications system ... ***assigns shorter symbol duration ... to the fast subscribers***”); Ex. 1017 (“Nystrom”), [0043] (“It is beneficial ... to ***assign resources*** for mobiles with certain ***fast varying channel or Doppler conditions*** in the ***dense parts of the pilot pattern*** and users with more slowly varying  
10 conditions in the less dense parts”). The teachings of these previously-unconsidered prior art references rendered the challenged claims obvious.

#### **E. Level of Ordinary Skill in the Art**

As of 2007, a person of ordinary skill in the art (“POSA”) in the field of the '096 patent would have had a Bachelor’s degree in electrical engineering, computer  
15 engineering, or a related field, and around two years of experience in the design or development of wireless communication systems, or the equivalent. Roy ¶¶ 49-51.

#### **F. Claim Construction**

Pursuant to 37 C.F.R. § 42.100(b), the Board construes claims in an IPR in accordance with the standard articulated in *Phillips v. AWH Corp.*, 415 F.3d 1303  
20 (Fed. Cir. 2005), under which the “words of a claim are generally given their

ordinary and customary meaning.” *Id.* at 1312-13. The following terms were construed in the *Apple* litigation. *See* Ex. 1011. Although Petitioner does not blanketly endorse all claim constructions in that case, these constructions are consistent with the positions advanced in this Petition.

- 5           • “frame structure” (claims 1, 8): “a single structure comprising one or more frames, wherein each frame may have one or more subframes”
- “data / non-data” (claims 1-3, 6-8): “[p]lain-and-ordinary meaning”
- “communication system” (claims 1, 8): “[p]lain-and-ordinary meaning, where the plain-and-ordinary meaning is ‘a combination of hardware and
- 10           software that transmits and receives data according to one or more communications standards”
- “symbol” (claims 1, 8): “[p]lain-and-ordinary meaning, wherein the plain-and-ordinary meaning means ‘a transmissible unit of information”
- “wherein the first communication system’s symbols and the second
- 15           communication system’s symbols co-exist in one transmission scheme” (claims 1, 8): “[p]lain-and-ordinary meaning[,] where the plain-and-ordinary meaning is ‘wherein symbols of the first communication system and symbols of the second communication system exist together in one transmission scheme”

- “support higher mobility than” (claim 1): “support higher relative velocity between a transmitter and a receiver than”
- “symbol period” (claim 1): “the time it takes to transmit one symbol”
- “at least one of [...] and [...]” (claims 1, 2, 3, 4, 6, 8): “[...] and/or [...]”
- “pilot symbols that are denser than” (claim 8): “more pilot symbols per unit time than, wherein a unit time is the symbol period of the first communication system”

## **VI. OVERVIEW OF THE PRIOR ART RELIED UPON IN THIS PETITION**

Like the '096 patent, Talukdar disclosed a frame structure that provided compatibility between multiple 802.16 systems. Li and Nystrom disclosed supporting higher-mobility systems by shortening the symbol duration and increasing the pilot symbol density, respectively, for these systems. None of these references was before the Patent Office during prosecution of the '096 patent.

### **A. Talukdar**

The Talukdar publication (Ex. 1012), assigned to Motorola, Inc., disclosed a radio frame with regions formatted for first and second transmission protocols. The application that led to Talukdar claimed priority to a provisional application filed on August 15, 2007, was filed on August 13, 2008, and published on March 12, 2009.

As discussed below, Talukdar was entitled to the filing date of its provisional and was therefore prior art to the '096 patent under pre-AIA 35 U.S.C. § 102(e).

Talukdar taught that evolving wireless systems should include “support for legacy system equipment.” Talukdar, [0003]. Because “some IEEE 802.16e and IEEE 802.16m base stations and mobile stations are likely to coexist within the same network,” “IEEE 802.16e mobile stations should be compatible with IEEE 802.16m base stations, and IEEE 802.16e base stations should support IEEE 802.16m mobile stations.” *Id.*; *id.*, [0027] (“[I]t is generally desirable for the new technologies to be backward compatible with the legacy technology[.]”). To this end, Talukdar proposed “frame structures” that “maintain[ed] backward compatibility” between 802.16(m) and 802.16(e) systems. *Id.*, [0003].

Talukdar described constructing a frame structure with distinct data regions formatted for 802.16(e) and 802.16(m) systems:

The 802.16(m) 5 msec frame can be perceived to be composed of following types of basic regions: ***e-DL region used for transmission of downlink traffic to 802.16(e) terminals***; e-UL: region allocated for transmission of data and control messages by 802.16(e) terminals; ***m-DL: region allocated for transmission to 802.16(m) terminals***; and m-UL: region allocated for transmission by 802.16(m) terminals.

*Id.*, [0029]; *id.*, Fig. 7 (showing hybrid frame 700). Consistent with the frame format defined by 802.16(e), the preamble and DL-MAP regions were placed at the beginning of the 802.16(e) block. *Id.*, [0051].

Talukdar thus disclosed methods for constructing a frame structure that included first and second sections comprising data formatted for first and second communication systems (802.16(e) and 802.16(m) systems), and a non-data section describing an aspect of the transmitted data. Roy ¶¶ 91-94.

5 Talukdar's priority date for prior art purposes is August 15, 2007, the filing date of its provisional application. See Ex. 1013 (Provisional Application No. 60/956,031, "Talukdar Provisional"). "[F]or a non-provisional application to claim priority to a provisional application for prior art purposes," the provisional application "must contain a written description of ... the invention claimed in the  
10 non-provisional application." *Amgen Inc. v. Sanofi*, 872 F.3d 1367, 1380 (Fed. Cir. 2017) (citing *Dynamic Drinkware, LLC v. National Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015)); see also *Merck Sharp & Dohme Corp. v. Microspherix LLC*, IPR2018-00393, Paper 13, at 15-16 (PTAB July 9, 2018) ("*Dynamic Drinkware* requires a showing that a claim of the prior art reference relied on is supported by its  
15 provisional application."); MPEP § 2136.03. Talukdar and the Talukdar Provisional contained substantively identical disclosure: the only difference between the two applications was that the figures in Talukdar were more formally drawn. Compare Talukdar Provisional (paragraphs [0001]-[0074], Figures 1-18) with Talukdar (paragraphs [0001]-[0074], Figures 1-18). As described in the following chart, the

Talukdar Provisional provided written description support for at least claim 1 of Talukdar (Roy ¶ 95):

| <b>Talukdar Claim 1</b>                                                                                                                                           | <b>Example Support in Talukdar Provisional</b>                                                                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| A method in a second protocol wireless communication infrastructure entity, the method comprising:                                                                | Claim 1<br>[0024]<br>[00026]-[00027]<br><br>[0044]<br>[0062]                                                    |
| allocating radio resources, in a radio frame, to a wireless terminal compliant with a first protocol and to a wireless terminal compliant with a second protocol, | Claim 1<br>Fig. 7, 11, 16, 17<br>[00029]-[00030]<br>[00044]-[0048]<br>[00051]<br>[0061]-[0062]<br>[0070]-[0071] |
| the radio frame including a first protocol resource region and a second protocol resource region,                                                                 | Claim 1<br>Fig. 7, 11, 16, 17<br>[00029]-[00030]<br>[00044]-[0048]                                              |

| Talukdar Claim 1                                | Example Support in Talukdar Provisional |
|-------------------------------------------------|-----------------------------------------|
|                                                 | [00051]                                 |
|                                                 | [0061]-[0062]                           |
|                                                 | [0070]-[0071]                           |
| the radio frame including a first protocol      | Claim 1                                 |
| allocation control message and a second         | Fig. 7, 11, 16, 17                      |
| protocol allocation control message, the first  | [00044]-[00048]                         |
| protocol allocation control message allocating  | [00051]                                 |
| resources within the first protocol resource    | [00061]-[00062]                         |
| region to wireless terminal compliant with the  | [0070]-[0071]                           |
| first protocol, the second protocol allocation  |                                         |
| control message allocating resources within the |                                         |
| second protocol resource region wireless        |                                         |
| terminal compliant with the second protocol.    |                                         |

Talukdar is thus entitled to the benefit of the Talukdar Provisional filing date (August 15, 2007) under 35 U.S.C. §119(e)(1) and is prior art under pre-AIA 35 U.S.C. § 102(e) as of that date. Support for the Talukdar disclosure relied upon in

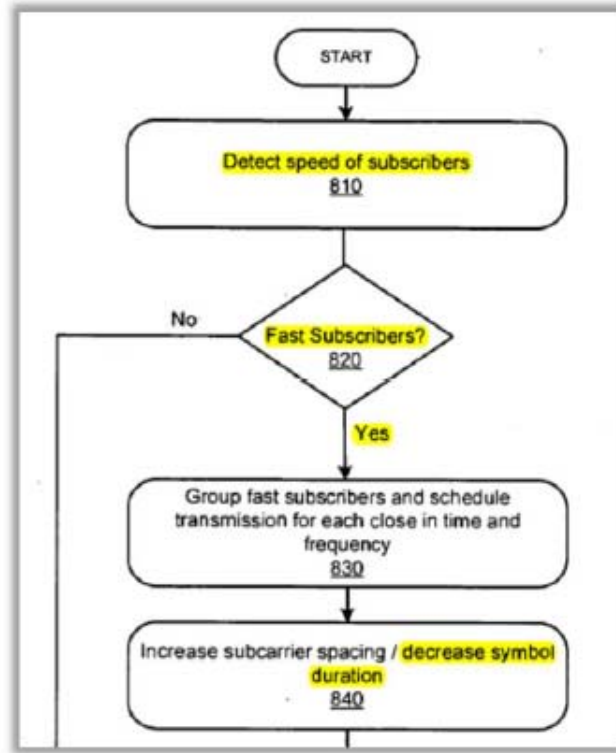
5 this Petition is found in like-numbered paragraphs and figures of the Talukdar Provisional.

**B. Li**

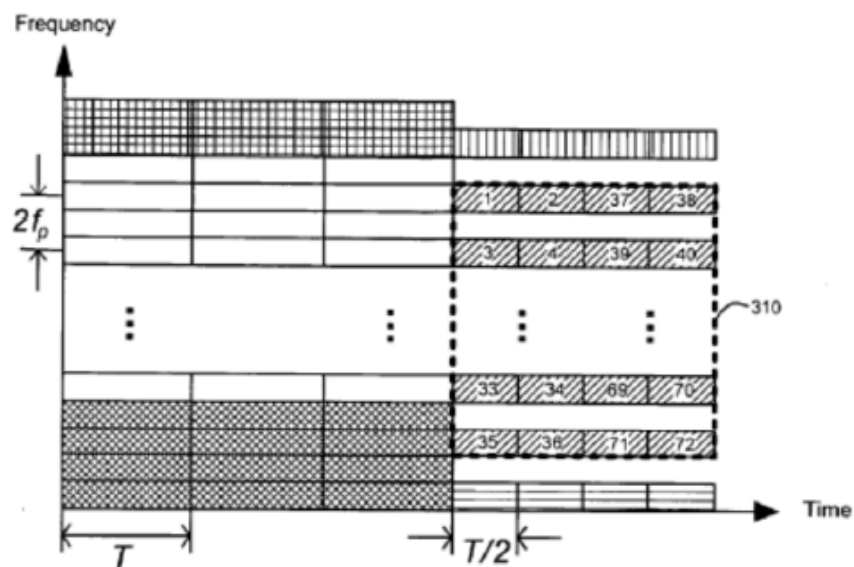
The Li publication (Ex. 1016), described a system that modified the duration of OFDM symbols to accommodate both faster-moving and slower-moving mobile subscriber stations. The application that led to Li was filed on December 30, 2005, and published on July 5, 2007, so Li was prior art to the '096 patent under pre-AIA 35 U.S.C. §§ 102(a) and (e).

Li taught that 802.16(e) “aim[ed] to enhance the specifications to the 802.16 standard to support ... subscriber stations moving at vehicular speeds.” Li, [0001]. Higher mobility caused interference between subcarriers in OFDM/OFDMA systems, preventing fast-moving subscriber stations from being able to transmit over multiple subcarriers. *Id.*, [0034]. Li recognized, however, that “a short OFDM symbol duration” could “reduce[] ICI [inter-subcarrier interference].” *Id.*, [0035].

Li thus disclosed a “scheduling/adaptation scheme for OFDMA” in which “different ... [OFDM] symbol durations are employed for slow and fast subscribers respectively.” Li, [0010]. A base station detected the speed of a subscriber station and scheduled “slow subscribers with ... longer OFDM symbol durations” and “fast subscribers with ... shorter OFDM symbol durations.” *Id.*, [0022]; *id.*, [0042] & Fig. 8 (excerpted and highlighted):



For example, Li's system could "transmit to the fast subscriber two OFDM symbols ... in two time slots with  $T/2$  each," which was "half the duration of the slow subscriber symbol duration." *Id.*, [0038]; *id.*, Fig. 5:



Li thus disclosed a communication system configured to support higher mobility that used symbols with a shorter symbol period for faster-moving subscriber stations. Roy ¶¶ 96-100.

**C. Nystrom**

5 The Nystrom publication (Ex. 1017), assigned to Telefonaktiebolaget LM Ericsson, disclosed a set of pilot symbol structures for use in different environments, including high-speed environments. Nystrom was filed on December 1, 2004, and published on May 10, 2007, making it prior art to the '096 patent under pre-AIA 35 U.S.C. §§ 102(a) and (e).

10 Nystrom taught that “most wireless systems” used “special well known training sequences or pilot signals ... so that the receiver can estimate the channel parameters sufficiently well for detection of any data signal, not previously known by the receiver.” Nystrom, [0002]. Channel estimation was substantially more complex in multi-carrier, multi-user systems, where a base station had to  
15 accommodate many mobile stations with “different channel characteristics” that “travel[ed] at different speeds.” *Id.*, [0004]. Existing pilot structures were “either not at all suitable for considerably changing radio conditions” or “designed for worst cases which ... result[ed] in vast pilot overhead.” *Id.*, [0009].

Nystrom proposed a way for a “multi-user multi-carrier wireless  
20 communication system ... to provide all users with sufficient pilots without causing

unnecessary pilot overhead[.]” Nystrom, [0010]. Specifically, Nystrom described “a number of pilot configurations ... to suit different radio conditions.” *Id.*, [0037]; *id.*, Fig. 4. The base station allocated each user portions of the radio resource space having “a pilot configuration that [wa]s matched to the [user’s] estimated radio conditions.” *Id.*, [0038]. Users with “radio conditions demanding a high density of pilots”—such as faster-moving users—were allocated portions of the resource space with increased pilot density in the time dimension, frequency dimension, or both. *Id.*, [0041], [0043]; *id.*, Fig. 5A (showing portions 110A, 110C, and 110D with higher pilot density):

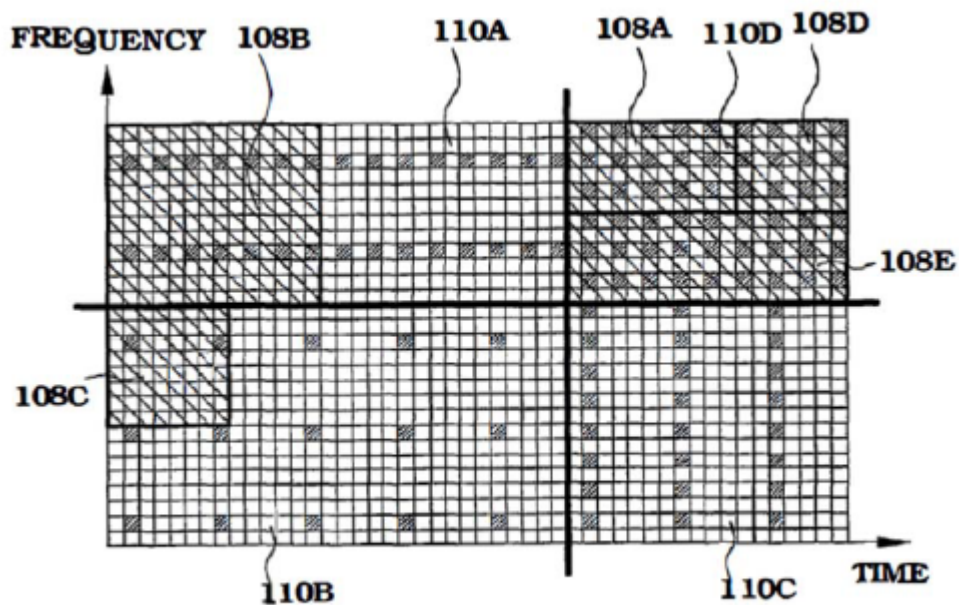


**Fig. 5A**

This hybrid design provided “each user ... a pilot pattern that [wa]s suited to its individual needs,” such that users with “fast varying channel or Doppler conditions”

were assigned resources “in the dense parts of the pilot pattern and users with more slowly varying conditions in the less dense parts.” *Id.*, [0043].

Nystrom thus disclosed a communication system that used denser pilot symbols to support faster-moving users. Roy ¶¶ 101-104.

5   **VII. ARGUMENT: THE CHALLENGED CLAIMS OF THE '096 PATENT ARE UNPATENTABLE OVER THE PREVIOUSLY-UNCONSIDERED PRIOR ART RAISED HERE**

The Talukdar reference disclosed constructing a frame structure in which data sections configured for distinct 802.16 communication systems co-existed in one  
10 transmission frame. The Li and Nystrom references disclosed providing support for higher-mobility communication systems by shortening the symbol period and increasing the density of pilot symbols, respectively. The Patent Office did not consider any of these references during prosecution of the '096 patent. The grounds  
15 presented in this Petition are therefore materially different from, and not cumulative of, the prior art considered during examination. *Cf. Oticon Medical AB v. Cochlear Ltd.*, IPR2019-00975, Paper 15, at 15 (PTAB Oct. 16, 2019) (precedential) (prior art reference was not cumulative of art considered during prosecution where it disclosed “different structures that serve different purposes”).

For the reasons that follow, Petitioner is reasonably likely to prevail with  
20 respect to at least one of the challenged claims, warranting institution of IPR under 35 U.S.C. § 314(a).

**A. Ground 1: Talukdar and Li Rendered Claims 1-4 and 6-7 Obvious**

**1. Claim 1**

**1[pre]: “A method of constructing a frame structure for data transmission, the method comprising.”** To the extent the preamble is limiting,

5 Talukdar disclosed it. Roy ¶¶ 108-110.

Talukdar disclosed a hybrid frame (or h-frame) for data transmission that supported both 802.16(e) and 802.16(m) remote units. “FIG. 7 is a **hybrid frame 700**, also referred to as a HEM-I frame, having equal size sub-blocks designed to **serve both 802.16(e) and 802.16(m) data traffic** in the same 5 msec interval.”

10 Talukdar, [0051]; *supra* § V(F) (construction of “frame structure”); Roy ¶ 109.

Talukdar disclosed “constructing” the hybrid frame by combining different types of regions that could be used for transmitting traffic to and from 802.16(e) and 802.16(m) units. *Id.*, [0030] (“Using these different types of regions, various types of 5 msec frame structures can be created to suit the traffic service requirements.

15 These are: ... h-frames containing both e-DL/e-UL and m-DL/m-UL regions for serving 802.16(e) and 802.16(m) terminals.”); Roy ¶ 109.

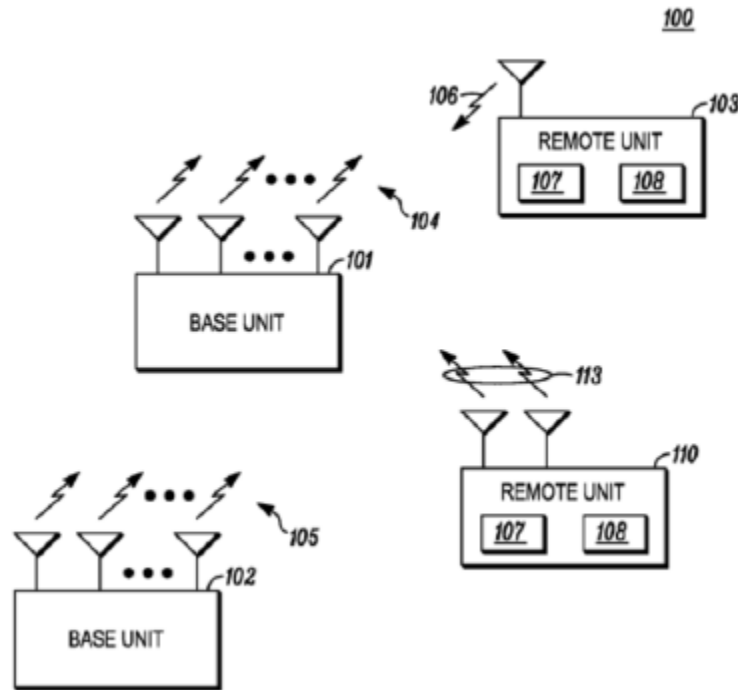
**1[a]: “generating a first section comprising data configured in a first format compatible with a first communication system using symbols.”** Talukdar

disclosed this limitation because it described generating a hybrid frame with a first

20 “e-DL” traffic section comprising data configured in a format compatible with an

802.16(e) remote unit (“a first communication system using symbols”). Roy ¶¶ 111-17.

Talukdar disclosed a wireless system with multiple base units and remote units. Talukdar, [0024] & Fig. 1 (system 100 including “base units,” “remote units”):



The remote units could be fixed or mobile stations. *Id.*, [0024]; Roy ¶ 112. Each remote unit communicated according to a communications standard, such as 802.16(e) or 802.16(m). Talukdar, [0027]; Roy ¶ 113. Each remote unit was thus a combination of hardware and software that included “one or more transmitters and one or more receivers” over which it communicated data according to one or more communications standards and was therefore a “communication system.” *Id.*,

[0025], [0027]; *supra* § V(F) (construction of “communication system”). Roy ¶¶ 112-13.

Wireless system 100 included remote units that implemented “legacy technology,” such as the “IEEE 802.16(e) protocol.” Talukdar, [0027]. The 802.16(e) protocol was OFDM-based and transmitted information in symbols. *Id.*, [0026] (“In OFDM based systems, the radio resources include OFDM symbols ... An exemplary OFDM based protocol is IEEE 802.16(e).”); Roy ¶¶ 114-15; *supra* § V(F) (construction of “symbol”). Figure 7 of Talukdar depicted the 802.16(e) DL block as being transmitted in the first 12 symbols of the hybrid frame, confirming that the 802.16(e) units used symbols. Thus, each 802.16(e) remote unit in Talukdar’s wireless system 100 was “a first communication system using symbols.” Roy ¶ 115.

Talukdar further disclosed an “e-DL” traffic resource region 708 that was a “first section comprising data configured in a first format compatible with a first communication system using symbols,” *i.e.*, an 802.16(e) remote unit. Talukdar, Fig. 7. Talukdar’s hybrid frame included an “802.16(e) DL traffic resource region 708” section containing downlink traffic (“a first section comprising data”) configured for 802.16(e) units (“a first format compatible with a first communication system”). Roy ¶ 116. The hybrid frame had “equal size sub-blocks designed to serve both **802.16(e)** and 802.16(m) **data traffic**.” Talukdar, [0051]. The frame began with a “first block

[that was] an 802.16(e) DL region” that included “an **802.16(e) DL traffic resource region 708.**” *Id.*; *id.*, Fig. 7 (e-DL [802.16(e)-downlink] section 708 in yellow; labels and color-coding added):

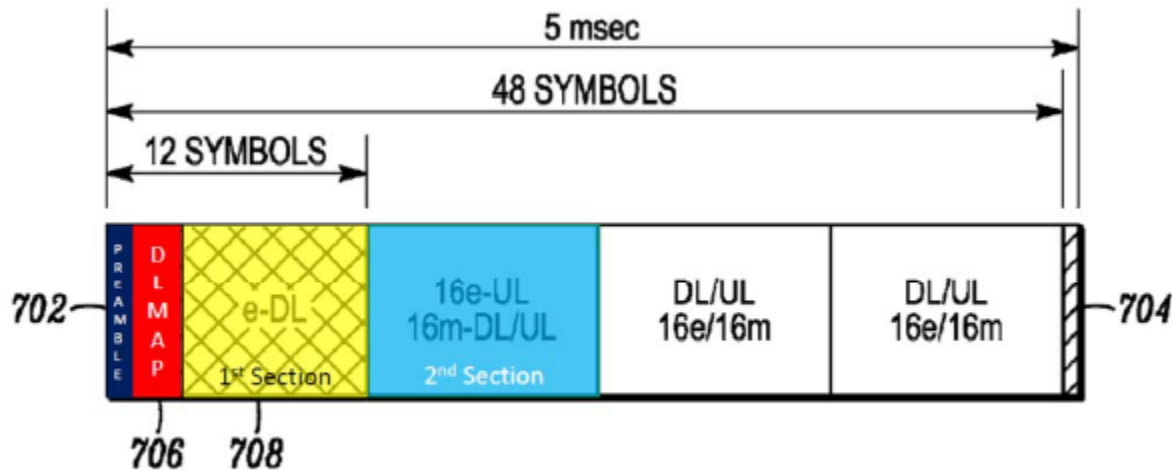


**FIG. 7**

5 See also *id.*, [0029]-[0030] (describing “types of basic [frame] regions” used to create “h-frames ... for serving 802.16(e) and 802.16(m) terminals” that included an “e-DL region used for transmission of downlink traffic to 802.16(e) terminals”); see also *id.*, [0047]-[0048]; Roy ¶¶ 116-17.

10 1[b]: “generating a second section following the first section, the second section comprising data configured in a second format compatible with a second communication system using symbols ...” Talukdar disclosed this portion of 1[b] because it disclosed generating a second “16e-UL / 16m-DL/UL” traffic section within the hybrid frame comprising data configured in a format compatible

with an 802.16(m) remote unit (“a second communication system using symbols”).  
Roy ¶¶ 118-24.

Talukdar disclosed that system 100 included units with “newer generation technologies, for example IEEE 802.16(m)” base and remote units. Talukdar,  
5 [0027]; *id.* (“802.16(m) base stations should be able to service both 802.16(m) and legacy terminals [remote units] within the common frame structure”); Roy ¶ 119. The 802.16(m) protocol used symbols to transmit information. Talukdar, [0051] (hybrid frame 700 included “sub-blocks designed to serve both 802.16(e) and **802.16(m) data traffic**”); *id.*, Fig. 7 (hybrid frame 700 comprised 48 symbols,  
10 allocated between sub-blocks); *supra* § V(F) (construction of “symbol”). Thus, each of the 802.16(m) remote units in Talukdar’s wireless system 100 was “a second communication system using symbols.” Roy ¶ 119.

Talukdar further disclosed an “16e-UL / 16m-DL/UL” sub-block that was a “second section comprising data configured in a second format compatible with a  
15 second communication system using symbols.” Talukdar’s hybrid frame included an “16e-UL / 16m-DL/UL” section containing uplink or downlink traffic (“a second section comprising data”) that was configured for an 802.16(m) unit (“a second format compatible with a second communication system”). Roy ¶ 120. Talukdar disclosed that the sub-blocks following the e-DL section in the hybrid frame could  
20 be “a combination of 802.16(e) and 802.16(m) regions (DL or UL).” Talukdar,

[0051]. Specifically, as shown in Figure 7, the sub-block (labeled “2nd section” and shown in light blue, below) following the e-DL section could be a “16m-DL” block, carrying downlink data for an 802.16(m) remote unit, or a “16m-UL” block, carrying uplink data from an 802.16(m) unit:

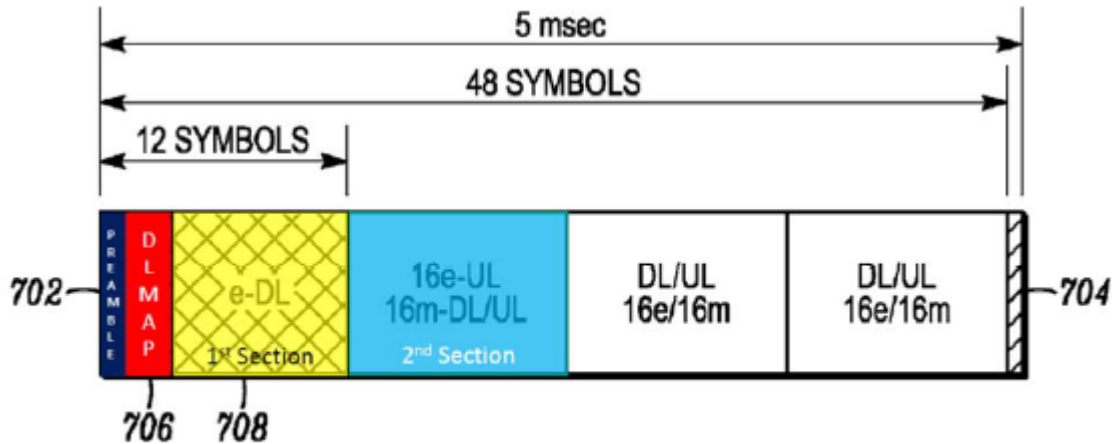


**FIG. 7**

*Id.*, [0029]-[0030] (describing “m-DL: region allocated for transmission to 802.16(m) terminals” and “m-UL: region allocated for transmission by 802.16(m) terminals” as regions used to create “h-frames ... for serving 802.16(e) and 802.16(m) terminals”); Roy ¶ 120. Figure 7 showed that the sub-block could also be a “16e-UL” block that carried traffic from an 802.16(m) remote unit. Talukdar, [0029] (“The ... e-UL regions can also be used for transmissions [from] 802.16(m) terminals”); *see also id.*, [0046]-[0048].

Figure 7 shows that the “16e-UL / 16m-DL/UL” sub-block followed the “e-DL” section 708 (the “first section”) in time within the frame structure. Roy ¶ 121.

Talukdar’s description of the ordering of the hybrid frame’s components further

confirmed that the sections “followed” each other in sequence. Talukdar, [0051] (“The first block [in the hybrid frame] is an 802.16(e) DL region starting with a 1-symbol preamble ***followed by*** 802.16(e) MAPs 806 and an 802.16(e) DL traffic resource region 708.”); *see also id.*, [0048]; Roy ¶ 121. Thus, Talukdar disclosed  
5 “generating a second section [the “16e-UL / 16m-DL/UL” sub-block] following the first section [the e-DL traffic resource region 708].”

**1[b] (continued): “... wherein the first communication system’s symbols and the second communication system’s symbols co-exist in one transmission scheme.”** Talukdar disclosed that “the first communication system’s symbols and  
10 the second communication system’s symbols co-exist[ed] in one transmission scheme” because symbols for the 802.16(e) and 802.16(m) remote units—contained within the “e-DL” and “16e-UL / 16m-DL/UL” sections, respectively—co-existed in hybrid frame 700. Talukdar, Fig. 7 (depicting hybrid frame 700 containing symbols); '096 patent 4:20-24 (“present invention may allow data of ... a legacy  
15 system[] and data of a new OFDMA system to co-exist in an OFDMA frame”); Roy ¶ 122; Ex. 1010 at 28, 41; *supra* § V(F).

Additionally, Li disclosed that “the first communication system’s symbols and the second communication system’s symbols co-exist[ed] in one transmission scheme” because Li described a frame that included symbols for both slower-  
20 moving and faster-moving subscriber stations. *E.g.*, Li, Fig. 5; *id.*, [0022] (“In an

embodiment, the communications system 100 is arranged to schedule slow subscribers with smaller subcarrier spacing and longer OFDM symbol durations.

The communications system 100 is further arranged to schedule fast subscribers with larger sub-carrier spacing and shorter OFDM symbol durations.”) & [0038]; *id.*,

5 [0015] (“It can be appreciated that the described embodiments are applicable to any type of communication content or format, such as ... frames[.]”); Roy ¶¶ 123-24. For

example, Li disclosed an embodiment in which a base station “assign[ed] the even OFDM subcarriers (e.g.,  $N/2$  nonadjacent subcarriers) to a fast subscriber and shorten[ed] the symbol duration from  $T$  to  $T/2$ ” for that fast subscriber. Li, [0038] &

10 Fig. 5. As discussed for 1[c], a POSA would have found it obvious to incorporate these teachings of Li teachings into Talukdar. Roy ¶¶ 124, 135-38.

**1[c]: “and wherein: the second format is compatible with the second communication system configured to support higher mobility than the first communication system ...”** Talukdar disclosed a “second communication system

15 configured to support higher mobility than the first communication system” because wireless system 100 included an 802.16(m) mobile remote unit. Roy ¶¶ 125-26.

Talukdar disclosed that wireless system 100 (which included both 802.16(e) and 802.16(m) units) included both fixed and mobile units. Talukdar, [0024] (“The remote units may be fixed ... The remote units may also be ... mobile stations[.]”) &

20 Fig. 1; *id.*, [0027] (units in wireless system 100 may implement UMTS cellular

technology); Roy ¶¶ 125-26. At a minimum, a POSA would have found it obvious for wireless system 100 to have included a mobile 802.16(m) remote unit and a fixed or slower-moving 802.16(e) remote unit, given this disclosure that system 100 included 802.16(e)- and 802.16(m)-compliant remote units, and included fixed and mobile remote units. Roy ¶ 126. The disclosed hybrid frame structure was generally applicable to the units within system 100. Talukdar, [0027] (“In FIG. 1, for example ... 802.16(m) base stations should be able to service both 802.16(m) and legacy terminals [remote units] within the common frame structure.”); Roy ¶ 126. Thus, an 802.16(m) remote unit within system 100 that was mobile was a “second communication system configured to support higher mobility than [a] first communication system,” *e.g.*, an 802.16(e) remote unit that was fixed or simply slower-moving relative to a base station than the 802.16(m) unit. Roy ¶¶ 125-26; see *supra* § V(F).

A POSA would have understood Talukdar’s disclosure—of a system that included both fixed and mobile remote units and a hybrid frame structure that was generally applicable to the units within that system—to provide a teaching, suggestion, or motivation for generating a hybrid frame that included a first section with data configured in a format compatible with a fixed or slower-moving 802.16(e) remote unit (a “first communication system”) and a second section with data configured in a format compatible with a faster-moving mobile 802.16(m) remote

unit (a “second format [] compatible with the second communication system configured to support higher mobility than the first communication system”). Roy ¶

127. Additionally, this frame configuration would have provided the benefit of enabling the hybrid frame to accommodate data for a greater range of remote units

5 within Talukdar’s wireless system 100. *Id.* Further still, this permutation of Talukdar’s hybrid frame (including a second section formatted to be compatible with

a mobile 802.16(m) remote unit, and a first section compatible with a fixed or slower-moving 802.16(e) remote unit) would have been one of a finite number of

configuration scenarios that would have been obvious to try with a reasonable

10 expectation of success, because Talukdar expressly disclosed that its system included remote units configured for 802.16(e) or 802.16(m) that were fixed or

mobile. Talukdar [0024], [0027]; Roy ¶ 127. Thus, Talukdar’s disclosure rendered obvious the portion of 1[c] reciting “the second format ... compatible with the second

15 communication system configured to support higher mobility than the first communication system.” *Id.*

Additionally, Li disclosed this portion of 1[c], because Li described using a shorter symbol period to communicate with wireless subscriber stations that were moving at higher speeds relative to a base station (each a “second communication system configured to support higher mobility”) than slower-moving or fixed

20 subscriber stations (each a “first communication system”). Roy ¶¶ 128-133; *supra* §

V(F). Li, like Talukdar (at, *e.g.*, [0024], [0027]), recognized that “802.16e aim[ed] ... to support both fixed and mobile subscriber stations to accommodate ... subscriber stations moving at vehicular speeds.” Li, [0001]. Subscriber stations could have “mobile speeds ... [that] may be substantially different from other subscribers,” with speeds “rang[ing] from 0 to 250 km/h.” *Id.*, [0034]. Li disclosed that a base station designated “subscribers ... as either fast or slow” and then “employ[ed] two OFDM symbol durations ... one set assigned to the slow and fast subscribers respectively.” *Id.*, [0037]. Thus, each of Li’s faster-moving subscriber stations was a “second communication system configured to support higher mobility than [a] first communication system,” *e.g.*, each of Li’s fixed or slower-moving subscriber stations. *See supra* § V(F); Roy ¶ 128.

A POSA would have found it obvious to modify Talukdar’s technique for generating a hybrid frame to include the steps of generating a first section with data configured for a fixed or slower-moving 802.16(e) remote unit (a “first communication system”) and a second section with data configured for a faster-moving 802.16(m) remote unit (a “second communication system configured to support higher mobility than the first communication system”) in view of Li’s teaching of 802.16-compliant stations that moved at “substantially different speeds,” for the reasons discussed below. *See infra* at 48-50. Additionally, this modification would have been obvious because a hybrid frame having this structure would have

accommodated data for a greater range of remote units within Talukdar's wireless system. Roy ¶ 129. A POSA would have had a reasonable expectation of success in combining Li's teachings with Talukdar in this way, because Talukdar expressly disclosed that its system included remote units configured for 802.16(e) or 5 802.16(m) that were fixed or mobile and described its techniques as being generally applicable to units within system 100, without making any distinction between fixed and mobile remote units. *Id.*

Thus, Talukdar alone or in combination with Li rendered obvious the first portion of 1[c], "wherein: the second format is compatible with the second 10 communication system configured to support higher mobility than the first communication system." Roy ¶¶ 125-29.

**1[c] (continued): "... wherein each symbol in the second communication system has a shorter symbol period than that in the first communication system."** Li disclosed this portion of 1[c]. Li disclosed that a higher-mobility

15 subscriber station (a "second communication system") experienced a greater degree of interference between subcarriers than a lower-mobility or fixed subscriber station.

"[H]igh mobility, [or] high speed ... causes ICI [inter-subcarrier interference] for OFDM and OFDMA systems that may limit their application to mobile channels."

Li, [0034]; Roy ¶¶ 130, 73. Li taught that using a shorter symbol duration for a faster-

20 moving station helped reduce the inter-subcarrier interference experienced by that

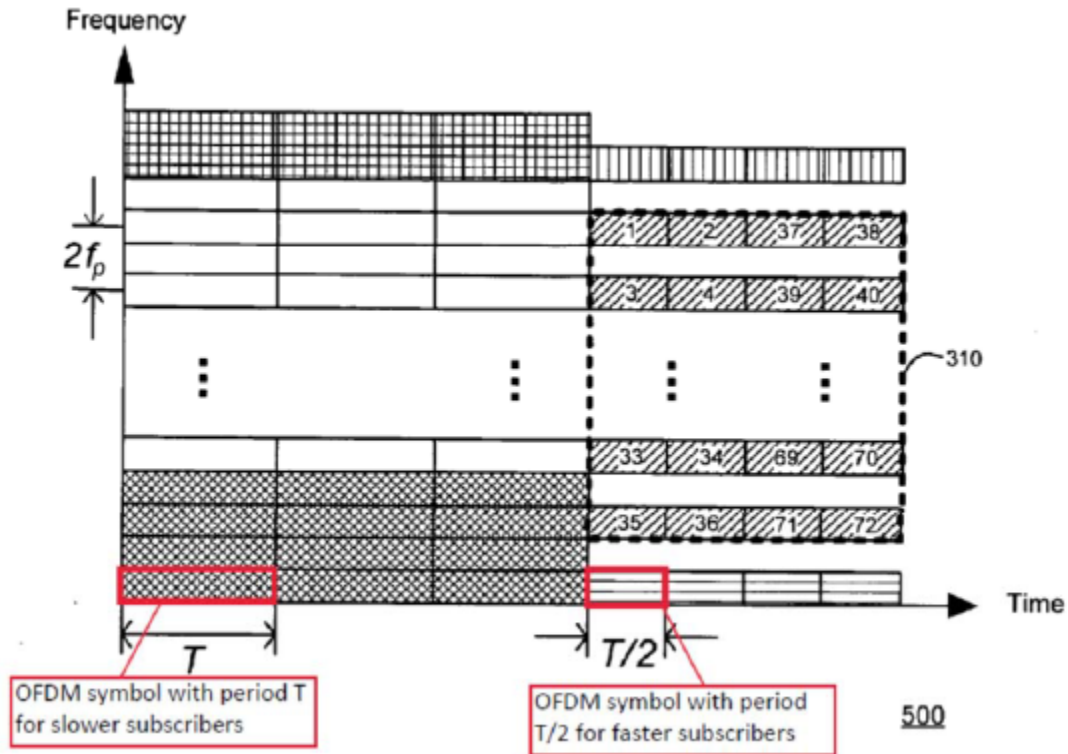
station. “[A] short OFDM symbol duration and larger subcarrier spacing reduces ICI[.]” Li, [0035]; *id.*, [0010] (“The grouping of subscribers according to their speed ... may reduce inter-subcarrier interference (‘ICI’) in OFDM and the corresponding OFDMA systems that support the subscribers.”); Roy ¶¶ 130-31.

5           Specifically, Li disclosed that a node (such as a base station; see Li, [0026]) assigned a faster-moving subscriber station OFDM symbols that had a shorter symbol period than the symbols assigned to a slower-moving station:

[O]nce subscribers have been designated as either fast or slow ... node 110 of an embodiment **may employ two OFDM symbol durations ... one set assigned to the slow and fast subscribers** respectively. In an embodiment, the communications system 100 and/or node 110 of an embodiment **assigns shorter symbol duration** and larger sub-carrier spacing (e.g., OFDM signal 410) **to the fast subscribers** and longer symbol duration and smaller subcarrier spacing (e.g., OFDM signal 400) to the slow subscribers less prone to ICI.

*Id.*, [0037]; Roy ¶¶ 130-31; *supra* § V(F). For example, the base station “**assign[ed] to a fast subscriber** a symbol duration that is **half the duration** of the slow subscriber symbol duration.” Li, [0038]. Figure 5 of Li showed an OFDM signal in which the base station transmitted OFDM symbols having a duration of T “to [a] slow subscriber,” but “shorten[ed] the symbol duration from T to T/2” for “a fast

subscriber.” *Id.*, [0038]; Roy ¶¶ 131-32; *id.*, Figure 5 (showing OFDM symbols with shortened period “ $T/2$ ” for faster station 310) (annotations added):



Li thus disclosed that “each symbol in the second communication system  
 5 ha[d] a shorter symbol period than that in the first communication system.” Roy ¶¶  
 130-133.

A POSA would have understood Li to provide a teaching, suggestion, or  
 motivation to modify Talukdar by using shorter symbol periods for a faster-moving  
 802.16(m) remote unit, because Li disclosed that doing so reduced the inter-  
 10 subcarrier interference that would be experienced by these units. Roy ¶ 135. Li  
 taught that subscriber stations experienced inter-subcarrier interference when  
 traveling at higher speeds and that shortening the symbol period used for faster-

moving stations helped reduce this interference. Li, [0034]-[0035], [0010]. Talukdar's wireless system included mobile remote units (Talukdar, [0024]) that would have been affected by inter-subcarrier interference in the manner Li described. Roy ¶¶ 130, 135-36. A POSA would have recognized that shortening the  
5 symbol period used for faster-moving remote units in Talukdar's system would have yielded the predictable, and beneficial, result of reducing inter-subcarrier interference experienced by those remote units, as taught by Li. *Id.* ¶ 135. And a POSA would have had a reasonable expectation of success in making this combination because Li identified an example implementation that a POSA would  
10 have been able to execute in the context of Talukdar's hybrid frame—by using symbols in the section for a mobile 802.16(m) remote unit (the “second communication system configured to support higher mobility”) with a symbol period shorter than (*e.g.*, half as long as) the symbol period for a fixed 802.16(e) unit. *Id.* ¶¶ 136, 138. A POSA would have recognized Talukdar's teaching that “[i]t is  
15 possible to define a new pilot/subchannel/control structure in the 802.16(m) zones,” by modifying “parameters such as ... symbol duration” to further indicate a reasonable expectation of success in making this combination. Talukdar, [0064]; Roy ¶ 136.

Additionally, a POSA would have been motivated to combine the teachings  
20 of Li identified above with Talukdar with a reasonable expectation of success

because Talukdar and Li disclosed similar systems. Both Talukdar and Li described 802.16 systems that used OFDM/OFDMA symbols. *E.g.*, Talukdar, [0027], [0029]-[0030] (describing 802.16(m) and 802.16(m) remote units/terminals and base units) & [0002], [0026] (recognizing 802.16m as “an evolution of the WiMAX-OFDMA specification for the IEEE 802.16e protocol” and 802.16(e) as an “exemplary OFDM based protocol”); Li, [0016] (system “communicate[d] information according to ... [the] 802.16 standards”), [0025] & [0020] (system comprised an OFDM or OFDMA network); Roy ¶¶ 137-38. Additionally, both Talukdar and Li disclosed combining symbols for different communication systems in a single frame. Talukdar, Fig. 7 & [0051]; Li, Fig. 5 & [0015], [0022], [0038]; Roy ¶ 137.

Modifying Talukdar to incorporate the identified teachings of Li would also have been obvious because it amounted to combining prior art elements according to known methods to yield predictable results. The combination involved incorporating Li’s technique of using a shorter symbol period for the higher-mobility device into Talukdar’s process of generating a hybrid frame for communication with a fixed or slow-moving 802.16(e) station and a faster-moving 802.16(m) station, and this would have resulted in a 802.16(m) mobile remote unit that was configured to support higher mobility and a hybrid frame that used symbols with shorter symbol periods for the mobile 802.16(m) unit than for the 802.16(e) unit. Roy ¶ 138. A POSA would have implemented this combination by simply shortening the symbol

period used for the faster-moving stations (as taught by Li, [0037]-[0038]). Roy ¶¶ 136, 138. This would have resulted in a reduction of inter-subcarrier interference for the faster-moving units, a result that was predictable in view of Li's teachings (*e.g.*, at [0034]-[0035], [0010]). Roy ¶ 135, 138. The proposed combination would also  
5 have been obvious because it used a known technique (Li's technique of communicating with faster stations using OFDM symbols with shorter periods) to improve Talukdar's similar method (communicating with mobile remote units using OFDM symbols) in the same way (by reducing inter-subcarrier interference experienced by the mobile units). *Id.* ¶ 138.

10 The combination of Talukdar and Li thus rendered limitation 1[c] obvious.

**1[d]: “generating at least one non-data section containing information describing an aspect of data in at least one of the first section and the second section.”** The construction of “at least one of [...] and [...]” as meaning “[...] and/or [...]” from the *Apple* litigation (*supra* § V(F)) is correct here. The “at least one of”  
15 language in limitation 1[d] applies to only two items and operates as shorthand for “and/or.” *E.g.*, *Rex Med., L.P. v. Intuitive Surgical, Inc.*, No. CV 19-005 (MN), 2020 WL 2128795, at \*6 (D. Del. May 5, 2020) (“Here, ‘at least one of’ is not modifying a list of three items, but only two. Where there are only two items, courts have understood the use of ‘and’ to operate as a shorthand for ‘[A] or [B] or [A and B].’”) (citing cases). Further, the '096 patent discloses embodiments in which a non-data  
20

section contains information describing an aspect of data in only one of the two sections. *E.g.*, '096 patent at 5:18-26 (non-data sections sub-MAP 42-2 and UL-MAP in DL burst #1 contain information for data in the zones for the high-mobility system); *Rex Med*, 2020 WL 2128795, at \*7 (“It is not uncommon for courts to  
5 interpret [“at least one of... and”] in the disjunctive when such an interpretation is necessary to accommodate the specification [.]”). Limitation 1[d] thus requires generating at least one non-data section containing information describing an aspect of data in the first section and/or the second section. Roy ¶ 139.

Talukdar disclosed generating a section of the 802.16(e) DL block that  
10 included a DL-MAP message (a “non-data section containing information describing an aspect of data in at least one of the first section and the second section”) that described aspects of the 802.16(e) traffic (“data in ... the first section”). Roy ¶¶ 139-141. The 802.16(e) DL block “start[ed] with a 1-symbol preamble followed by **802.16(e) MAP[.]**” Talukdar, [0051]; *id.*, Fig. 7 (DL-MAP 706, in red):

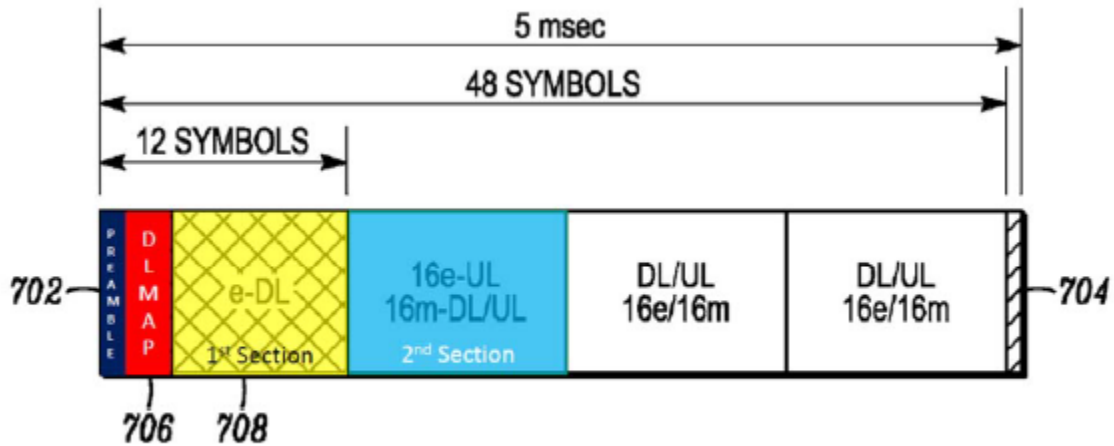


**FIG. 7**

The DL-MAP message was “a full size [802.]16e MAP overhead to support 802.16(e) traffic.” *Id.*, [0051]. The 802.16(e) MAP message contained information for allocating resources within the 802.16(e) e-DL traffic resource region 708.

5 Talukdar, [0073] (“the first protocol allocation control message (e.g., **802.16(e) MAP**) can allocate resources within the first protocol resource region (e.g., 802.16(e) region or zone”), [0059] (“The 802.16(e) terminals determine the 802.16(e) and 802.16(m) allocations from the 802.16(e) MAP in which the 802.16(m) region is allocated as a separate zone. ... This scheme is similar as HEM-I [in Fig. 7].”),

10 [0045], Abstract; Roy ¶ 140. The MAP messages defined by 802.16(e) included information describing data regions that were allocated to different users and data modulation and coding schemes. Ex. 1005 at 44; Roy ¶¶ 69, 139, 141. Talukdar’s Table 305, which depicted a compressed version of a “802.16(e) basic MAP” (Talukdar, [0052]), showed that the 802.16(e) MAP included such data-related

information as the “[n]umber of OFDMA symbols in the DL subframe”; a “Map message length” field, which also indicated the length of the traffic portion; and DL IE [Information Element] count and DL-MAP\_IE fields, which identified the start time and channel details of the traffic portion. *Id.*, Table 305; Roy ¶ 140.

5           A POSA would have understood Talukdar’s description of a “basic 802.16(e) MAP” to refer to the MAP of the 802.16(e) standard, consistent with the 802.16(e) DL-MAP of Figure 7. Roy ¶¶ 140-41. Talukdar’s disclosure of the DL-MAP section also matched the embodiment of the ’096 patent, which recognizes DL-MAP messages as being distinct from the “data” sections of the frame. ’096 patent at 1:46-  
10   49 (“The DL sub-frame 16 may include ... a downlink map (DL-MAP) ... and a data region (DATA)[.]”); *id.*, Fig. 1 (showing DL-MAP as “Prior Art” and separate from DATA section); Roy ¶ 141. Thus, DL-MAP message 706 was a “non-data section containing information describing an aspect of data in ... the first section [802.16(e) DL traffic resource region 708].”

15           1[e]: “combining the first section, the second section and the at least one non-data section to form the frame structure.” Talukdar disclosed this limitation because it described combining the “e-DL” and “16e-UL / 16m-DL/UL” traffic regions (“the first section, the second section”) and the DL-MAP message (“the at least one non-data section”) to form hybrid frame 700. Roy ¶¶ 142-43. Talukdar’s  
20   “FIG. 7 [wa]s a hybrid frame 700 .... The first block [wa]s an 802.16(e) DL region

starting with a 1-symbol preamble followed by 802.16(e) MAPs [7]06 and an 802.16(e) DL traffic resource region 708. The other 3 blocks [we]re a **combination** of 802.16(e) and 802.16(m) regions (DL or UL).” Talukdar, [0051]; *id.*, Fig. 7 (frame combining 802.16(e) DL-MAP region, 802.16(e) data region, and 802.16(m) data region).

The combination of Talukdar and Li thus rendered all limitations of claim 1 obvious.

## 2. Claim 2

Dependent claim 2 recites: **“The method of claim 1, wherein the non-data section comprises mapping information for at least one of the first section and the second section.”** The construction of “at least one of [...] and [...]” as meaning “[...] and/or [...]” (*supra* § V(F)) is correct as applied to this claim. This language in claim 2 applies to only two items (*see Rex Med*, 2020 WL 2128795, at \*7) and the '096 patent discloses embodiments in which a non-data section comprises mapping information for only one of the first and second sections. *E.g.*, '096 patent at 5:18-26 (non-data sections sub-MAP 42-2 and UL-MAP in DL burst #1 contain mapping information for data in the zones for the high-mobility system only). Claim 2 thus requires a non-data section that comprises mapping information for the first section and/or the second section. Roy ¶ 145.

Talukdar disclosed the additional limitation of claim 2 because Talukdar's frame included an 802.16(e) DL-MAP message region, which was "mapping information for ... the first section." Roy ¶¶ 144-46; *supra* § V(F). "The first block [of frame 700] [wa]s an 802.16(e) DL region starting with a 1-symbol preamble  
5 ***followed by 802.16(e) MAPs ...***" Talukdar, [0051]; *id.*, Table 305 ("Compressed DL-MAP message format"). Talukdar indicated that the 802.16(e) MAP message contained information ("mapping information") for allocating resources within the 802.16(e) e-DL traffic resource region 708, which included information regarding subcarrier assignment and the location of data for specific users. Roy ¶¶ 145-46;  
10 Talukdar, [0073] ("the first protocol allocation control message (e.g., 802.16(e) MAP) can allocate resources within the first protocol resource region (e.g., 802.16(e) region or zone)"), [0059] ("The 802.16(e) terminals determine the 802.16(e) and 802.16(m) allocations from the 802.16(e) MAP in which the 802.16(m) region is allocated as a separate zone. ... This scheme is similar as HEM-I [in Fig. 7.]"),  
15 [0045], Abstract.

### 3. Claim 3

Dependent claim 3 recites: **"The method of claim 1, wherein the non-data section comprises at least one of a preamble, a frame control header (FCH), a burst, and a map of at least one of the first section and the second section."** The  
20 construction of "at least one of [...]" as meaning "[...] and/or [...]" (*supra* §

V(F)) is correct as applied to this claim. In the last clause of claim 3, this language applies to only two items (*see Rex Med*, 2020 WL 2128795, at \*7) and the '096 patent discloses embodiments in which the non-data section comprises a map of only one of the two sections. *E.g.*, '096 patent at 5:18-26 (non-data sections sub-MAP 42-2 and UL-MAP in DL burst #1 contain mapping information for data in the zones for the high-mobility system). Regarding the occurrence of this language in the first clause of claim 3, the '096 patent discloses embodiments in which the non-data section includes fewer than all of the recited components. *E.g.*, '096 patent at Fig. 4 & 5:18-33 (non-data section comprising only preamble 43 and sub-MAP 42-2), 5:43-45 (DL sub-frame 16 “may” include the illustrated components); *Rex Med*, 2020 WL 2128795, at \*7 (construing “at least one of... and” in the disjunctive when necessary to accommodate the specification). The disjunctive construction is therefore correct, and claim 3 requires that the non-data section comprises a preamble, a frame control header (FCH), a burst, or a map (or a preamble, a frame control header (FCH), a burst, *and* a map) of the first section and/or the second section. Roy ¶ 147.

Talukdar disclosed this additional limitation by explaining that the non-data section of the frame included both a preamble and a DL-MAP message (“a preamble ... and a map of at least one of the first section”). Roy ¶ 148; *supra* § V(F). “The first block [of frame 700] [wa]s an 802.16(e) DL region starting with a **1-symbol**

**preamble followed by 802.16(e) MAPs.”** *Id.*, [0051]; *id.*, Fig. 7; *supra* § VI(A)(2).

Additionally, Talukdar disclosed that the non-data section included an 802.16(e) frame control header (the claimed “frame control header (FCH)”). “There [we]re five types of 802.16(e) sub-blocks that [could] be allocated in the 802.16(m) frame structure ... [and] conform[ed] to the legacy specification of 802.16(e) frames,” including a “Legacy DL Lead Sub-Block” that contained “a 802.16(e) preamble, **802.16(e) FCH**, 802.16(e) DL-MAP.” *Id.*, [0047]; *id.*, [0051] (“Control channel overhead of frame 700 is medium. As many as 5 bits may be required to signal the construction of a 802.16(m) frame.”) & [0057]; *id.*, [0048] (“The following sub-blocks may be allocated to the first sub-frame position: ... Legacy DL Lead Sub-Block. The following sub-blocks may be allocated to the second sub-frame position: ... 802.16(m) DL Sub-Block[.]”).

#### 4. Claim 4

Dependent claim 4 recites: **“The method of claim 3, wherein the second section follows the first section in at least one of time sequence and frequency spectrum.”** The construction of “at least one of [...] and [...]” as meaning “[...] and/or [...]” (*supra* § V(F)) is correct here. The language in claim 4 applies to only two items (see *Rex Med*, 2020 WL 2128795, at \*7) and the '096 patent discloses embodiments in which the second section follows the first section in only the time

sequence. *E.g.*, '096 patent at Figs. 3, 4. Claim 4 thus requires that the second section follows the first section in time sequence and/or frequency spectrum. Roy ¶ 149.

Talukdar disclosed this additional limitation because Figure 7 showed that the “16e-UL / 16m-DL/UL” traffic section (the “second section”) followed the “e-DL” traffic resource region 708 (the “first section”) in the time sequence. Roy ¶¶ 149-51; *supra* § V(F). Figure 7 depicted the structure of hybrid frame 700 in the time domain, with the frame having a duration of 5 msec:

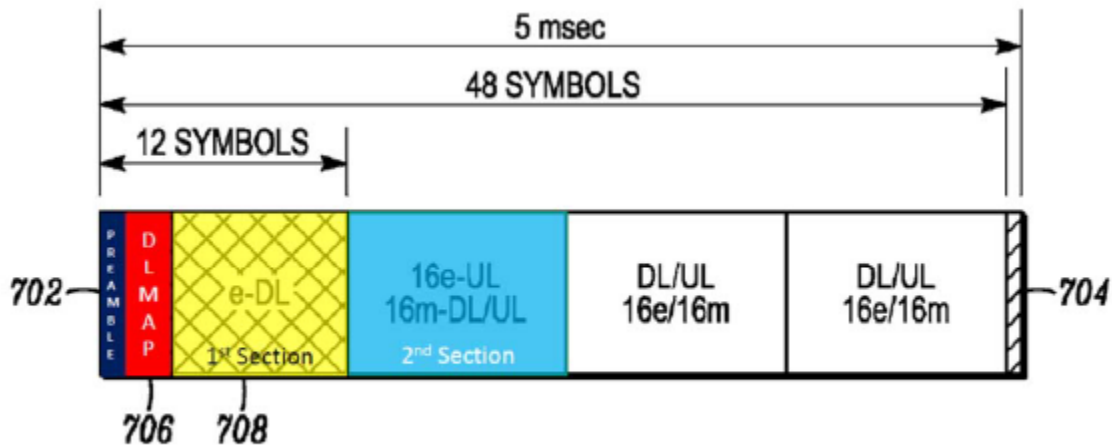


**FIG. 7**

*Id.*, Fig. 7 (showing “second section” 16m-DL/UL [802.16m-downlink/uplink] in light blue, following “first section” e-DL [802.16(e)-downlink] in yellow); *id.*, [0034] (teaching that “a position within the frame in time” may “be denoted by the symbol number within the frame or absolute time or time offset from the start of the frame”). Talukdar’s description of the ordering of the hybrid frame’s components confirmed that the “16e-UL / 16m-DL/UL” section (the “second

section”) followed the “e-DL” section 708 (the “first section”) in the time sequence. Talukdar, [0051] (“The first block [in the hybrid frame] is an 802.16(e) DL region starting with a 1-symbol preamble ***followed by*** 802.16(e) MAPs 806 and an 802.16(e) DL traffic resource region 708.”); *see also id.*, [0048]; Roy ¶ 121.

5                   **5.     Claim 6**

Dependent claim 6 recites: **“The method of claim 1, wherein each of the first section and the second section carries at least one of uplink and downlink data.”** The construction of “at least one of [...] and [...]” as meaning “[...] and/or [...]” (*supra* § V(F)) is correct here. The language in claim 6 applies to only two  
10 items (*see Rex Med*, 2020 WL 2128795, at \*7) and the '096 patent discloses embodiments in which the first and second sections carry only uplink or downlink data. *E.g.*, '096 patent at Fig. 4 & 4:39-5:40 (sections 40-1 and 40-3 carry downlink data only for the old and new systems, respectively; sections 44-1 and 44-3 carry uplink data only for the old and new systems, respectively). Claim 6 thus requires  
15 that each of the first section and the second section carries uplink and/or downlink data. Roy ¶ 152.

Talukdar disclosed the additional limitation of claim 6 because it described the “e-DL” traffic resource region 708 (the “first section”) as carrying downlink data and the “16e-UL / 16m-DL/UL” traffic section (the “second section”) as carrying  
20 either uplink or downlink data. Roy ¶ 153; *supra* § V(F); Talukdar, Fig. 7 (showing

e-DL region 708, followed by 16m-DL/UL region); *id.*, [0029] (the “e-DL region [was] used for transmission of downlink traffic to 802.16(e) terminals”; “m-DL [was a] region allocated for transmission to 802.16(m) terminals” and “m-UL [was a] region allocated for transmission by 802.16(m) terminals”).

5                   **6.     Claim 7**

Dependent claim 7 recites: **“The method of claim 1, wherein the second section carries mapping information for data in the second section.”** Talukdar disclosed the additional limitation of claim 7 because Talukdar disclosed an implementation in which the “16e-UL / 16m-DL/UL” traffic section (the “second section”) included an 802.16(m) MAP message (“mapping information for data in the second section”). Roy ¶¶ 154-55. “An 802.16(m) DL Sub-Block is a generic 16m sub-block that contains 802.16(m) Downlink data **and 802.16(m) control**. This may be occupying the **2nd**, 3rd or 4th **sub-frames**.” Talukdar, [0046]; *id.*, [0045] (“The radio frame includes an allocation control message for allocating resources within a protocol block.”); *id.*, [0048] (“The following sub-blocks may be allocated to the first sub-frame position: ... Legacy DL Lead Sub-Block. The following sub-blocks may be allocated to the second sub-frame position: ... 802.16(m) DL Sub-Block[.]”).

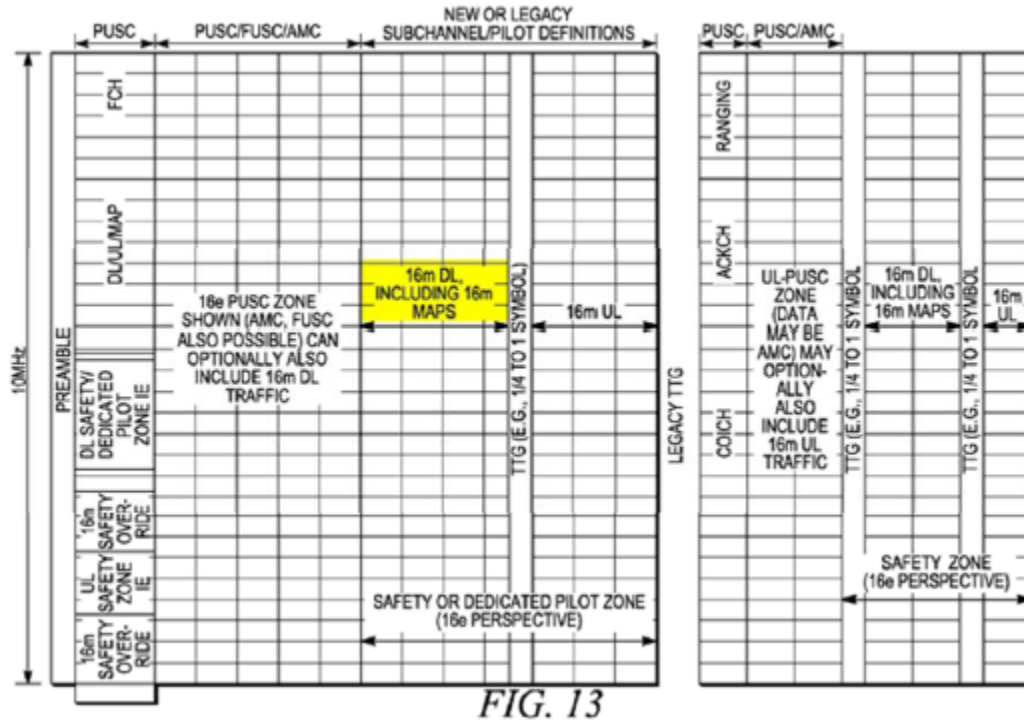
10                   

15                   

Talukdar further disclosed that “the first symbol of the frame contain[ed] the 802.16(e) preamble,” and “**the 802.16(m) MAP** or control channel/control signaling ... [was] **in a different position or positions in the frame**. For example: **within the**

20

*portion of the frame labeled as 16m DL[.]*" Talukdar, [0064]; Figure 13 of Talukdar disclosed an example of the hybrid frame in which a 802.16(m) downlink region "includ[ed] 16m MAPs":



5 See also *id.*, Fig. 14 (“16m DL INCLUDING 16m MAPS”); Roy ¶ 155.

## B. Ground 2: Talukdar and Nystrom Rendered Claim 8 Obvious

Independent claim 8 is identical to claim 1, except for limitation 8[c]. See Ex. 1008. Talukdar disclosed limitations 8[pre]-8[b] and 8[d]-8[e] for the reasons stated above for limitations 1[pre]-1[b] and 1[d]-1[e]. *Supra* § V(A)(1).

10 The second part of limitation 8[b] recites: “... wherein the first communication system’s symbols and the second communication system’s symbols coexist in one transmission scheme.” As discussed above (*supra* at 40),

Talukdar disclosed this aspect of 8[b] because it disclosed that symbols for the 802.16(e) and 802.16(m) units (within the “e-DL” and “16e-UL / 16m-DL/UL” sections, respectively) co-existed in hybrid frame 700. Additionally, Nystrom disclosed this portion of limitation 8[b], because it disclosed a radio resource space having time and frequency dimensions that included symbols for both faster-moving and slower-moving mobile stations. Nystrom, Fig. 5A & [0041], [0043]. As discussed for 8[c], a POSA would have found it obvious to incorporate this teaching into Talukdar.

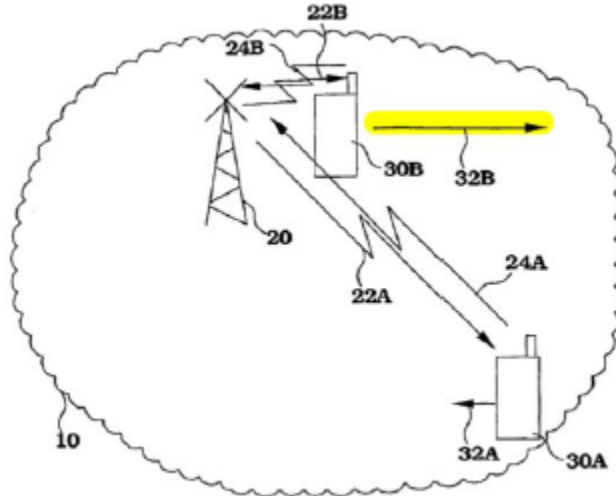
Limitation 8[c] recites: **“and wherein the second communication system**

**has pilot symbols that are denser than those in the first communication system.”**

Nystrom taught that faster-moving user equipment (or “mobile stations,” see Nystrom, [0029]) needed to receive “frequent pilots” because of their quickly-changing channel conditions:

A base station ... communicates with two mobile stations or user equipments 30A, 30B. ... ***User equipment 30B ... has a high speed 32B*** (also illustrated as an arrow).  
... ***[T]he radio conditions [for 30B] are probably changing rapidly in time, whereby frequent pilots in time dimension are required.***

Nystrom, [0029]; see also *id.*, Figure 1 (showing higher-speed mobile station 30B; highlighting added):

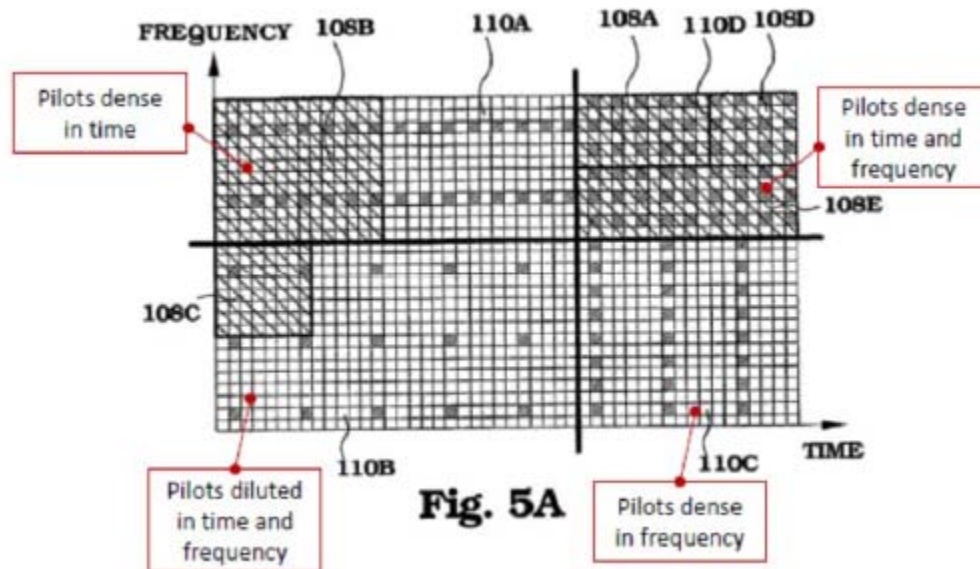


Nystrom taught that “the available radio resources constitute[d] a grid of basic resources that c[ould] be used for data, control signaling or pilot signals.” *Id.*, [0039]. To accommodate mobile stations with different speeds, Nystrom disclosed allocating mobile stations “different parts of the radio resource space,” with pilot density “dependent on their estimated radio conditions.” *Id.*, [0038]. “[W]henver a certain user ha[d] certain demands, the user [wa]s assigned resources in the resource space where pilots with the appropriate density c[ould] be utilised for channel estimation.” *Id.*, [0042].

Nystrom’s base station allocated faster-moving mobile stations (each a “communication system”) resource sub-spaces with more pilot symbols per unit of time (see *supra* § V(F)). For example, a “resource space part 110A ha[d] a pilot pattern, **having a dense occurrence in time dimension (every second OFDM symbol at certain carriers)**, but a more dispersed behaviour in the frequency dimension (only every sixth OFDM carrier)”;

“resource space part 110D ha[d] a **very**

**dense pilot structure in both [time and frequency] dimensions**, comprising a pilot symbol in every fourth resource unit”; whereas “resource space part 110B ha[d] a very diluted pilot pattern, having only one pilot in 36 resource units, evenly spread in time and frequency dimensions.” *Id.*, [0041]; *id.*, Fig. 5A (showing radio resource space parts with different pilot density patterns for different mobile stations) (labels added):



Roy ¶ 160.

Nystrom taught that mobile stations were allocated different pilot density patterns within this resource space based on their mobility levels:

A first user, having radio conditions demanding a high density of pilots in both dimensions is allocated to the resource sub-space 108A within the part 110D. A second user, only having need for dense pilot in the time dimension is allocated resources in a resource sub-space

108B within the part 110A. A third user with very  
favourable radio conditions is allocated to a resource sub-  
space 108C in part 110B. Finally, two more users, having  
high demands on pilot density are given resources in two  
5 subspaces 108D and 108E, respectively in part 110D.

Nystrom, [0043]. Mobile stations with fast-varying conditions could be assigned  
denser pilot patterns as necessary. *Id.* (“It is beneficial, e.g. to assign resources for  
mobiles with certain fast varying channel or Doppler conditions in the dense parts  
of the pilot pattern[.]”).

10 Thus, Nystrom disclosed a “second communication system [with] pilot  
symbols that are denser than those in the first communication system” (a faster-  
moving and slower-moving mobile station, respectively). Roy ¶¶ 157-61.

A POSA would have found it obvious to incorporate Nystrom’s teaching of  
using denser pilot symbols for faster-moving 802.16(m) mobile stations into  
15 Talukdar, because Nystrom expressly provided a teaching, suggestion, or motivation  
to do so in having taught that denser pilot symbols counteracted the effects of  
Doppler shift and fading experienced by faster-moving remote units. Roy ¶¶ 162-  
63. Nystrom taught that mobile stations traveling at faster speeds experienced higher  
Doppler shift and fading in time and/or frequency. Nystrom, [0004], [0029].  
20 Nystrom further taught that increasing the density of pilot symbols for these mobile  
stations allowed mobile stations to better estimate their channel conditions and to

better adapt and compensate for the effects of Doppler shift and fading. *Id.*, [0037], [0042]-[0043]. As discussed for limitation 1[c], Talukdar disclosed and rendered obvious a wireless system that included a 802.16(m) remote unit that was faster-moving relative to a fixed or slower-moving 802.16(e) remote unit (Talukdar, [0024], [0027]; *supra* at 41-43), and this faster-moving unit would have experienced Doppler shift and fading when moving at higher speeds. Roy ¶ 163. A POSA would have recognized that increasing the density of pilot symbols for a faster-moving remote unit would have yielded the benefits taught by Nystrom—specifically, enhancing the faster-moving remote unit’s ability to perform channel estimation and thus reducing the effects of Doppler shift and fading. *Id.*

A POSA would have had a reasonable expectation of success in making this combination because Nystrom identified an example implementation that a POSA would have been able to execute in the context of Talukdar—by using a less dense, “diluted” pilot pattern for a fixed or slower-moving 802.16(e) remote unit (*e.g.*, a “first communication system”), but a “a pilot pattern[] having a dense occurrence in [the] time dimension (every second OFDM symbol at certain carriers)” (“pilot symbols that are denser”) for a faster-moving 802.16(m) remote unit (a “second communication system”). Roy ¶¶ 163-64. A POSA would have recognized Talukdar’s teaching (at [0029]) that “[i]n general, the structures of the 802.16(m) region (sub-channel and pilot structures) can be different from those of the 802.16(e)

regions,” as further indicating a reasonable expectation of success in making this combination. *See also* Talukdar, [0064]; Roy ¶ 164.

Additionally, a POSA would have been motivated to combine Nystrom’s teachings with Talukdar with a reasonable expectation of success because Talukdar  
5 and Nystrom similarly disclosed using different OFDM symbols in the time dimension of the same resource space for different systems in one OFDM transmission scheme. *E.g.*, Talukdar, [0026] (“the communication system utilizes OFDMA ... In OFDM based systems, the radio resources include OFDM symbols[.]”), [0051] (“FIG. 7 is a hybrid frame 700, ... having equal size sub-blocks  
10 designed to serve both 802.16(e) and 802.16(m) data traffic in the same 5 msec interval.”); Nystrom, [0027] (“OFDM ... systems are used for exemplifying the present invention”), [0041] (“The entire radio resource space illustrated is divided into four rectangular parts, 110A-D. ... The resource space part 110B has a very diluted pilot pattern ... [while] resource space part 110D has a very dense pilot  
15 structure in both dimensions, comprising a pilot symbol in every fourth resource unit”), [0043] (“A first user, having radio conditions demanding a high density of pilots in both dimensions is allocated to the resource sub-space 108A within the part 110D. ... A third user with very favourable radio conditions is allocated to a resource sub-space 108C in part 110B.”); Roy ¶ 165.

Modifying Talukdar to incorporate Nystrom's pilot density teachings would also have been obvious because it amounted to combining prior art elements according to known methods to yield predictable results. Specifically, the proposed combination would have involved using a denser pilot symbol pattern (as taught by Nystrom) for a faster-moving 802.16(m) remote unit by, for example, inserting additional pilot symbols (as taught by Nystrom) in the second section of Talukdar's hybrid frame that contained data configured for the faster-moving 802.16(m) remote unit (the "second communication system"). Roy ¶ 166. This would have resulted in enhancing the faster-moving unit's ability to perform channel estimation, which was predictable in view of Nystrom's teachings. Nystrom, [0037], [0042]-[0043]; Roy ¶ 166. This modification would also have been the use of a known technique (using symbols with different pilot density patterns to communicate with different communication systems, as taught by Nystrom) to improve a similar method (using symbols configured in different formats to communicate with different communication systems, as taught by Talukdar) in the same way (by improving the faster-moving communication system's ability to perform channel estimation, as taught by Nystrom). *Id.*

The combination of Talukdar and Nystrom rendered limitation 8[c] obvious. Thus, Talukdar in combination with Nystrom rendered claim 8 obvious.

## VIII. CONCLUSION

As explained above, Petitioner is likely to prevail in showing that the challenged claims of the '096 patent are unpatentable and requests that IPR be instituted and that the challenged claims be canceled.

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**CERTIFICATION OF WORD COUNT UNDER 37 C.F.R. § 42.24(d)**

Under the provisions of 37 CFR § 42.24(d), the undersigned hereby certifies that the word count for the foregoing *Petition for Inter Partes Review* totals 12,924 words, excluding the cover page, signature block, and the parts exempted by 37 C.F.R. § 42.24(a).

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**CERTIFICATE OF SERVICE**

The undersigned hereby certifies that true copies of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 8,265,096 and supporting materials (Exhibits 1001-1028 and Power of Attorney) have been served this 29th day of March, 2021, by UPS® mail delivery service on Patent Owner at the correspondence address for the attorney of record for the '096 Patent shown in USPTO PAIR:

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