

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of: Li et al.
U.S. Patent No.: 10,447,450 Attorney Docket No.: 00035-0021IP1
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Title: METHOD AND SYSTEM FOR MULTI-CARRIER PACKET
COMMUNICATION WITH REDUCED OVERHEAD

DECLARATION OF DR. DING

I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

By:  Digitally signed by Zhi Ding
Date: 2021.09.15 11:26:57 -07'00'

Zhi Ding, Ph.D.

Date: September 15, 2021

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I. QUALIFICATIONS AND BACKGROUND INFORMATION

1. My education and experience are described more fully in the accompanying curriculum vitae (Ex-1004). For ease of reference, I have highlighted certain information below.

2. I presently hold the title of Distinguished Professor in the Department of Electrical and Computer Engineering at the University of California, Davis. Since my appointment on July 1, 2000, I have held the position of professor for over 20 years at the same institution. I have served full time as a faculty member at three major research universities in the United States over the past 30 years, including Auburn University from 1990 to 1998, University of Iowa from 1999 to 2000, and University of California, Davis, from 2000 to present. I have more than three decades of research experience on a wide range of topics related to data communications, networking, and signal processing. I also serve as a private technical consultant on various technologies related to information systems.

3. I earned my Bachelor of Engineering degree in 1982 in wireless engineering from the Nanjing Institute of Technology (later renamed as Southeast University) in Nanjing, China. I earned my Master of Applied Science degree in 1987 in electrical engineering from the University of Toronto in Toronto, Canada. I earned my Ph.D. in 1990 in electrical engineering from Cornell University in Ithaca, New York.

4. My responsibilities as a Professor at University of California, Davis, include classroom instruction on various topics of communication systems and signal analysis, as well as mentoring undergraduate students and supervising graduate students in their research and development efforts on various topics related to digital communications. I have directly supervised such research and development works ranging from signal detection to wireless networking. As the chief academic advisor, I have also directly supervised the completion of over 30 Masters degrees and 30 Ph.D. dissertations on various topics related to digital communications.

5. Since 1990, I have been selected as the principal investigator of multiple highly competitive federal and local research grants, including more than two dozen major research projects supported by the National Science Foundation and other US government agencies. These competitive research projects focused on developing more efficient and effective digital communication transceivers, networks, and signal processing tools. I have also participated in several large-scale projects supported by the Defense Advanced Research Projects Agency (DARPA) with teams of researchers. I have applied for, and received support from, other federal, state, and industry sponsors.

6. I have published over 220 peer-reviewed research articles in premier international journals, in addition to over 240 refereed technical articles at top international conferences on communications and information technologies.

According to Google Scholar, my published works have been cited by over 14,000 times by peers in the technical field of communication systems and signal processing. I also authored two books on communications technologies. My most recent book, coauthored with B.P. Lathi, is entitled, "Modern Digital and Analog Communication Systems," 5th edition, and was published by the Oxford University Press in 2018. The 4th edition of this book (published in 2009) had been widely adopted as a foundational textbook to communication systems.

7. In addition to the over 460 published technical papers that have been cited over 14,000 times according to Google Scholar, I am also co-inventor of 4 issued U.S. patents on communication technologies.

8. I am a member of the Institute of Electrical and Electronics Engineers (IEEE) and was elevated to the grade of Fellow in January 2003 for contributions made in signal processing for communication. The IEEE is the world's largest professional society of engineers, with over 400,000 members in more than 160 countries. The IEEE has led the development of many standards for modern digital communications and networking, most notably, the IEEE 802 series of network standards. The IEEE Grade of Fellow is conferred by the Boards of Directors upon a person with an extraordinary record of accomplishments in any of the IEEE fields of interest. The total number selected in any one year does not exceed one-tenth of one percent of the total voting Institute membership.

9. I have served the IEEE in the following capacities:
10. Chief Information Officer of the IEEE Communications Society from Jan. 2018 to present.
11. Chief Marketing Officer of the IEEE Communications Society from Jan. 2020 to present.
12. General Chair of the 2016 IEEE International Conference on Acoustics, Speech, and Signal Processing, the flagship conference of the IEEE Signal Processing Society.
13. Chair of the Steering Committee for the IEEE Transactions on Wireless Communications from 2008 to 2010.
14. Distinguished Lecturer of the IEEE Communications Society from January 2008 to December 2009.
15. Technical Program Chair of the 2006 IEEE Globecom, one of two flagship annual IEEE Communication Society conferences.
16. Distinguished Lecturer of the IEEE Circuits and Systems Society from 2004 to 2005.
17. Associate Editor of the IEEE Transactions on Signal Processing from 1994 to 1997 and from 2001 to 2004.
18. Member of the IEEE Statistical Signal and Array Processing for Communications Technical Committee from 1993 to 1998.

19. Member of the IEEE Signal Processing for Communications Technical Committee from 1998 to 2004.
20. In 2012, I received the Wireless Communications Technical Committee Recognition Award from the IEEE Communications Society, an award given to a person with a high degree of visibility and contribution in the field of "Wireless and Mobile Communications Theory, Systems, and Networks." I received the 2020 Education Award from the IEEE Communications Society. According to the Society, this award "recognizes distinguished and significant contributions to education within the Society's technical scope."
21. I have also served as a technical consultant for the telecommunication industry. For example, in 1995 I consulted for Analog Devices, Inc., on the development of the first generation DOCSIS cable modem systems. I have also consulted for other companies, including Nortel Networks and NEC US Laboratories. I worked as a visiting faculty research fellow at NASA Glenn Research Center in 1992 and at U.S. Air Force Wright Laboratory in 1993. I have served on multiple review panels of the National Science Foundation to evaluate competitive research proposals in the field of communication. I have also reviewed a large number of research proposals at the request of the National Science and Engineering Research Council (NSERC) of Canada as an expert panelist from

2010 to 2013, and also at the request of the Research Grant Council (RGC) of Hong Kong as an external reviewer.

22. I have served as an expert witness or consulting expert on a number of matters related to intellectual property, mostly in the arena of telecommunications, including cellular communications, Wi-Fi technologies, Bluetooth, and optical communications. For example, since 2007, I have been engaged to work on various litigations involving cellular, WiFi, Bluetooth, and optical communication networks.

23. Further experience and a complete list of my publications are presented in my curriculum vitae (Ex-1004).

24. Based on my above-described near three decades of experience in communications technologies, and the acceptance of my publications and professional recognition by societies in my field, I believe that I am qualified to be an expert in wireless communication systems, communication networks, and signal processing.

25. I have been retained on behalf of Petitioner to offer technical opinions relating to U.S. Patent No. 10,447,450 (“the **’450 patent**”) and prior art references relating to its subject matter. I have reviewed the ’450 Patent, and relevant excerpts of the prosecution history of the ’450 Patent. Among various textbooks,

documents, and publications, I have also reviewed the following prior art references:

Prior Art References
U.S. Patent Publication 2005/0157803 (“Kim” or “Ex-1005”)
IEEE 802.16-2004 Standard (“IEEE802.16-2004” or “Ex-1008”)

26. Counsel (Fish & Richardson) has informed me that I should consider these materials through the lens of one of ordinary skill in the art related to the '450 Patent at the time of the earliest possible priority date of the '450 Patent, and I have done so during my review of these materials. The '450 Patent claims priority to U.S. Provisional Application No. 60/721,451, filed September 28, 2005. I have been informed by Counsel to use September 28, 2005 as the “Priority Date” in my analysis below.

27. I have no financial interest in the outcome of this proceeding. I am being compensated for my time spent as an expert on an hourly basis. My compensation is not dependent on the outcome of these proceedings or the content of my opinions.

28. In writing this declaration, I have considered the following: my own knowledge and experience, including my work experience in the fields of electrical engineering and wireless communication networks; my experience in teaching related subjects; and my experience in working with others involved in those

fields. In addition, I have analyzed various publications and materials, in addition to other materials I cite in my declaration.

29. My opinions, as explained below, are based on my education, experience, and expertise in the fields relating to the '450 Patent. Unless otherwise stated, my testimony below refers to the knowledge of one of ordinary skill in the art as of the earliest possible priority date. Any figures that appear within this document have been prepared with the assistance of Counsel and reflect my understanding of the '450 Patent and the prior art discussed below.

II. OVERVIEW OF CONCLUSIONS FORMED

30. This declaration explains the conclusions that I have formed based on my analysis. To summarize those conclusions, based upon my knowledge and experience and my review of the prior art references listed above, I believe that Kim and IEEE802.16-2004 render obvious claims 1-18 of the '450 Patent.

31. In support of these conclusions, I provide an overview of the references in Section VI and more detailed comments regarding the obviousness of claims 1-18 (“**the Challenged Claims**”) of the '450 Patent in Section VII.

III. LEVEL OF ORDINARY SKILL IN THE ART

32. One of ordinary skill in the art relating to, and at the time of, the Priority Date would have been someone with at least a Bachelor's degree in an academic area emphasizing electrical engineering, computer engineering, or a similar

discipline, plus at least two years of experience in the field working with, teaching, or researching wireless communication networks. More advanced degrees and additional education could compensate for shorter work experience, and *vice-versa*.

33. Based on my experiences, I have a good understanding of the capabilities of a person of ordinary skills in the art (POSITA). Indeed, I have taught, mentored, participated in organizations, and worked closely with many such persons over the course of my career. Based on my knowledge, skill, and experience, I have an understanding of the capabilities of a POSITA. For example, from my industry consulting or conference interactions, I am familiar with what a POSITA would have known and found predictable in the art. From teaching and supervising my post-graduate students, I also have an understanding of the knowledge that a person with this academic experience possesses. Furthermore, I possess those capabilities myself.

IV. LEGAL STANDARDS

A. Terminology

34. I have been informed by Counsel and understand that the best indicator of claim meaning is its usage in the context of the patent specification as understood by one of ordinary skill. I further understand that the words of the claims should be given their plain meaning unless that meaning is inconsistent with the patent

specification or the patent's history of examination before the Patent Office.

Counsel has also informed me, and I understand that, the words of the claims should be interpreted as they would have been interpreted by one of ordinary skill at the time of the invention was made (not today). I have been informed by Counsel that I should use February 13, 2004 as the point in time for claim interpretation purposes with respect to this declaration.

B. Legal Standards

35. I have been informed by Counsel and understand that documents and materials that qualify as prior art can render a patent claim unpatentable as being anticipated or obvious.

36. I am informed by Counsel and understand that all prior art references are to be looked at from the viewpoint of a person of ordinary skill in the art at the time of the invention, and that this viewpoint prevents one from using his or her own insight or hindsight in deciding whether a claim is anticipated or rendered obvious.

1. Anticipation

37. I understand that patents or printed publications that qualify as prior art can be used to invalidate a patent claim as anticipated or as obvious.

38. I understand that, once the claims of a patent have been properly construed, the second step in determining anticipation of a patent claim requires a comparison

of the properly construed claim language to the prior art on a limitation-by-limitation basis.

39. I understand that a prior art reference “anticipates” an asserted claim, and thus renders the claim invalid, if all limitations of the claim are disclosed in that prior art reference, either explicitly or inherently (i.e., necessarily present).

2. Obviousness

40. I understand that even if a patent is not anticipated, it is still invalid if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a POSITA.

41. I have been informed by Counsel and understand that a claim is unpatentable for obviousness and that obviousness may be based upon a combination of prior art references. I am informed by Counsel and understand that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. However, I am informed by Counsel and understand that a patent claim composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art.

42. I am informed by Counsel and understand that when a patented invention is a combination of known elements, a court determines whether there was an

apparent reason to combine the known elements in the fashion claimed by the patent at issue by considering the teachings of prior art references, the effects of demands known to people working in the field or present in the marketplace, and the background knowledge possessed by a person having ordinary skill in the art.

43. I am informed by Counsel and understand that a patent claim composed of several limitations is not proved obvious merely by demonstrating that each of its limitations was independently known in the prior art. I am informed by Counsel and understand that identifying a reason those elements would be combined can be important because inventions in many instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known. I am informed by Counsel and understand that it is improper to use hindsight in an obviousness analysis, and that a patent's claims should not be used as a "roadmap."

44. I am informed by Counsel and understand that an obviousness inquiry requires consideration of the following factors: (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called "secondary considerations" of non-obviousness, which include: (i) "long felt need" for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) "copying" of the claimed invention by others.

45. I have been informed by Counsel and understand that an obviousness evaluation can be based on a single reference or a combination of multiple prior art references. I understand that the prior art references themselves may provide a suggestion, motivation, or reason to combine, but that the nexus linking two or more prior art references is sometimes simple common sense. I have been informed by Counsel and understand that obviousness analysis recognizes that market demand, rather than scientific literature, often drives innovation, and that a motivation to combine references may be supplied by the direction of the marketplace.

46. I have been informed by Counsel and understand that if a technique has been used to improve one device, and a person of ordinary skill at the time of invention would have recognized that it would improve similar devices in the same way, using the technique is obvious unless its actual application is beyond his or her skill.

47. I have been informed by Counsel and understand that practical and common sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. I have been informed by Counsel and understand that a person of ordinary skill looking to overcome a problem will often be able to fit together the teachings of multiple prior art references. I have been informed by Counsel and understand that

obviousness analysis therefore takes into account the inferences and creative steps that a person of ordinary skill would have employed at the time of invention.

48. I have been informed by Counsel and understand that a proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill at the time of invention, not just the patentee. Accordingly, I understand that any need or problem known in the field of endeavor at the time of invention and addressed by the patent can provide a reason for combining the elements in the manner claimed.

49. I have been informed by Counsel and understand that a claim can be obvious in light of a single reference, without the need to combine references, if the elements of the claim that are not found explicitly or inherently in the reference can be supplied by the common sense of one of skill in the art.

50. I have been informed by Counsel and understand that there must be a relationship between any such secondary considerations and the invention, and that contemporaneous and independent invention by others is a secondary consideration supporting an obviousness determination.

51. In sum, my understanding is that prior art teachings are properly combined where one of ordinary skill having the understanding and knowledge reflected in the prior art and motivated by the general problem facing the inventor, would have been led to make the combination of elements recited in the claims. Under this analysis, the prior art references themselves, or any need or problem known in the

field of endeavor at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner.

52. I have been informed by Counsel and understand that in an *inter partes* review (IPR), “the petitioner shall have the burden of proving a proposition of unpatentability,” including a proposition of obviousness, “by a preponderance of the evidence.” 35 U.S.C. § 316(e).

V. THE '450 PATENT

A. Overview of the '450 Patent

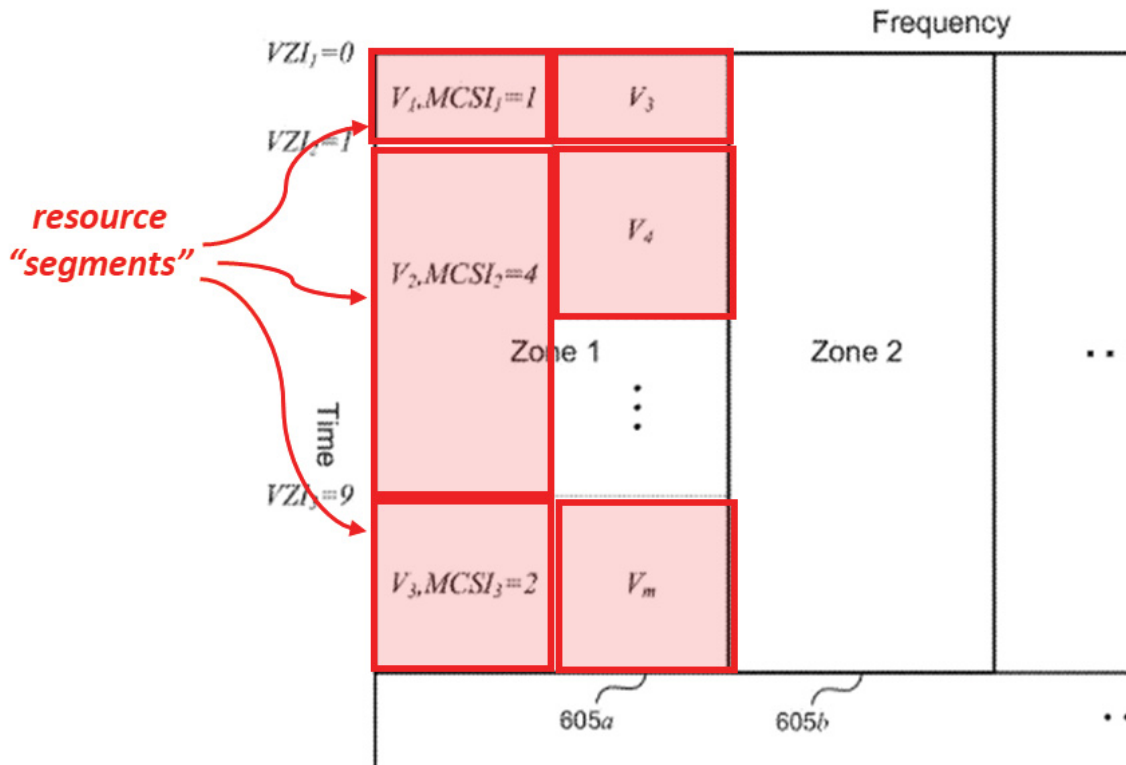
53. The '450 patent relates to a “multi-carrier wireless communication network” based on the **IEEE 802.16** wireless communication standard (“WiMAX”). Ex-1001, Abstract; 1:41-49. The '450 patent describes a wireless network in which a **base station** (which provides wireless coverage for a particular geographic cell) communicates with a **mobile station** (which “may be **fixed** or may **roam** within the geographic region covered by the network.”). Ex-1001, 3:35-42. The claims of the '450 patent are specifically directed to “downlink (DL)” communication directed from the base station to the mobile station. Ex-1001, 3:52-54, claims 1-18.

54. The '450 patent describes a communication signaling framework based on the IEEE 802.16 standard using physical **resources** in both “frequency and time domains.” Ex-1001, 4:16-18. In the time domain, the signal utilizes a “**frame**

structure” in which “[e]ach frame consists of a number of **time slots**, and each time slot is comprised of one or more OFDM **symbols**.” Ex-1001, 4:63-66, claim 1. In the frequency domain, a signal is made up of multiple “**subcarriers**.” Ex-1001, 4:29-31, 4:57-59.

55. Building on this signaling framework, the ’450 patent “contemplates the application of the disclosed technology to an Orthogonal Frequency Division Multiple Access (**OFDMA**) system” as specified in the prior art IEEE 802.16 standard. Ex-1001, 3:6-8. Specifically, the ’450 patent explains that, “in a typical wireless system based on the IEEE 802.16 standard (‘WiMAX’), multiple packet streams are established for each mobile device” to provide “simultaneously supported communications” between a single base station and a single mobile station (*i.e.*, reflecting the term “multiple access” in “OFDMA”). Ex-1001, 5:30-37. To provide simultaneous communication, the ’450 patent explains that the IEEE 802.16 standard specifies different information “may be spread throughout the available time-frequency resource.” Ex-1001, 5:39-31.

56. Reflecting this well-known concept of multi-access communication in OFDMA, the ’450 patent allocates different “**segments**” of time-frequency resources for transmissions of different packet streams. Ex-1001, 6:12-21, Fig. 6 (below, annotated).

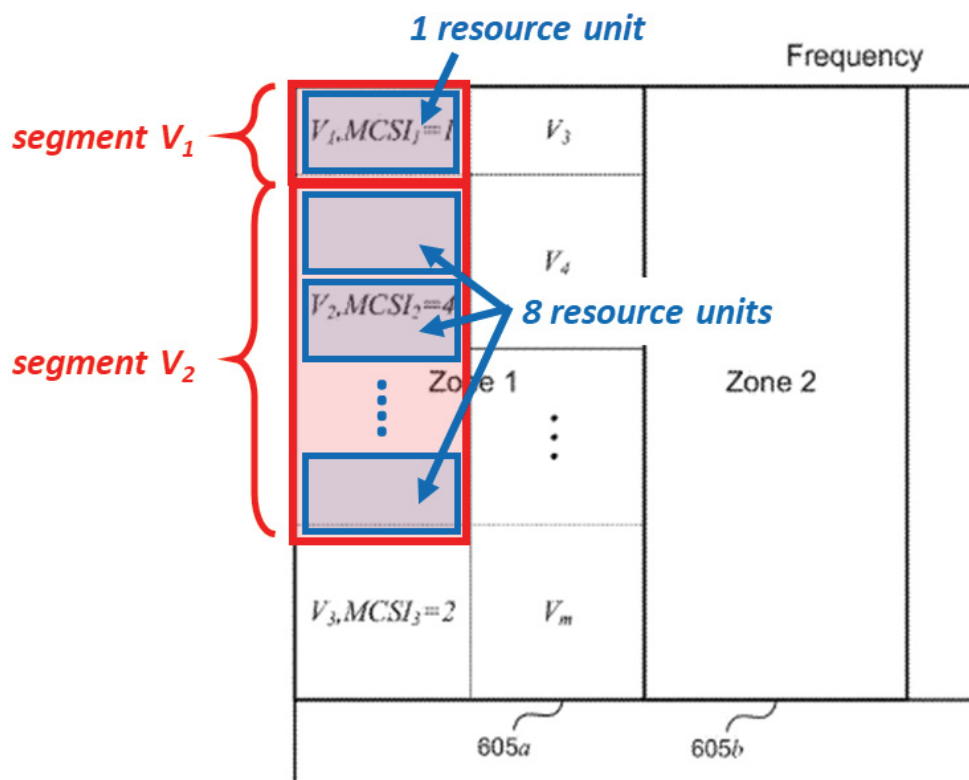


Ex-1001, Fig. 6 (annotated)

57. The location of each resource segment is identified by a “**starting time-frequency coordinate**” of the segment, where the starting “time coordinate” is specified with a granularity of “one or multiple OFDM symbols” and the starting “frequency coordinate” is specified with a granularity of “one or multiple subcarriers.” Ex-1001, 5:57-63.

58. Further, the ’450 patent describes that each resource segment is allocated in multiples of a basic “**resource unit**.” Ex-1001, 6:45-52. The ’450 patent refers to this as utilizing “modular resources” whereby each segment is “simply an integer multiple of the basic unit.” Ex-1001, 6:45-52. As an example, with reference to Figure 6, the ’450 patent explains that segment “ V_1 ” includes “one basic resource

unit” and segment “ V_2 ” includes “eight basic resource units.” Ex-1001, 7:20-24, Figure 6 (below, annotated).



Ex-1001, Fig. 6 (annotated)

59. The '450 patent specification proposes various allegedly novel features designed to improve over the prior art by “minimizing the control overhead” that is required to identify the location of each of the different resource segments. Ex-1001, Abstract, 5:45-6:2, 7:28-30. Specifically, the '450 patent specification proposed reduction in control signaling overhead by “**grouping** applications of a similar type together within a **zone**” (each zone consisting of a group of segments) and identifying the location of a segment “relative to the starting point of the **zone**”

using the “basic resource units as the granularity of a location offset.” Ex-1001, Abstract, 5:45-62, 7:28-30. Although earlier patents in the family of the ’450 patent family included these features,¹ over time Patent Owner removed them from the claims pursued in the ’450 patent family. As a result, none of the allegedly novel features are recited in the claims of the ’450 patent.

60. Instead, the claims of the ’450 patent merely recite features of OFDMA systems that were well-known in prior art IEEE 802.16 technology. For example, the Background Section of the ’450 patent acknowledges that various features of claim 1 were known, such as the feature that mobile station is assigned a “16-bit **connection ID** (CID).” Ex-1001, 1:51-55. The Background Section of the ’450 patent also recognized that, in the prior art IEEE 802.16 standard, “resource allocation is **identified** in the **time domain** scale with a **start** symbol **offset** (8 bits)” and “in the **frequency domain** scale with a **start** logical subchannel **offset** (6 bits) and a **number** of allocated subchannels (6 bits).” Ex-1001, 1:61-66. With the acknowledged similarity between the ’450 patent claims and the prior art IEEE 802.16 standard, it is unsurprising to find all features of the ’450 patent in prior

¹ See Ex-1012 (US 7,948,944), claim 1 (“allocating a **zone** in the time-frequency resource, wherein: the zone is designated for a **type of application**”); Ex-1013 (US 8,693,430), claim 1 (“the **zone** is designated for carrying packets of **the class**”).

802.16 or WiMAX publications. In fact, as I explain in detail below, Kim and IEEE802.16-2004 teach all of the features of the '450 patent, rendering the Challenged Claims obvious.

B. Prosecution History of the '450 Patent

61. During prosecution of the '450 patent, the Examiner did not issue any rejections based on prior art, and instead only issued a double patenting rejection which Patent Owner overcame by submitting a terminal disclaimer for allowance. The Examiner did not provide any reasons for allowance. During prosecution, the Examiner did not consider or substantively apply Kim or IEEE802.16-2004, which in combination render the Challenged Claims obvious.

VI. OVERVIEW AND COMBINATIONS OF PRIOR ART REFERENCES

62. All of the features claimed in the '450 patent were well-known in prior art IEEE 802.16 technology and were specifically disclosed in numerous references prior to the Critical Date of the '450 patent. An example of such a reference, Kim, is discussed below. Kim utilizes the same IEEE 802.16-based OFDMA signaling framework as the '450 patent, namely time-domain **frames** each composed of multiple **slots** including multiple OFDM **symbols**, and frequency-domain **subcarriers**. Based on this signaling framework, Kim discloses allocating channel resources (the claimed “*segments*” of the '450 patent) in integer multiples of a minimum allocation unit (the claimed “*resource unit*”). Kim also describes a

coding scheme which encodes information over integer multiples of the minimum allocation unit (the claimed “*modular coding*”).

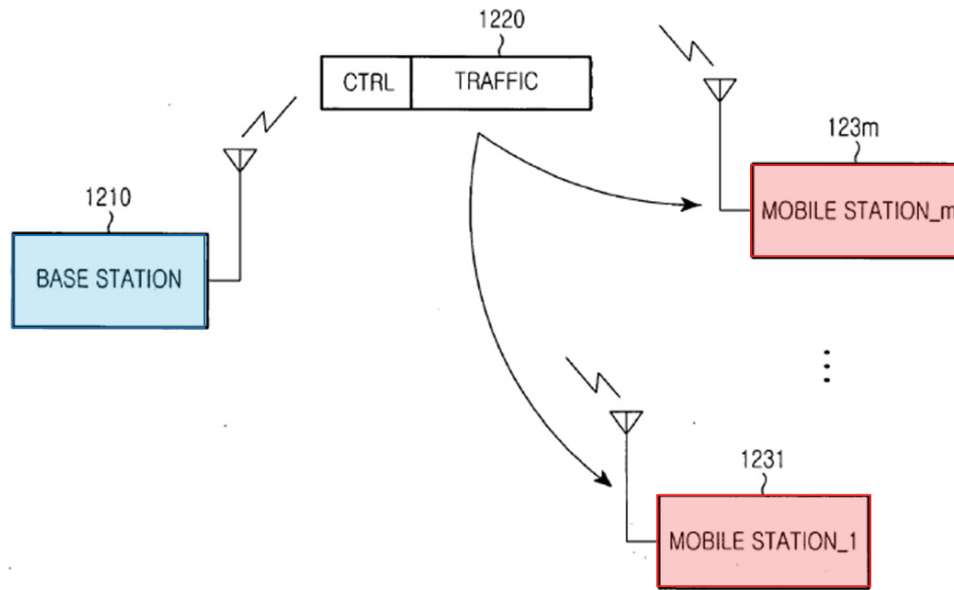
63. IEEE802.16-2004 (the technical standard that is foundational to both the ’450 patent and Kim) supplements Kim by providing further details of other claim features of the ’450 patent, including: (i) “*assigning an **identifier** to a mobile station*” (claim feature [1.1], *infra*) and (ii) “*the segment having a **starting time-frequency coordinate***” (claim feature [1.3], *infra*).

A. Kim²

64. Kim is titled “[m]odulating and coding apparatus and method in a high-rate wireless data communication system.” Ex-1005, Cover. Like the ’450 patent, Kim describes a wireless communication system based on the **IEEE 802.16 standard** that uses Orthogonal Frequency Division Multiple Access (**OFDMA**) technology for **downlink** communication from a base station to a mobile station. Ex-1005, Abstract, [0006], [0007], Fig. 12.

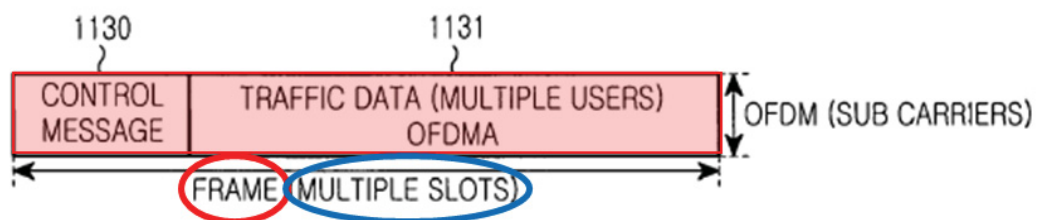
² The general descriptions I provide for the references and combinations discussed in Section VI are incorporated into each subsection addressing/applying those references, as are the discussions of combinations.

65. An example of Kim's wireless network is shown in Figure 12, which includes a **base station** 1210 that communicates with **mobile stations** 1231, ..., 123m. Ex-1005, Fig. 12, [0085].



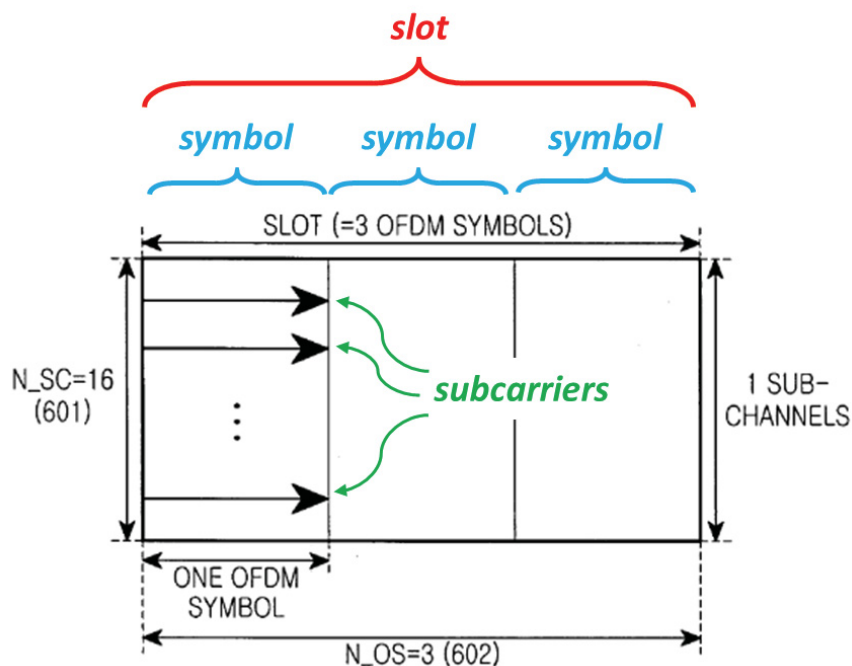
Ex-1005, Fig. 12 (annotated)

66. The base station transmits data in a “**frame**” (e.g., frame 1220 in Fig. 12), with each frame consisting of “multiple **slots**.” Ex-1005, Figs. 11 (below, annotated) and 12, [0085].



Ex-1005, Fig. 11 (annotated)

67. In the time domain, “one slot comprises one or more OFDM **symbols**.” Ex-1005, [0014]. Kim provides examples in which “one slot comprises three OFDM symbols” (e.g., in Figs. 2, 3, and 6), and more generally explains that there may be a parameter that defines the “number of OFDM symbols allocated per slot,” expressed as “N_OS.” Ex-1005, [0057]. In the frequency domain, the frequency bandwidth is divided into “**subcarriers**,” where a subcarrier “refers to an orthogonal carrier used in OFDM.” Ex-1005, [0014], Fig. 6. Kim’s Figure 6 (below, annotated) shows an example of a slot which includes 3 symbols in time, and each symbol includes 16 subcarriers in frequency.



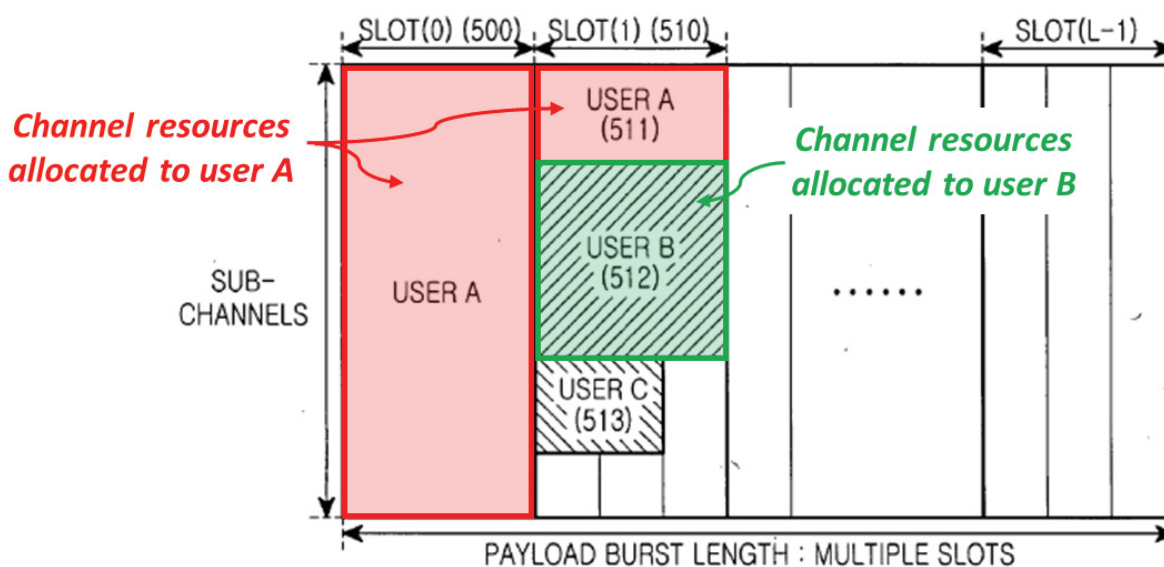
Ex-1005, Fig. 6 (annotated)

68. Kim further discloses a resource allocation scheme in which “channel resources are allocated to multiple users.” Ex-1005, [0013]. Kim explains that

“the amount of **channel resources** allocated to one user is determined based on the number of **subchannels** ... and the number of **slots**” (where a “subchannel” refers to a set of subcarriers). Ex-1005, [0011], [0052]–[0054], [0058], Figs. 5, 7, 8.

Each “**channel resource**” in Kim’s network is composed of a single “**subchannel**” in frequency spanning a single “**slot**” in time. Ex-1005, [0053], [0058].

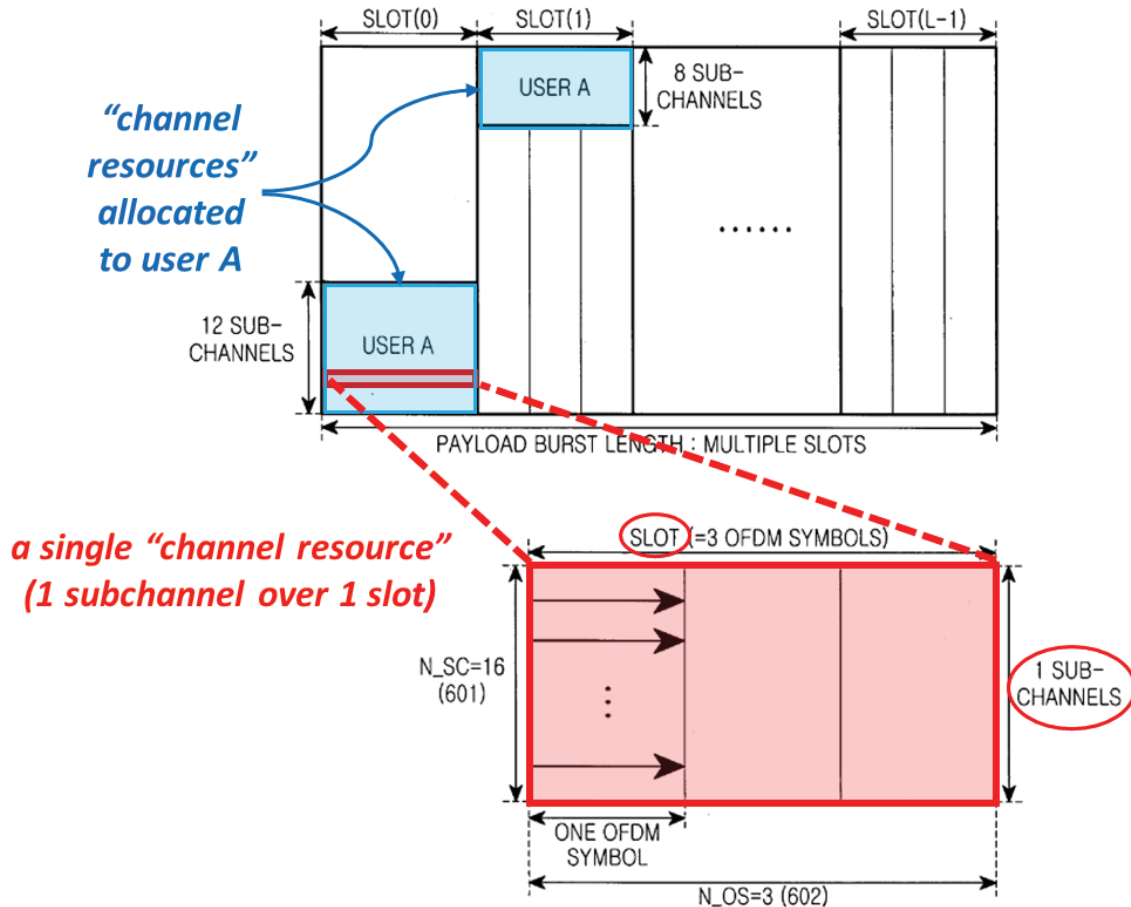
69. One embodiment of Kim’s resource allocation is shown in Figure 5 (below), in which “user A is allocated all of the subchannels of a first slot SLOT(0) 500 and occupies some subcarriers of a second slot SLOT(1)” and where “user B occupies some other subcarriers of the second slot SLOT(1) 510.” Ex-1005, [0058], Fig. 5 (below, annotated).



Ex-1005, Fig. 5 (annotated)

70. Another example is shown in Figure 7 (below, annotated), where user A is allocated 12 subchannels in the first slot (SLOT 0) and 8 subchannels in the second

slot (SLOT 1). Ex-1005, Fig. 7 (below, annotated to illustrate an individual “channel resource”).



Ex-1005, Figs. 7 and 6 (annotated)

71. In Kim’s system, data is transmitted over one or more of these channel resources using an adaptive coding and modulation scheme corresponding to a Modulation order Product code Rate (MPR), which depends on the number of subchannels allocated to a user’s data in a slot. Ex-1005, [0061]-[0067]. In particular, Kim’s network uses “a modulation scheme and a code rate based on a block size” where “the block has a different **number of subchannels for each**

slot” and thus “provides **various block sizes for error correction codes.**” Ex-1005, [0053], [0054]. Kim also discloses “symbol **repetition & puncturing**” which “performs symbol repeating and puncturing on the FEC-encoded data.” Ex-1005, [0010], [0069]. Kim explains that a system uses “a symbol puncturing and symbol **repetition** to match a code rate,” thereby providing the final Modulation order Product code Rate (MPR) of the encoding scheme. Ex-1005, [0067]; *Id.*

72. The contents of each frame in Kim’s network include a control message (“CTRL”) and user data (“TRAFFIC”). Ex-1005, Figs. 11, 12, [0085]. The control message CTRL in Kim’s frame includes various control information which allows a mobile station to correctly locate and recover user data from the TRAFFIC portion of the frame. Ex-1005, [0072], [0075], [0076], [0082], [0085] (which I discuss in more detail, *infra*). The “TRAFFIC” portion of Kim’s frame includes user data for “multiple users,” as provided by OFDMA technology in which multiple “user data is multiplexed every transmission frame.” Ex-1005, [0014], [0075].

73. When a base station transmits a frame to a mobile station, the “mobile station first detects the CTRL part from the frame 1220 to determine whether its **own data** has been transmitted” in the frame. Ex-1005, [0085]. This allows the mobile station to “determine whether a signal transmitted by a base station is a signal transmitted to the mobile station itself.” Ex-1005, [0072]. In addition, the

CTRL part of the frame also “includes **location information** in a frame where user data is multiplexed every transmission frame” as well as information regarding “the **number of subchannels**” and a “subchannel index” of the user data. Ex-1005, [0075], [0081]. As a result, the mobile station is able to “determine whether the data heading therefor has been received by detecting the control message” and “acquire data information” and “perform data demodulation and decoding” of the user data. Ex-1005, [0076], *see also* [0082].

B. IEEE802.16-2004

74. IEEE802.16-2004 is a wireless communication standard that “specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed [broadband wireless access, BWA] systems... It consolidates IEEE Std 802.16, IEEE Std 802.16a, and IEEE Std 802.16c, retaining all modes and major features without adding modes.” Ex-1008 at 37. In particular, IEEE802.16-2004 discloses a physical layer (PHY) “WirelessMAN-**OFDMA PHY**” specification which is “based on OFDM modulation.” Ex-1008, 529, §8.4.

75. IEEE802.16-2004 specifies a communication standard for a “**base station (BS)**” communicating with a “**subscriber station (SS)**.” Ex-1008, Title, 43 (definition 3.5), 47 (definition 3.56). The basic signaling structure consists of time domain “OFDMA **symbol[s]**” and frequency domain “**subcarriers**.” Ex-1008, 530 (§§8.4.2.1, 8.4.2.2).

76. Resource allocation in IEEE802.16-2004 is based on a “**minimum possible data allocation unit**” which consists of “one **slot**” in the time domain (each slot consisting of multiple OFDMA symbols) and “one **subchannel**” in the frequency domain (where a subchannel is a “subset” of subcarriers). Ex-1008, 532 (§8.4.3.1), 530 (§8.4.2.2). For example, each slot consists of “two OFDMA symbols” in the mode of “partial usage of subchannels” (PUSC). Ex-1008, 532 (§8.4.3.1). Based on this “minimum possible data allocation unit,” IEEE802.16-2004 specifies a “**data region**” as a “two-dimensional allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols.” Ex-1008, 532 (§8.4.3.1), Fig. 215 (below).

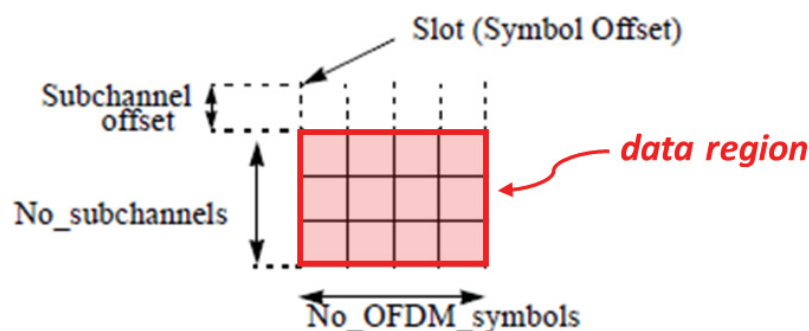


Figure 215—Example of the data region which defines the OFDMA allocation

Ex-1008, Figure 215 (annotated)

77. IEEE802.16-2004 provides an example of allocating a “data region” using a “minimum possible data allocation unit” consisting of one subchannel (in frequency) and one slot (in time) in Figure 216 (below, annotated).

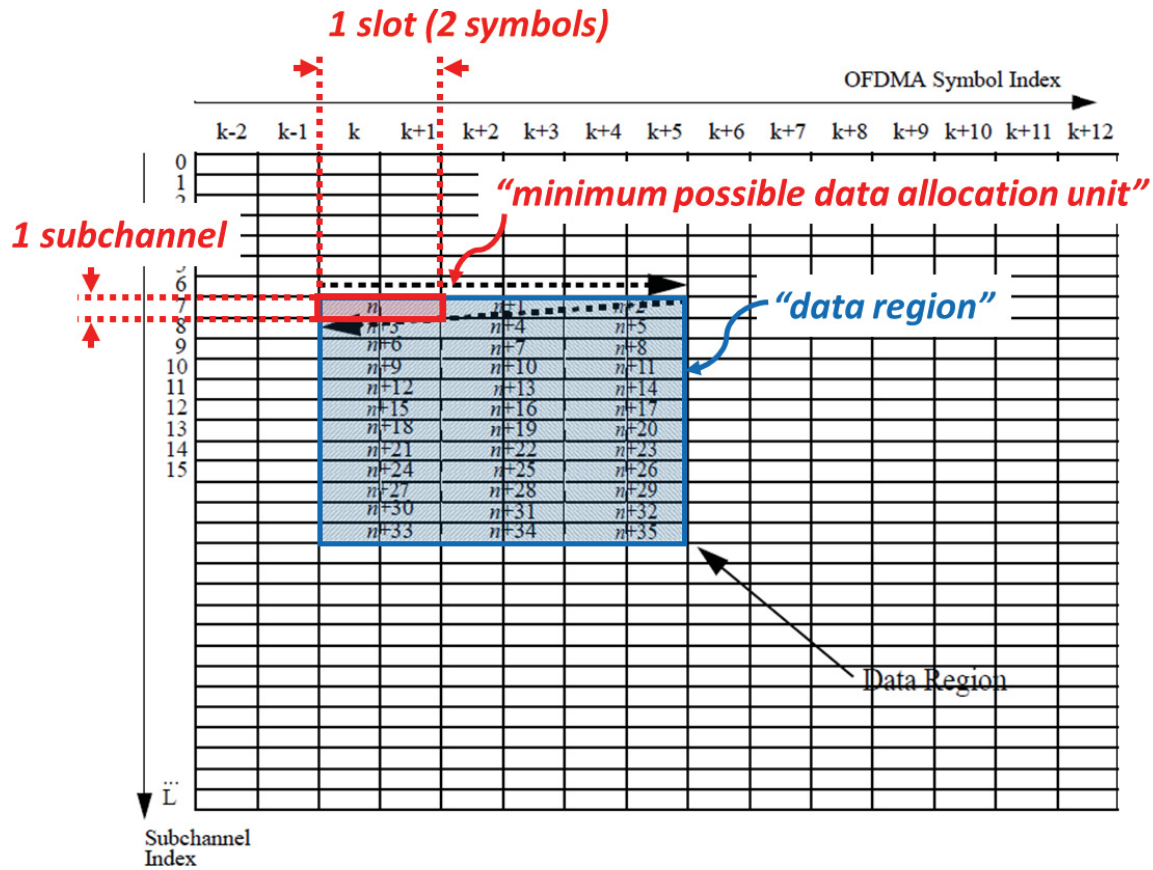
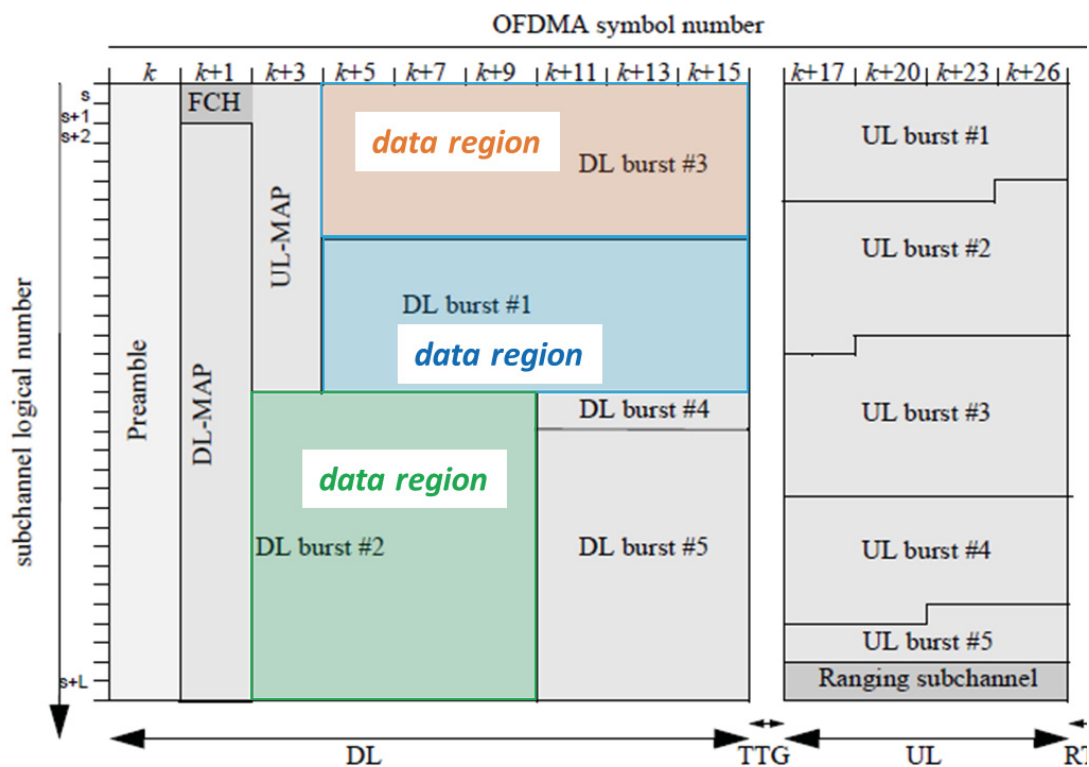


Figure 216—Example of mapping OFDMA slots to subchannels and symbols in the downlink (in PUSC mode)

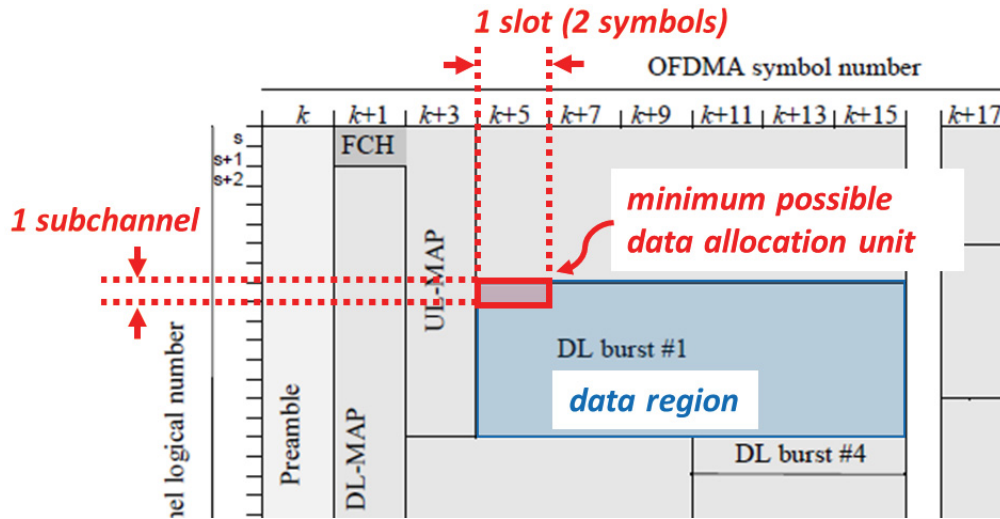
Ex-1008, Figure 216 (annotated)

78. IEEE802.16-2004 specifies that “data shall be processed ... and shall be mapped to an OFDMA Data Region.” Ex-1008, 533 (§8.4.3.4, first paragraph). Each “data region” is allocated for transmission of a “burst” of information for a particular subscriber station. Ex-1008, 533 (§8.4.3.4, first paragraph, subsection 8.4.9.2.3.5.6 “Modulation order of DL traffic **burst**”). IEEE802.16-2004 provides an example of allocating resources to different downlink “bursts” (“DL bursts”) in a frame. Ex-1008, Fig. 218 (below, annotated to illustrate a single “minimum

possible data allocation unit” within a data region). I note that Figure 218 shows time indexing in increments of two OFDMA symbols (e.g., “ $k+5$ ” followed by “ $k+7$ ”) and therefore each time increment corresponds to a slot (in IEEE802.16-2004’s PUSC mode of operation).

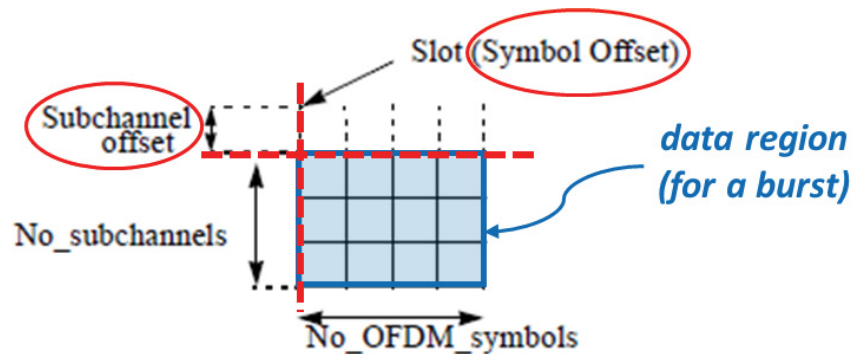


Ex-1008, Figure 218 (annotated)



Ex-1008, Figure 218 (annotated)

79. Furthermore, IEEE802.16-2004 specifies that the location of each data region (allocated for a “burst” of information) is identified in the time domain by a “**symbol offset**” (or, alternatively, a “slot” offset) and in the frequency domain by a “**subchannel offset**,” as shown in Figure 215 (below, annotated). Ex-1008, 558 (end of §8.4.5.3).



Ex-1008, Figure 215 (annotated)

80. IEEE802.16-2004 specifies details of a “**frame structure**,” as shown in Figure 218 (below, annotated). Ex-1008, page 535 (§8.4.4). Each frame includes,

in addition to data regions allocated to various “bursts” (as I discussed, *supra*), a “DL-MAP” message which is located in the beginning part of each frame. Ex-1008, Table 275, Figure 218 (below, annotated).

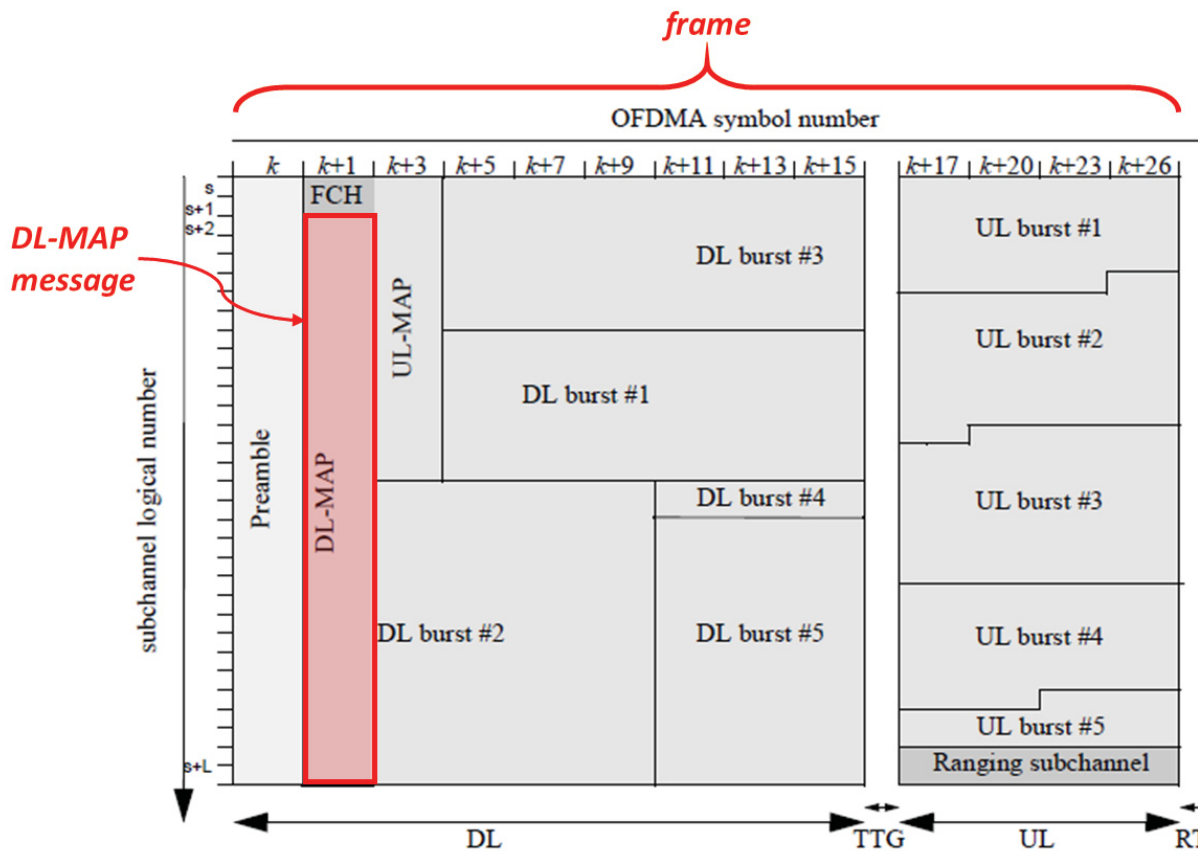


Figure 218—Time plan - one TDD time frame (with only mandatory

Ex-1008, Figure 218 (annotated)

81. This DL-MAP message includes information that “defines a two-dimensional allocation pattern” of each burst, and information regarding the assignment of a “connection identifier (CID).” Ex-1008, 557 (§8.4.5.3), 43 (definition 3.13), Table 275, Figure 218. This is consistent with the Background Section of the ’450 patent, which acknowledges that, in the IEEE 802.16 standard,

“[s]pecial scheduling messages, DL-MAP ... , are utilized to broadcast the scheduling decisions to the mobile stations” and “a 16 bits connection ID (CID) ... is included in the MAP message to identify the mobile station” Ex-1001, 1:47-55. In particular, as shown in Table 275 (below, annotated), the DL-MAP message includes the time-domain “OFDMA **Symbol offset**” of a burst (indicating the “offset of the OFDMA symbol in which the burst starts”), the frequency-domain “**Subchannel offset**” of a burst (indicating the “lowest index OFDMA subchannel used for carrying the burst”), and the “**No. Subchannels**” in a burst (indicating the “**number of subchannels** with subsequent indexes, used to carry the burst”). Ex-1008, 558, Table 275. In addition, the DL-MAP message includes the “**connection identifier (CID)**” (as I had discussed, *supra*). Ex-1008, Table 275.

Table 275—OFDMA **DL-MAP** IE format

Syntax	Size	Notes
DL-MAP_IE() {		
DIUC	4 bits	
if (DIUC == 15) {		
Extended DIUC dependent IE	<i>variable</i>	See subclauses following 8.4.5.3.1
} else {		
if (INC_CID == 1) {		The DL-MAP starts with INC_CID = 0. INC_CID is toggled between 0 and 1 by the CID-SWITCH_IE() (8.4.5.3.7)
N_CID	8 bits	Number of CIDs assigned for this IE
for (n=0; n< N_CID; n++) {		
CID	16 bits	
}		
}		
OFDMA Symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	000: normal (not boosted); 001: +6dB; 010: -6dB; 011: +9dB; 100: +3dB; 101: -3dB; 110: -9dB; 111: -12dB;
No. OFDMA Symbols	7 bits	
No. Subchannels	6 bits	
Repetition Coding Indication	2 bits	0b00 – No repetition coding 0b01 – Repetition coding of 2 used 0b10 – Repetition coding of 4 used 0b11– Repetition coding of 6 used

Ex-1008, Table 275 (annotated)

C. The Kim-IEEE802.16-2004 Combination

82. As I previously discussed in §VI.A, *supra*, Kim describes an “IEEE 802.16a system” that “uses Orthogonal Frequency Division Multiple Access

(OFDMA).” Ex-1005, Abstract, [0006], [0007]. A POSITA would have understood that IEEE802.16-2004 is an updated version of the IEEE 802.16a standard, and “consolidates IEEE Std 802.16, IEEE Std 802.16a, and IEEE Std 802.16c, retaining all modes and major features without adding modes.” Ex-1008 at 37. Therefore, a POSITA would have understood that the teachings of IEEE802.16-2004 would have been directly applicable to Kim. Furthermore, a POSITA would have understood that incorporating the teachings of IEEE802.16-2004 into Kim’s network would have involved use of a known technique (e.g., the known techniques specified in the IEEE 802.16 standard) to known devices (e.g., Kim’s network based on the IEEE 802.16 standard), ready for improvement to yield predictable results.

83. In particular, as I discuss in more detail below, a POSITA would have implemented the network of Kim by utilizing the following details specified in IEEE802.16-2004 (resulting in a combination which I will refer to as “Kim-IEEE802.16-2004”): **(a)** a POSITA would have utilized IEEE802.16-2004’s “connection ID (**CID**)” to assign **identifiers** to Kim’s mobile stations, and **(b)** a POSITA would have utilized IEEE802.16-2004’s “**symbol offset**” and “**subchannel offset**” to implement Kim’s “**location information**” which identifies the location of Kim’s channel resources.

1. A POSITA Would Have Utilized IEEE802.16-2004's
"CID" as Identifiers for Kim's Mobile Stations

84. As I previously discussed in §VI.A, *supra*, Kim explains that, when a base station transmits a frame, “each mobile station first detects the CTRL part from the frame 1220 to determine whether its own data has been transmitted” and thus “determine whether a signal transmitted by a base station is a signal transmitted to the mobile station itself.” Ex-1005, [0072], [0085], Figs. 11, 12.

85. Although Kim does not provide details of how a mobile station is able to utilize the “CTRL part” of a frame to “determine whether its own data has been transmitted,” a POSITA would have understood that such details are provided in the IEEE 802.16-2004 standard.

86. In particular, IEEE802.16-2004 specifies that each frame includes a “DL-MAP” message in the beginning part of each frame. Ex-1008, Table 275, Figure 218. IEEE802.16-2004 further specifies that the DL-MAP message includes a “connection identifier (CID)” as a “16-bit value that identifies a connection to equivalent peers in the MAC of the base station (BS) and subscriber station (SS).” Ex-1008, 43 (definition 3.13), Table 275, Figure 218. IEEE802.16-2004 further specifies that “each SS [subscriber station] joining the IEEE Std 802.16 system shall request a dedicated CID” and “[t]he SS's Basic CID ... is the first static CID

the BS assigns to an SS during initial ranging.” Ex-1008, 56 (§5.1.2.4, last paragraph), 309 (last paragraph of the page, §7.2.1).

87. Consistent with Kim, IEEE802.16-2004 explains that the CID is utilized for the purpose of determining whether data in a frame is intended for a particular station, in particular by specifying that upon receiving a downlink subframe, “[t]he SSs check the CIDs in the received PDUs [protocol data units] and retain only those PDUs addressed to them.” Ex-1008, 67 (§6.1, first paragraph); *see also* 69, §6.3.1.1 (“[t]he CID can be considered a connection identifier ... since it serves as a pointer to destination and context information”).

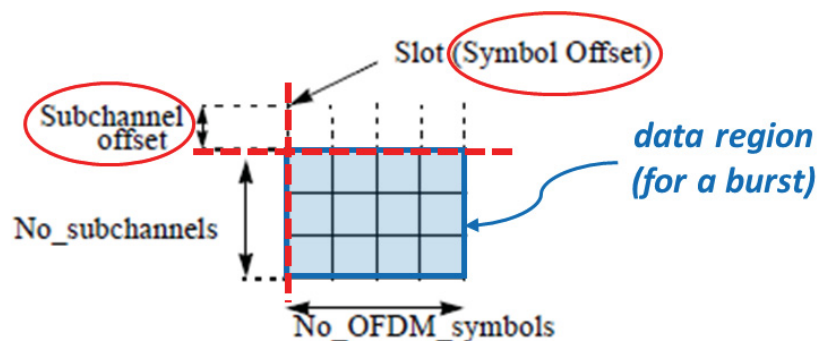
88. Therefore, a POSITA would have found it obvious to implement Kim’s feature of each mobile station detecting the “CTRL part” of each frame to determine “whether its own data has been transmitted” using the “connection ID (CID)” which is indicated in the “DL-MAP” message located at the beginning of each frame, as specified in IEEE802.16-2004. Thus, a POSITA would have understood that the “CID” specified in IEEE802.16-2004 would be transmitted, by a base station to a mobile station, as part of Kim’s “CTRL part” in each frame.

2. A POSITA Would Have Utilized IEEE802.16-2004’s
“Symbol Offset” and “Subchannel Offset” to Indicate the
Location of Kim’s Channel Resources

89. As I previously discussed in §VI.A.1, *supra*, Kim explains that a “mobile station should correctly receive information” regarding “channel resources

allocated to each user.” Ex-1005, [0072]. Specifically, Kim discloses a “control message” which is “transmitted from a base station to a mobile station” and “includes **location information** in a frame where user data is multiplexed every transmission frame.” Ex-1005, [0073], [0075]. When Kim’s mobile station receives the control message, it “detects **location information** in a multiplexed frame of data,” which allows the mobile station to decode the “user data” from the frame. Ex-1005, [0081]-[0082].

90. Although Kim does not provide details of how the “location information” indicates “where user data is multiplexed every transmission frame,” a POSITA would have understood that such details are provided in IEEE 802.16-2004. In particular, IEEE802.16-2004 specifies that the “DL-MAP” message (in the beginning of each frame) includes information regarding an “OFDMA **Symbol offset**” and a “[s]ubchannel offset.” Ex-1008, 558 (end of §8.4.5.3), Table 275. The “OFDMA symbol offset” and “subchannel offset” identify the location of a “data region” (allocated to a “burst” of information) within the frame. Ex-1008, 558 (end of §8.4.5.3), Figure 215 (below, annotated).



Ex-1008, Figure 215 (annotated)

91. A POSITA would have understood that IEEE802.16-2004’s “OFDMA **Symbol offset**” and “[s]ubchannel offset” (for locating a “data region” allocated to a “burst”) are appropriate for implementing the “**location information**” of Kim’s “user data” within a frame. In particular, both Kim and IEEE802.16-2004 describe two-dimensional resource allocation in multiples of “one **subchannel**” in frequency and “one **slot**” in time (referred to in IEEE802.16-2004 as the “minimum possible data allocation unit”). Ex-1005, [0011], [0053], [0054], [0058], Figs. 5, 7, 8; Ex-1008, 532 (§8.4.3.1), 530 (§8.4.2.2).

92. Therefore, in order to implement Kim’s feature that a mobile station should “detect **location information** in a multiplexed frame of data transmitted to each mobile station,” a POSITA would have understood that Kim’s mobile station would utilize the “OFDMA **symbol offset**” and the “**subchannel offset**” (as specified in IEEE802.16-2004) as part of Kim’s “location information” to identify the resource location of user data within a frame, and thereby achieve Kim’s goal that a mobile station should “correctly receive information on channel resources allocated to each user.” Ex-1005, [0080], [0081].

93. Further, a POSITA would have understood that Kim’s “**channel resources**” assigned to a “user” are analogous to IEEE802.16-2004’s “**data region**” assigned to a “burst” of information. Ex-1005, [0011], [0052]–[0054], [0058], Figs. 5, 7, 8;

Ex-1008, Figs. 215, 216, §8.4.3.1. I have provided an illustration showing this analogy between resource allocations in Kim and IEEE802.16-2004 in Diagram A, below.

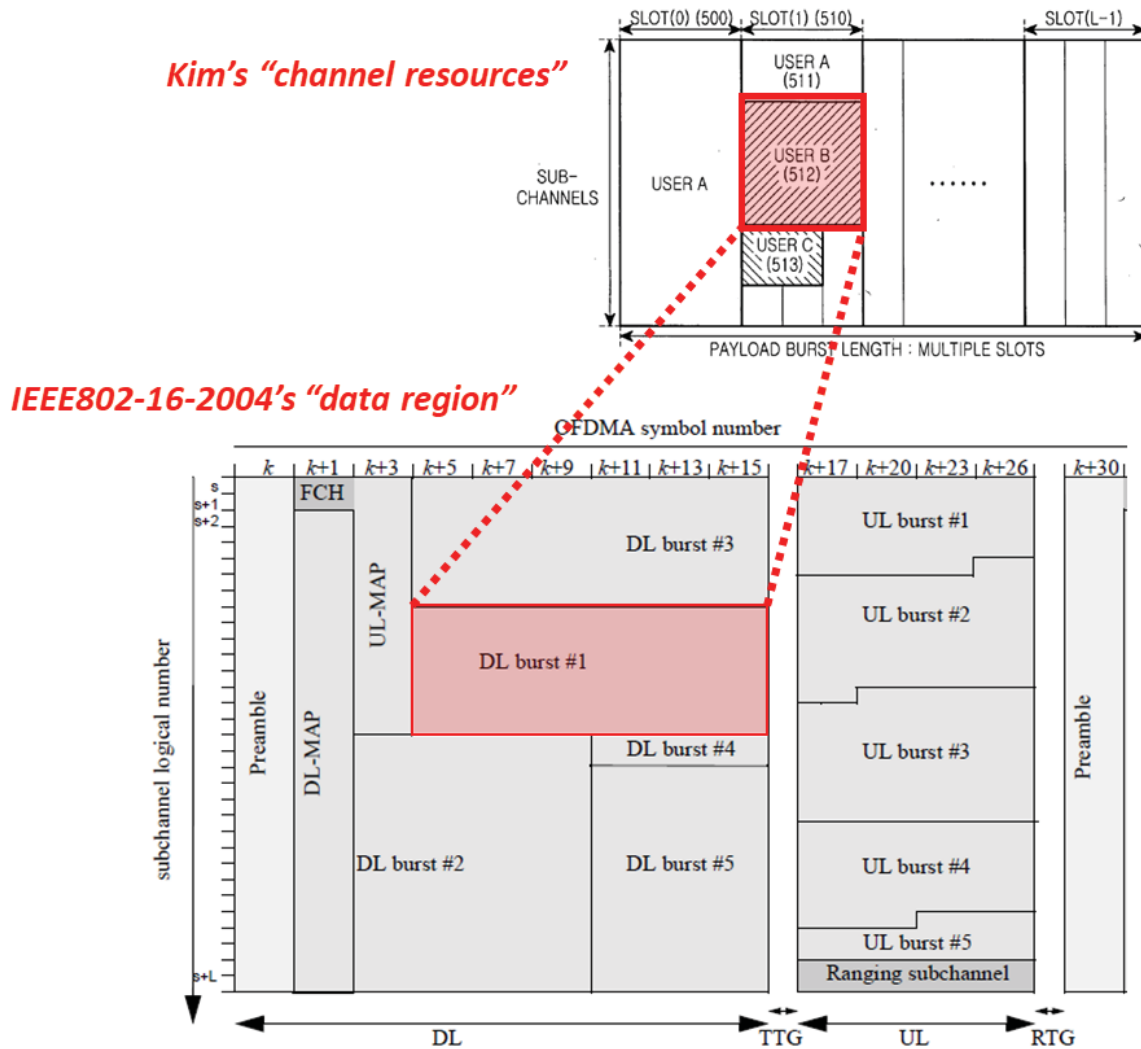


Figure 218—Time plan - one TDD time frame (with only mandatory zone)

Diagram A

94. As shown in Diagram A, a POSITA would have understood that Kim's per-user resource allocation is analogous to IEEE802.16-2004's per-burst resource allocation. This is evidenced, for example, by the similar techniques in which both

Kim and IEEE802.16-2004 determine the transmission scheme for Kim's per-user resources and IEEE802.16-2004's burst. Both Kim and IEEE802.16-2004 disclose a "Modulation order Product code Rate (MPR)" as a technique to calculate the "modulation scheme" and "code rate" for transmission over a resource. Ex-1005, [0029], [0046], [0061], [0062], [0067], Equation (4); Ex-1008, 641 (§8.4.9.2.3.5.6), Equation (128). Kim discloses that the MPR is calculated "for each multiaccess **user** according to the **number** of **subchannels**...allocated to each multiaccess **user**, the number of slots...and an EP size allocated to each multiaccess user." Ex-1005, [0067]. In particular, Kim discloses specific equations for calculating the MPR which depend on "the **number** of **subchannels** allocated to a kth **slot**" for a "particular **user**." Ex-1005, Equation (5), [0063]. Consistent with Kim, IEEE802.16-2004 discloses similar equations for calculating the MPR for a "DL traffic **burst**" depending on the "number of allocated subchannels" in the **burst**. Ex-1005, [0067]; Ex-1008, 641 (§8.4.9.2.3.5.6), Equation (128). Thus, a POSITA would have understood that Kim's per-user resource allocation is analogous to IEEE802.16-2004's per-burst resource allocation. A POSITA therefore would have found it obvious to utilize IEEE802.16-2004's "OFDMA **Symbol offset**" and "[s]**ubchannel offset**" (which identifies the location of a "data region" allocated to a "burst") to implement Kim's

“location information” which identifies the location of “user data” within a frame.

Id.

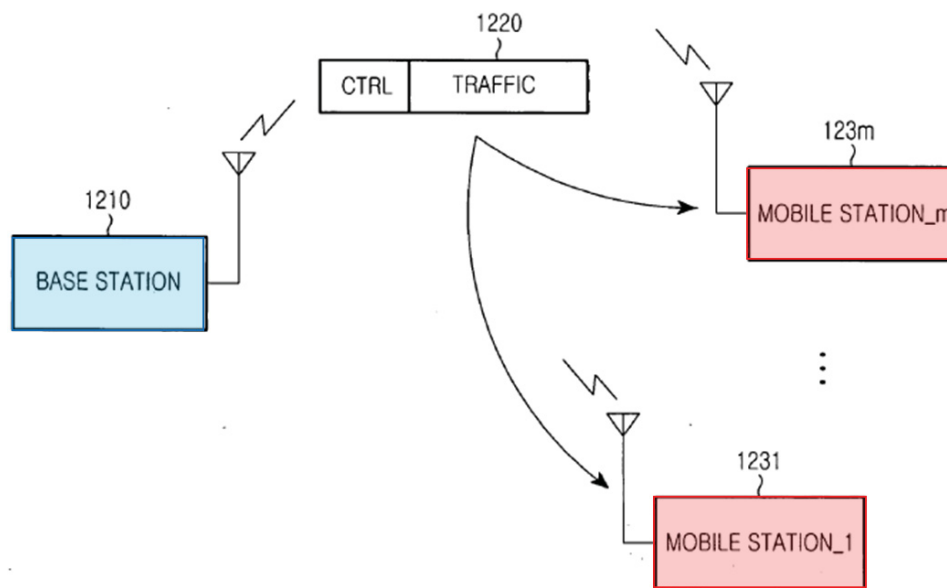
95. Thus, in the Kim-IEEE802.16-2004 network, the location of a user’s data within Kim’s frame is identified by (i) an OFDMA symbol in the time domain which is specified by IEEE802.16-2004’s “OFDMA **symbol offset**,” and (ii) a subchannel in the frequency domain which is specified by IEEE802.16-2004’s “**subchannel offset**.”

VII. MANNER IN WHICH THE PRIOR ART REFERENCES RENDER THE ’450 CLAIMS UNPATENTABLE

A. Claim 1

[1.P1] An operating method for a wireless network comprising at least a base station and a mobile station,

96. To the extent the preamble is deemed limiting, the Kim-IEEE802.16-2004 network renders it obvious. Kim discloses operations of a “wireless data communication networks.” Ex-1005, [0005]. In particular, as I previously discussed in §§VI.A and VI.C, *supra*, Kim describes “operation between a base station and mobile stations.” Ex-1005, [0084], [0086], FIG. 12 (below, annotated to highlight “base station 1210” and “mobile stations” 1231 to 123m).



Ex-1005, Fig. 12 (annotated)

97. This is consistent with IEEE802.16-2004, which is directed to “fixed broadband wireless access systems” that include a “base station (BS)” communicating with a “subscriber station (SS).” Ex-1008, Title, 43 (definition 3.5), 47 (definition 3.56).

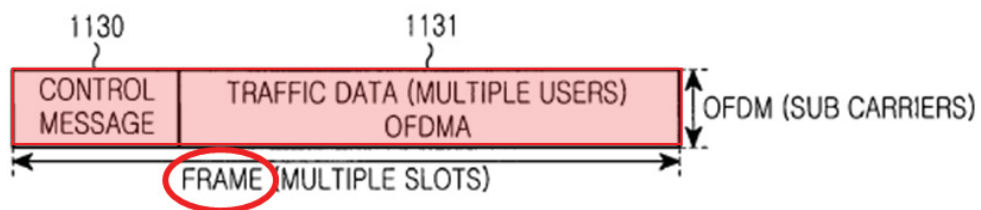
98. Furthermore, although the IEEE 802.16-2004 standard is specified for “**fixed** broadband wireless access systems” and although Kim explains that the IEEE 802.16a standard (the predecessor to IEEE 802.16-2004) “does not guarantee the mobility of a mobile station,” a POSITA would have understood that the IEEE 802.16a standard specifies subscriber stations as “mobile stations” except that a service quality under “mobility” is not guaranteed (i.e., the subscriber stations are **wireless** mobile stations that can be **wirelessly** moved but with limited mobility in

terms of velocity). Furthermore, a POSTIA would have also understood that the '450 patent itself describes its “mobile devices” as devices which **may be “fixed or may roam.”** Ex-1001, 3:40-42. Therefore, a POSITA would have understood that Kim-IEEE802.16-2004 discloses a fixed wireless implementation of a “mobile station” which is consistent with the description of the '450 patent.

99. Thus, the Kim-IEEE802.16-2004 network implements an “*operating method for a wireless network comprising at least a base station and a mobile station.*”

[1.P2] the wireless network employing a frame structure of multiple frames for transmission,

100. The Kim-IEEE802.16-2004 network utilizes a frame structure of multiple frames for transmission. For example, Kim’s base station can “transmit user data in a **frame**” such that “user data is multiplexed **every** transmission **frame**.” Ex-1005, [0014], [0075], Fig. 11 (below, annotated, showing an example of a “format” of Kim’s **frame**).



Ex-1005, Fig. 11 (annotated)

101. IEEE802.16-2004 provides additional details of a “frame structure” as specified in the IEEE 802.16 standard, shown in Figure 218 (below, annotated).

Ex-1008, page 535 (§8.4.4).

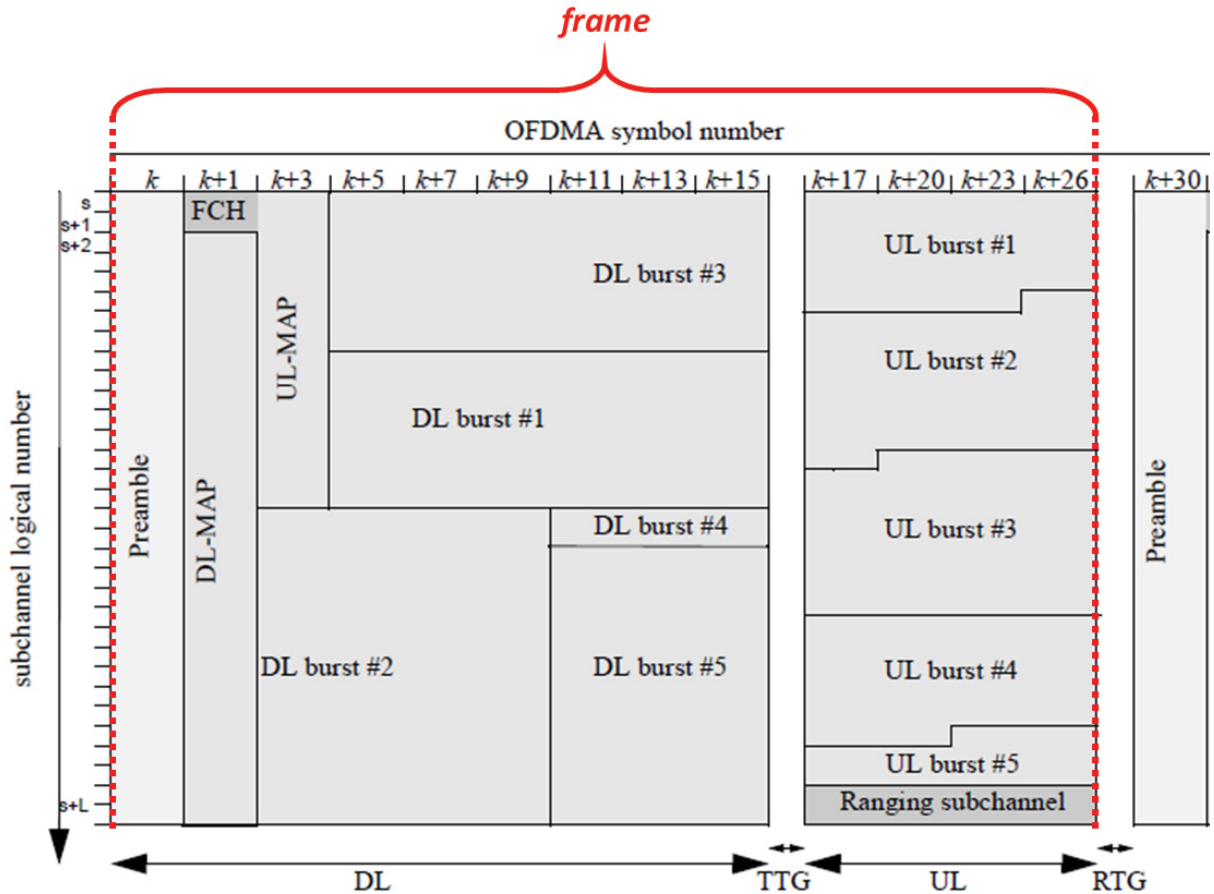


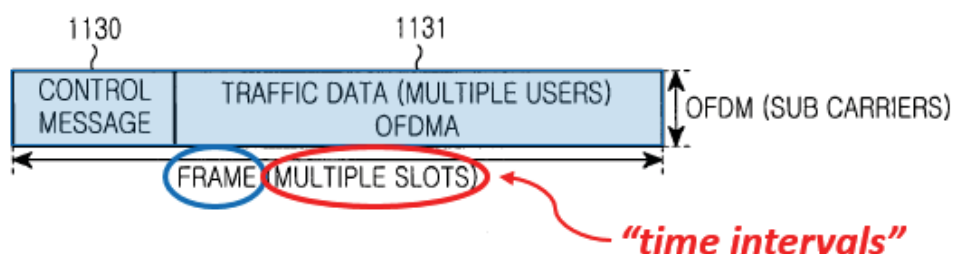
Figure 218—Time plan - one TDD time frame (with only mandatory zone)

Ex-1008, Figure 218 (annotated)

102. Thus, the Kim-IEEE802.16-2004 network employs “*a frame structure of multiple frames for transmission.*”

[1.P3] each frame comprising a plurality of time intervals,

103. As I previously discussed in §VI.C, *supra*, in the Kim-IEEE802.16-2004 network, each frame consists of multiple time **slots** (the claimed “*plurality of time intervals*”). Specifically, Kim discloses that each “**SLOT** refers to a transmission duration” which is “used to transmit user data in a frame.” Ex-1005, [0014]. Kim shows an example of a frame consisting of “multiple **slots**” in Fig. 11 (below, annotated).



Ex-1005, Fig. 11 (annotated)

104. Consistent with Kim, IEEE802.16-2004 provides further details of an “OFDMA **slot**” as consisting of “two OFDMA symbols” in the mode of “partial usage of subchannels” (PUSC), shown in Figures 216 and 218 (below, annotated). Ex-1008, 532 (§8.4.3.1).

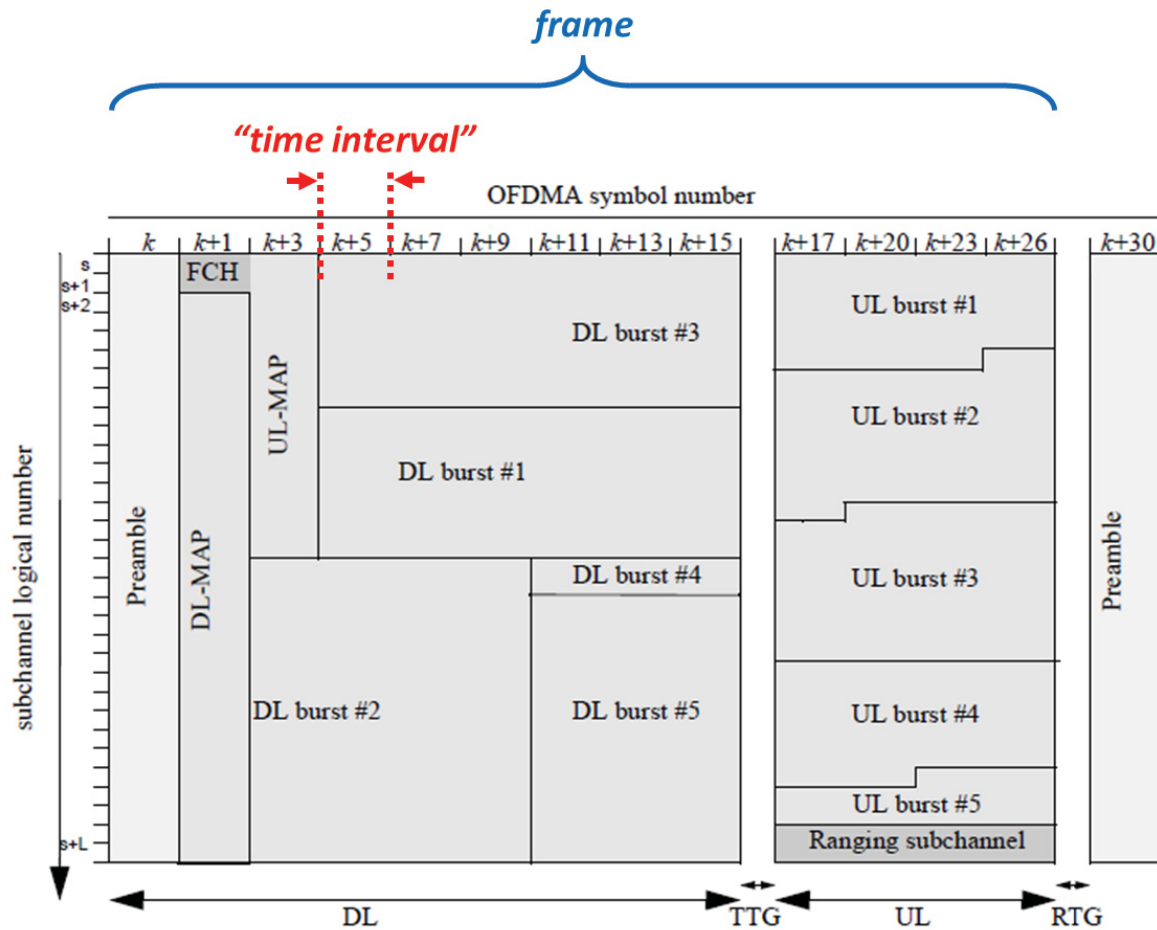


Figure 218—Time plan - one TDD time frame (with only mandatory zone)

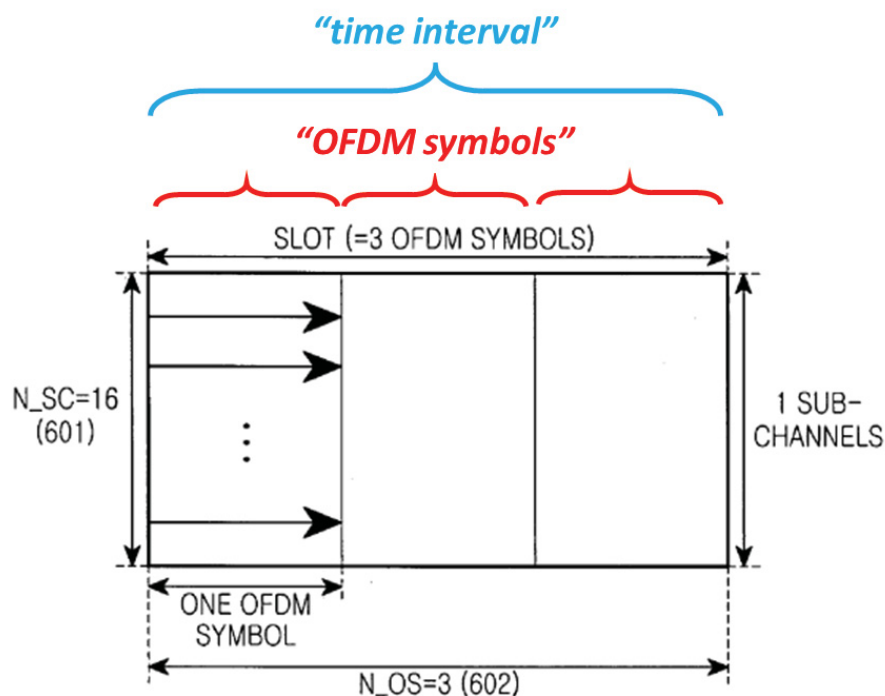
Ex-1008, Figure 218 (annotated)

105. Thus, by performing transmission with frames, each consisting of multiple **slots** (the claimed “*plurality of time intervals*”), the Kim-IEEE802.16-2004 network renders obvious “*each frame comprising a plurality of time intervals.*”

106. Such a system is consistent with the '450 patent, which discloses that a “frame consists of a number of time **slots**.” Ex-1001, 4:64-65, FIG. 3.

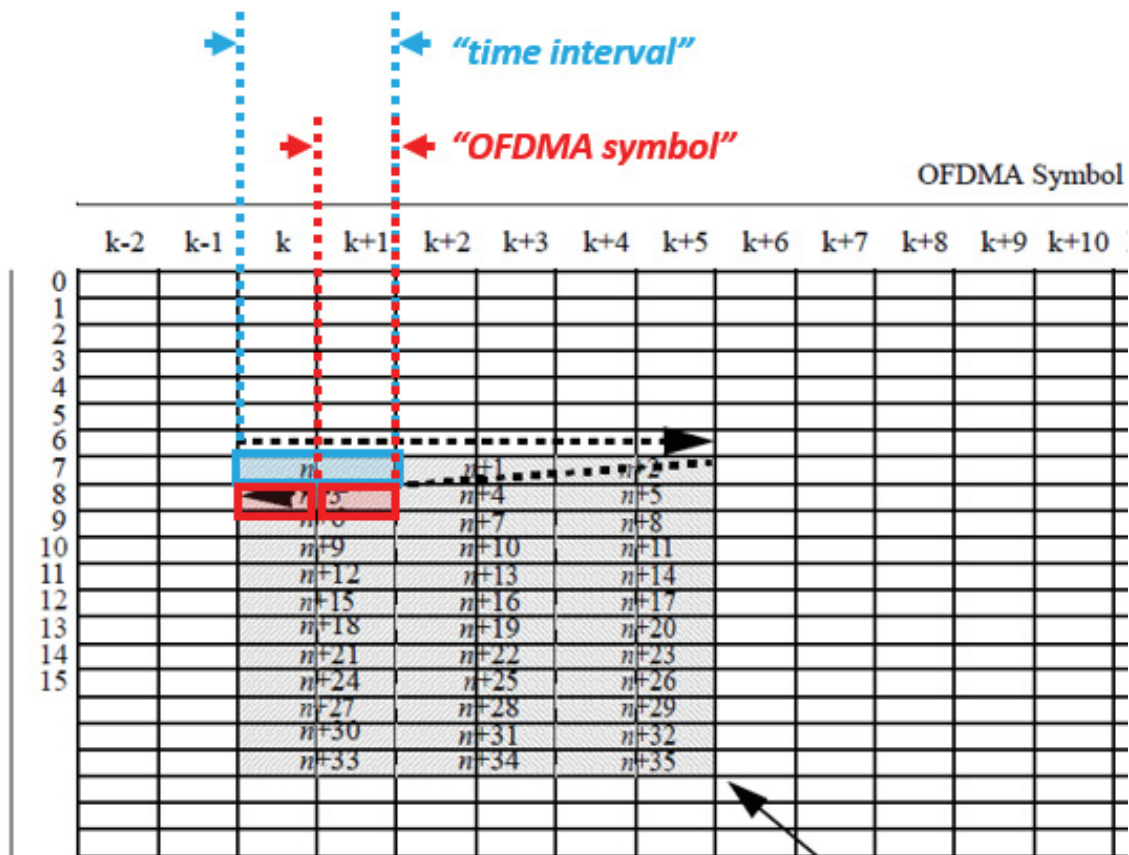
[1.P4] each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and

107. As I previously discussed in §VI.C, *supra*, in the Kim-IEEE802.16-2004 network, each **slot** (the claimed “*time interval*”) comprises a plurality of OFDM **symbols**. For example, Kim discloses that “one **slot** comprises one or more **OFDM symbols**.” Ex-1005, [0014]. Although Kim provides examples in which “one **slot** comprises three **OFDM symbols**” (e.g., in Fig. 6, shown below, annotated), Kim merely provides these as examples, and Kim generally discloses a variable “number of **OFDM symbols** allocated per **slot**” as a variable “N_OS.” Ex-1005, [0057].



Ex-1005, Fig. 6 (annotated)

108. IEEE802.16-2004 further specifies that in the OFDMA mode of the IEEE 802.16 standard (which is “based on OFDM modulation,” Ex-1008, page 529, §8.4.1, first paragraph), “[e]ach **slot** shall span...two **OFDMA symbols** in the time axis” for partial usage of subchannels (PUSC), as shown in Figures 216 and 218 (below, annotated). Ex-1008, 532 (§8.4.3.1), 533 (§8.4.3.4).



Ex-1008, Figure 216 (annotated)

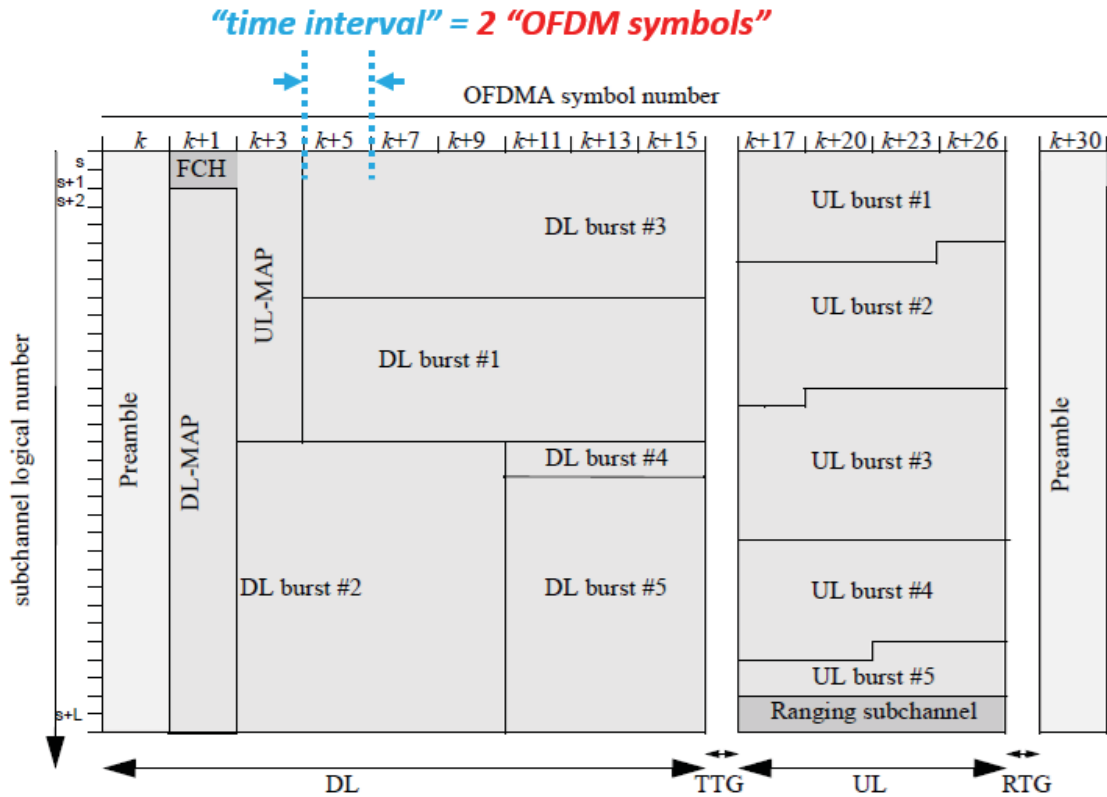


Figure 218—Time plan - one TDD time frame (with only mandatory zone)

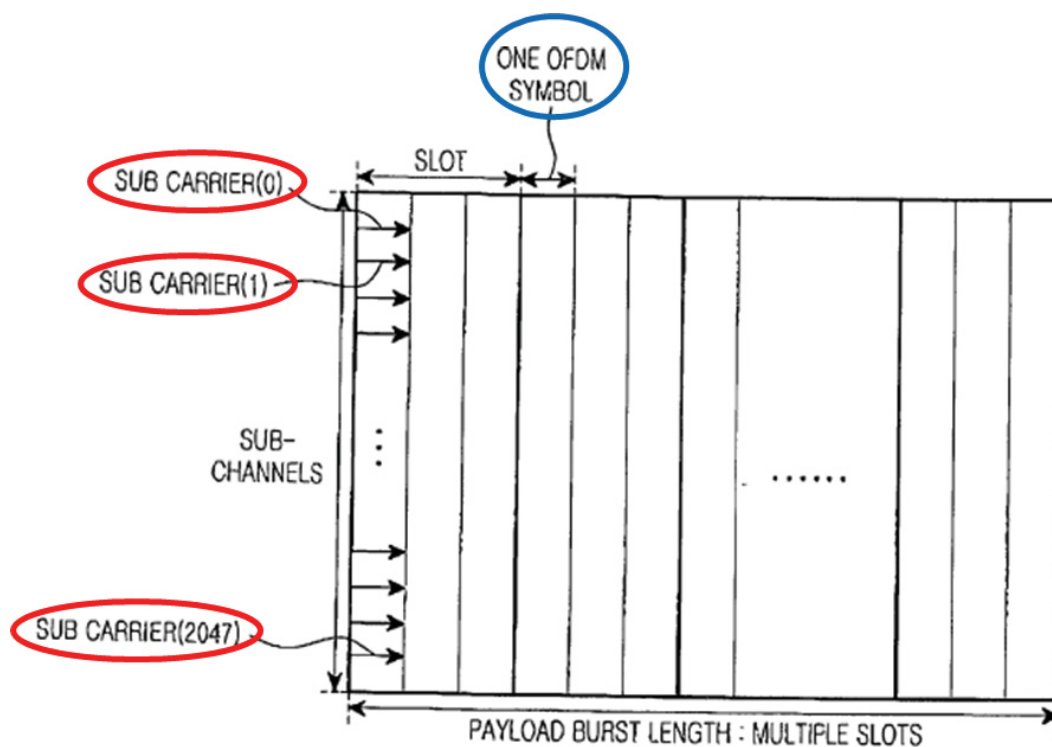
Ex-1008, Figure 218 (annotated)

109. Thus, by performing transmission using slots, with each **slot** comprising multiple **OFDM symbols**, the Kim-IEEE802.16-2004 network renders obvious *“each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols.”*

110. This is consistent with the '450 patent, which discloses that “each time **slot** is comprised of one or more OFDM **symbols**.” Ex-1001, 4:65-66.

[1.P5] each OFDM symbol containing a plurality of frequency subcarriers, the method comprising:

111. As I previously discussed in §VI.C, *supra*, in the Kim-IEEE802.16-2004 network, each OFDM symbol contains multiple subcarriers in frequency. In particular, Kim discloses a “**number of subcarriers** allocated per subchannel and **OFDM symbol.**” Ex-1005, [0056]. Kim discloses an example in which there can be a maximum of 2048 **subcarriers** within an **OFDM symbol** (Fig. 2, below, annotated). Ex-1005, [0014], [0060].



Ex-1005, Fig. 2 (annotated)

112. Consistent with Kim, IEEE802.16-2004 specifies that an OFDMA **symbol** “is made up of **subcarriers**” and defines, as a parameter, a “number of used subcarriers” (denoted “N_{used}”) to “characterize the OFDMA symbol.” Ex-1008, 530 (§8.4.2.2); 531 (§8.4.2.3).

113. Therefore, the Kim-IEEE802.16-2004 network performs transmission using OFDM symbols, with “*each OFDM symbol containing a plurality of frequency subcarriers.*”

[1.1] assigning an identifier to the mobile station;

114. Prior art knowledge of “*assigning an identifier to the mobile station*” is acknowledged in the Background of the ’450 patent itself, which explains it was known that the prior art IEEE 802.16 standard specifies a 16-bit “connection ID (CID)...to identify the mobile station.” Ex-1001, 1:51-55. Therefore, a POSITA would have understood prior art knowledge of “*assigning an identifier to the mobile station.*” Indeed, a POSITA would have found assignment of an identifier as being part of a POSITA’s general knowledge, as evidenced by the Background of the ’450 patent, and would have found assignment of an identifier to have been an obvious solution and design choice based on this general knowledge.

115. Such prior art knowledge is further evidenced in Kim and IEEE802.16-2004. As I previously discussed in §VI.C(1), *supra*, the Kim-IEEE802.16-2004 network assigns a connection identifier (CID) (as specified by IEEE802.16-2004) to each of Kim’s mobile stations, which allows a mobile station in Kim to determine whether any of the data received in a frame is intended for the mobile station, as discussed in Kim. Ex-1005, [0072], [0085]; Ex-1008, Table 275, Figure 218, 43 (definition 3.13). Specifically, the Kim-IEEE802.16-2004 network would include the

IEEE802.16-2004 “CID” in Kim’s “control message” (“CTRL” part) of a frame, in order to implement Kim’s feature that “each mobile station first detects the CTRL part from the frame 1220 to determine whether its own data has been transmitted.” Ex-1005, [0085].

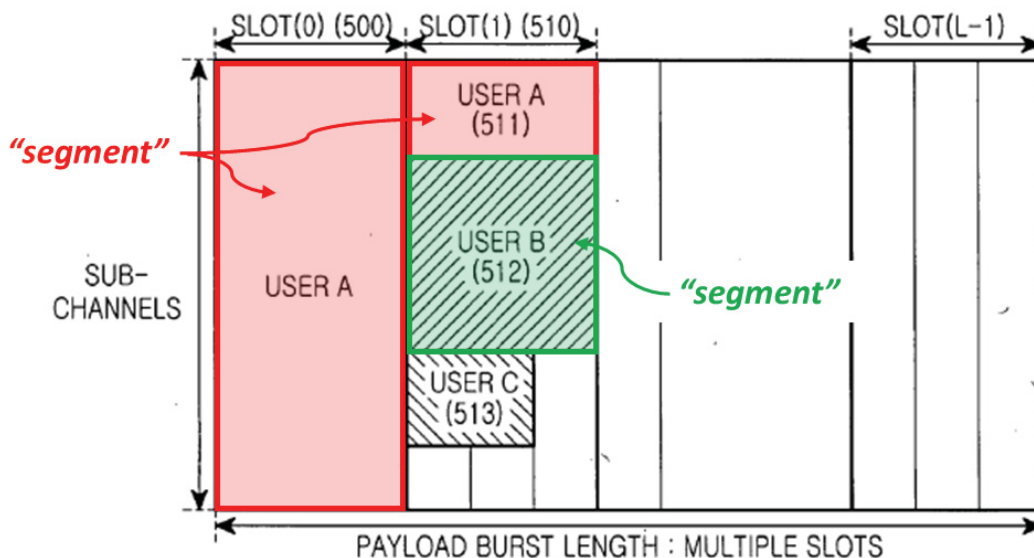
116. Thus, a POSITA would have understood that the Kim-IEEE802.16-2004 network assigns a connection ID (**CID**) (the claimed “*identifier*”) to each of Kim’s mobile stations.

117. Further, as discussed above, this is consistent with the ’450 patent, which explains that it was known that the IEEE 802.16 standard specifies a 16-bit “connection ID (**CID**)...to identify the mobile station.” Ex-1001, 1:51-55.

[1.2] transmitting a signal containing information from the base station to the mobile station over a segment of time-frequency resource,

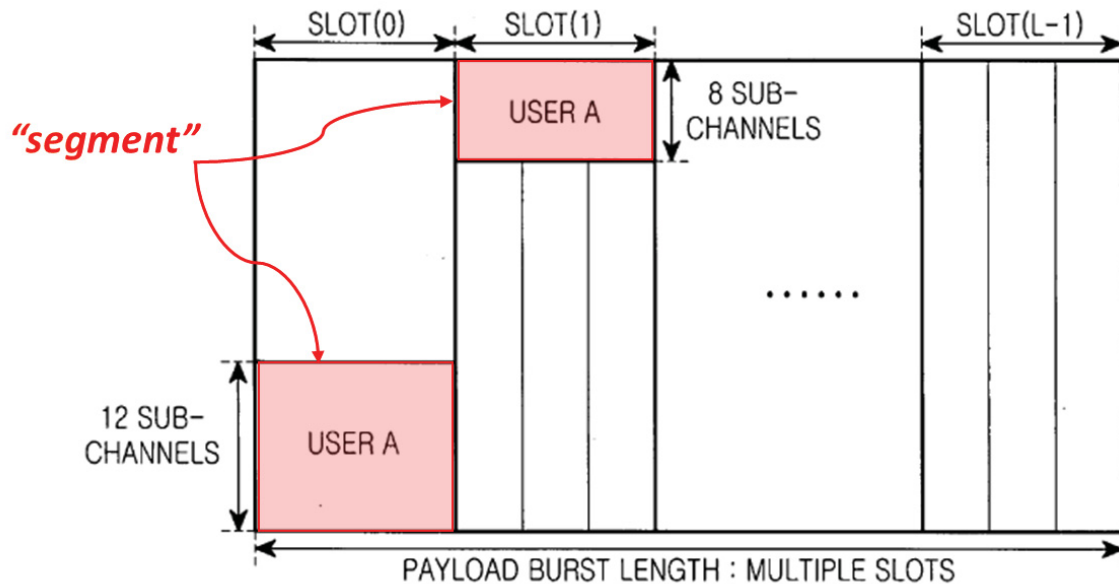
118. The Kim-IEEE802.16-2004 network transmits information from a base station to a mobile station over a “*segment of time-frequency resource.*” In particular, Kim discloses that information for the user is transmitted over “channel resources” (the claimed “*segment of time-frequency resource*”) consisting of multiple subchannels in frequency (e.g., a frequency resource) and one or more slots in time (e.g., a time resource). Ex-1005, [0058], Fig. 5. The multiple subchannels in frequency and one or more slots in time collectively comprise a “time-frequency resource.” *Id.*

119. Kim provides an example, in FIG. 5, in which “user A is allocated all of the subchannels of a first slot SLOT(0) 500 and occupies some subcarriers of a second slot SLOT(1)” and where “user B occupies some other subcarriers of the second slot SLOT(1) 510.” Ex-1005, [0058], Fig. 5 (below, annotated). Each group of resources (the claimed “*segment*”) is allocated for transmission of a particular user’s information, from the base station to the mobile station. Ex-1005, [0061]-[0067].



Ex-1005, Fig. 5 (annotated)

120. Another example is shown in Figure 7 (below, annotated), where user A is allocated 12 subchannels in the first slot (SLOT 0) and 8 subchannels in the second slot (SLOT 1). Ex-1005, Fig. 7 (below, annotated).



Ex-1005, Fig. 7 (annotated)

121. With these assignments in both time (e.g., x-axis time slots) and frequency (e.g., y-axis subcarriers), Kim discloses that user A and user B are allocated “channel resources” (the claimed “*segment of time-frequency resource*”) consisting of multiple subchannels in frequency and one or more slots in time, over which information is transmitted to the user.

122. Thus, a POSITA would have understood that the Kim-IEEE802.16-2004 network transmits “*a signal containing information from the base station to the mobile station over a segment of time-frequency resource.*”

[1.3] *the segment having a starting time-frequency coordinate and*

123. Prior art knowledge of transmitting a “*starting time-frequency coordinate*” for resource allocation is acknowledged in the Background Section of the ’450

patent itself. For instance, the Background explains that, according to the existing IEEE 802.16 standard, “resource allocation is identified in the time domain scale with a **start symbol offset** (8 bits)...and in the frequency domain scale with a **start logical subchannel offset** (6 bits).” Ex-1001, 1:60-66. Therefore, a POSITA would have understood prior art knowledge of transmission of a resource allocation that is identified in time by a **start symbol offset**, and is identified in frequency by a **start logical subchannel offset** (collectively, the claimed “*starting time-frequency coordinate*”). Indeed, a POSITA would have found transmission of a resource allocation using a starting time-frequency coordinate as being part of a POSITA’s general knowledge, as evidenced by the Background of the ’450 patent, and would have found transmission of a starting time-frequency coordinate to have been an obvious solution and design choice based on this general knowledge.

124. Such prior art knowledge is further evidenced in Kim and IEEE802.16-2004. For example, as I previously discussed, in the Kim-IEEE802.16-2004 network, the location of a user’s data within Kim’s frame is identified by (i) an OFDMA symbol in the time domain which is specified by IEEE802.16-2004’s “OFDMA **symbol offset**,” and (ii) a subchannel in the frequency domain which is specified by IEEE802.16-2004’s “**subchannel offset**” (collectively, the claimed “*starting time-frequency coordinate*”).

125. Specifically, as I previously discussed, Kim discloses that “**location information**” is included in a “control message” which is “transmitted from a base station to a mobile station,” and which specifies a location “**in a frame** where user data is multiplexed every transmission frame.” Ex-1005, [0073], [0075]. Kim explains that, when a mobile station receives the control message, it “detects **location information** in a multiplexed frame of data” which allows the mobile station to recover the “user data” from the frame. Ex-1005, [0081]-[0082].

126. As discussed in §§VI.B and VI.C(2), *supra*, IEEE802.16-2004 specifies the location of a “data region” (for transmitting a “burst” of information) by an “OFDMA **Symbol offset**” and a “[s]ubchannel **offset**.” Ex-1008, 558 (end of §8.4.5.3), Figures 215, 218 (below, annotated). The “OFDMA Symbol offset” is “[t]he offset of the OFDMA symbol in which the burst starts, measured in OFDMA symbols from beginning of the downlink frame” and the “[s]ubchannel offset” is “[t]he lowest index OFDMA subchannel used for carrying the burst, starting from subchannel 0.” Ex-1008, 558 (end of §8.4.5.3).

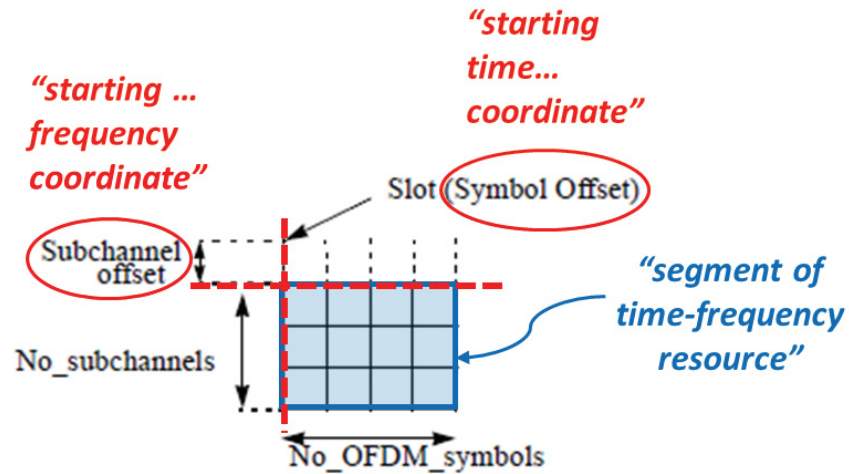


Figure 215—Example of the data region which defines the OFDMA allocation

Ex-1008, Figure 215 (annotated)

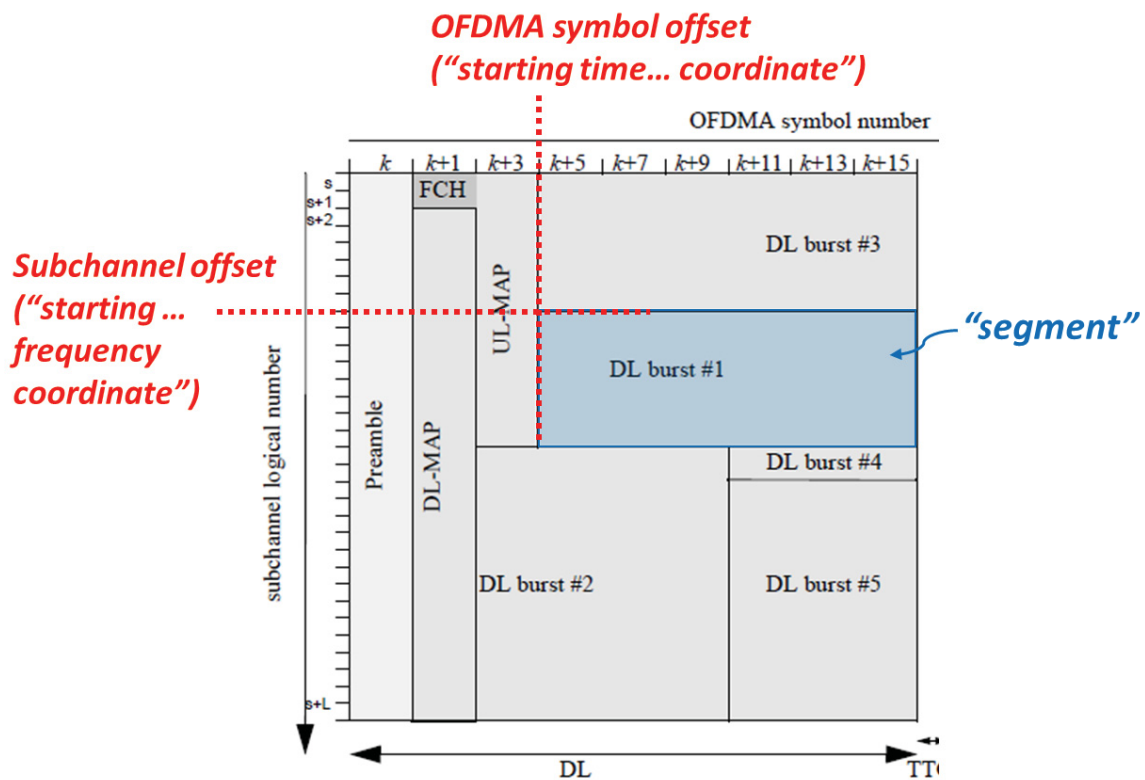


Figure 218—Time plan - one TDD time frame

Ex-1008, Figure 218 (annotated)

127. In the Kim-IEEE802.16-2004 network, a data region (the claimed “*segment*”) which is allocated to a “burst” of information for Kim’s user data is transmitted with (i) a “*starting time ... coordinate*” which is an OFDMA symbol specified by IEEE802.16-2004’s “OFDMA symbol offset,” and (ii) a “*starting ... frequency coordinate*” which is a subchannel specified by IEEE802.16-2004’s “subchannel offset” (collectively, the claimed “*starting time-frequency coordinate*”).

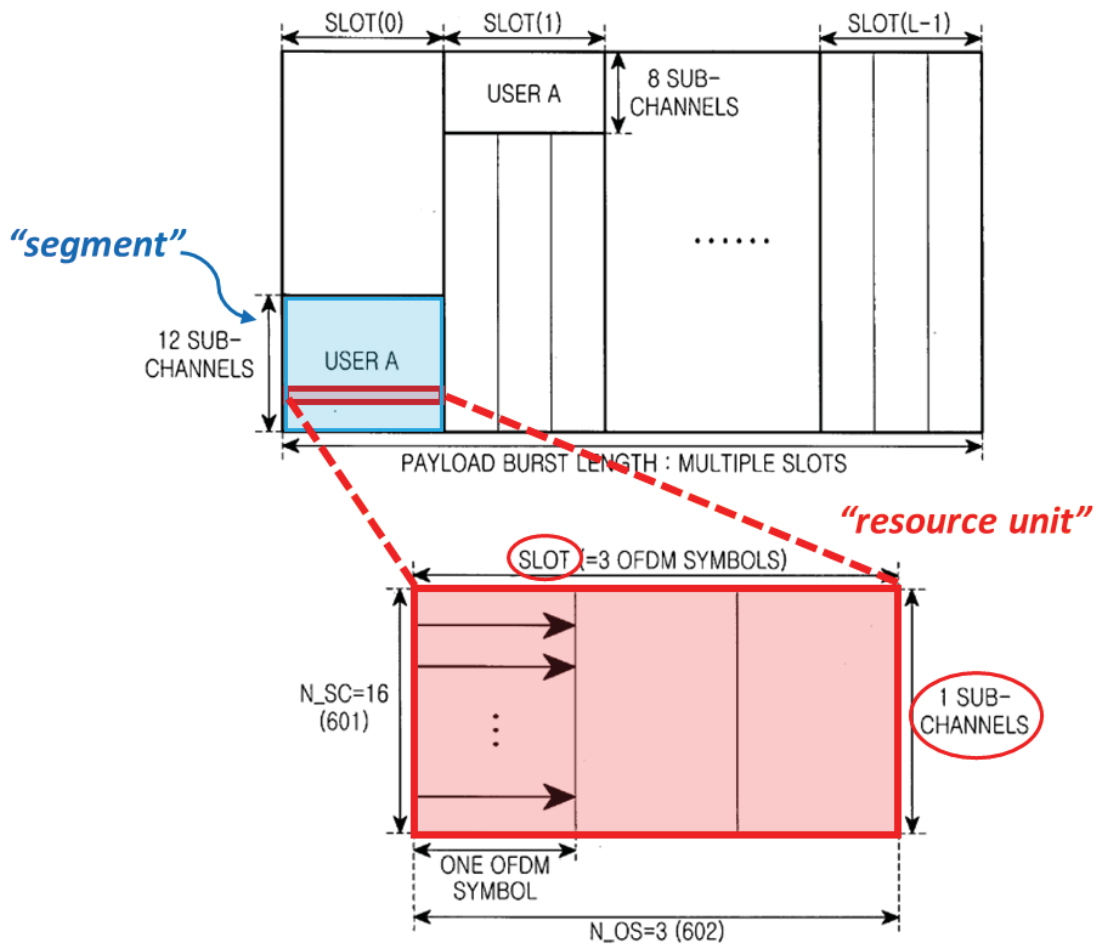
128. Thus, a POSITA would have understood that, in the Kim-IEEE802.16-2004 network, a resource segment is transmitted with a “*starting time-frequency coordinate*.”

[1.4] the segment comprising *N* time-frequency resource units within a time interval,

129. As discussed for claim feature [1.2], *supra*, the Kim-IEEE802.16-2004 network implements a “*segment*” (of time-frequency resource). As discussed below, the Kim-IEEE802.16-2004 network’s resource *segment* includes multiple resource units, each resource unit defined by a single subchannel (in frequency) and a single slot (in time).

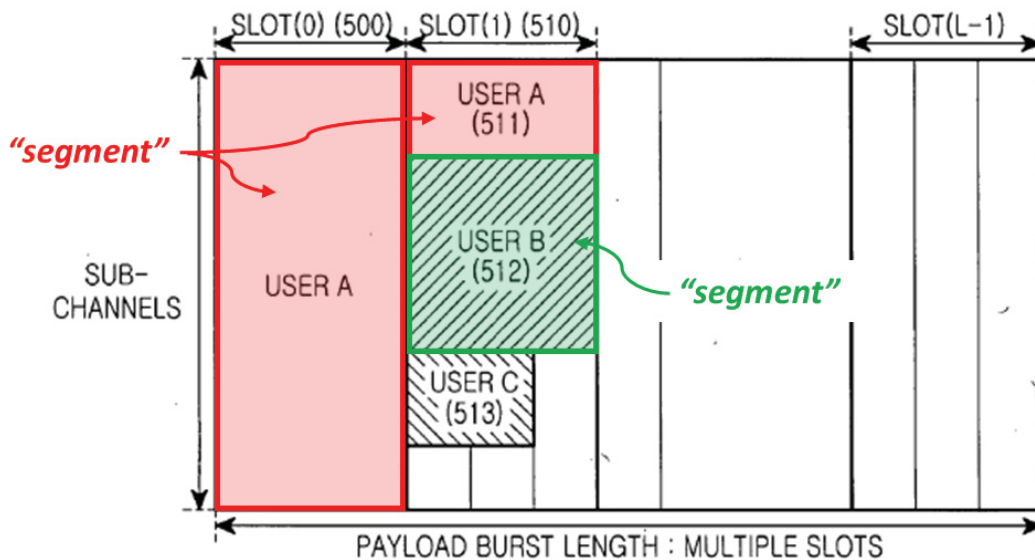
130. Specifically, as I previously discussed in §VI.C(2), *supra*, the Kim-IEEE802.16-2004 network performs resource allocation in multiples of a single “subchannel” in frequency and a single “slot” in time, which Kim refers to as a

“channel resource” and which IEEE802.16-2004 refers to as a “**minimum possible data allocation unit**” (the claimed “*resource unit*”). Ex-1005, [0011], [0053], [0054], [0058], Figs. 5, 7, 8; Ex-1008, 532 (§8.4.3.1), 530 (§8.4.2.2). An example of such resource allocation is shown with reference to Kim’s Figures 6 and 7 (illustrated below, and annotated to show a resource unit consisting of one slot in the time domain and one sub-channel in the frequency domain).



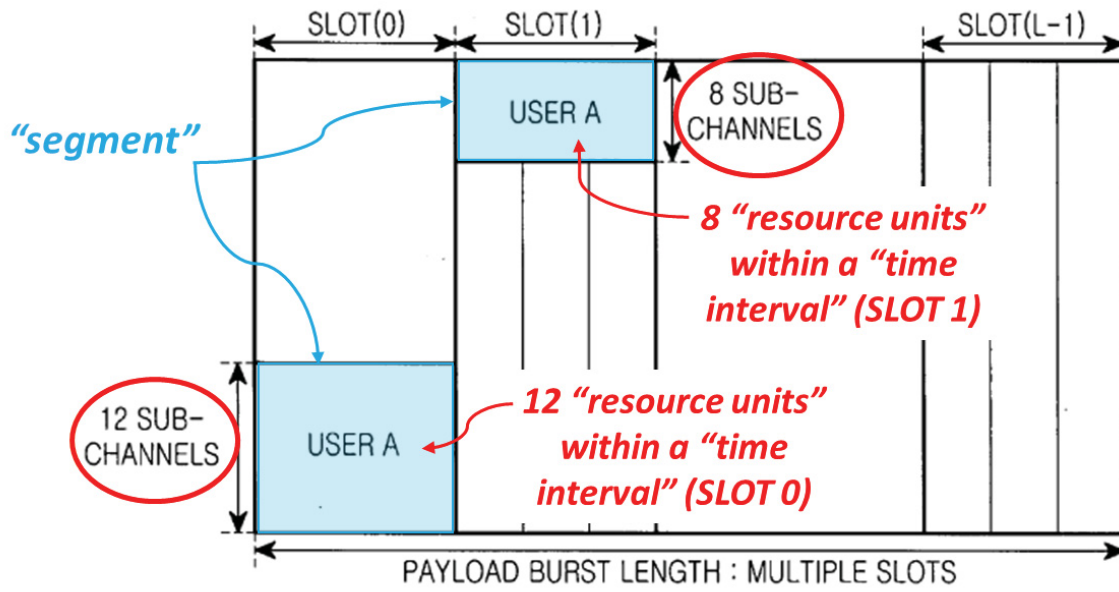
Ex-1005, Figs. 6 and 7 (annotated)

131. Kim further discloses various examples of allocating subchannels to a user. For example, with reference to Figure 5, Kim describes a scenario in which “user A” has “a different number of subchannels for each slot” (in SLOT(0) and SLOT(1)) and user B “has the same number of subchannels for every slot.” Ex-1005, [0062], Fig. 5 (below, annotated).



Ex-1005, Fig. 5 (annotated)

132. As another example, with reference to Figure 7, Kim describes “a user A transmits an OFDM symbol through **12** subchannels in a first slot SLOT(0) and an OFDM symbol through **8** subchannels in a second slot SLOT(1).” Ex-1005, [0063], Fig. 7 (below, annotated). Thus, Kim discloses allocating resources (the claimed “*segment*”) with an integer number of subchannels per slot (the claimed “*resource units*”), such as 8 subchannels within slot (0) and 12 subchannels within slot (1).



Ex-1005, Fig. 7 (annotated)

133. With this type of allocation, Kim discloses examples in which each user is allocated a resource “*segment*” including multiple (“*N*”) resource units, such as 8 resources units and 12 resource units, within a single time slot (the claimed “*time interval*”). Thus, a POSITA would have understood that, in the Kim-IEEE802.16-2004 network, allocates a resource segment “*comprising N time-frequency resource units within a time interval.*”

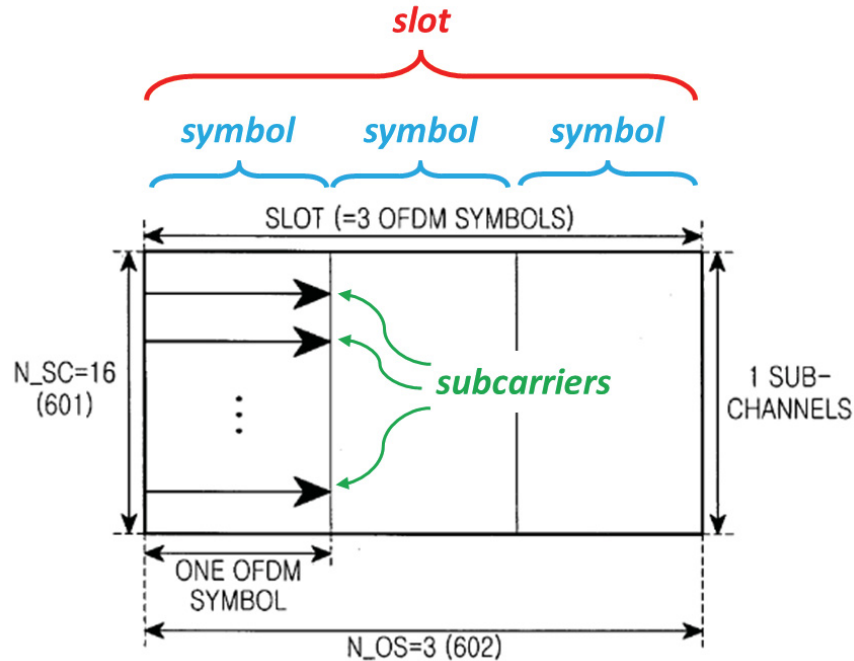
134. This is consistent with the ’450 patent itself. In particular, neither the language of claim feature [1.4] of the ’450 patent nor the written description of the ’450 patent requires that the claimed “segment” must consist of **only** (and no more than) “*N time-frequency resource units within a time interval.*” Instead, claim feature [1.4] uses the open-ended claim language “*comprising N time-frequency*

resource units within a time interval.” As I explained above, this is disclosed at least by Kim’s allocation of a resource segment to user A (in Figure 7) which comprises “**12** subchannels in a first slot SLOT(0)” (an example of the claimed “*N time-frequency resource units within a time interval*”) and “**8** subchannels in a second slot SLOT(1)” (another example of the claimed “*N time-frequency resource units within a time interval*”)) Ex-1005, [0063], Fig. 7.

[1.5] each unit containing a set of frequency subcarriers in a group of OFDM symbols,

135. As I previously discussed for [1.4], the Kim-IEEE802.16-2004 network performs resource allocation using a “minimum possible data allocation unit” (the claimed “*unit*”) which is defined by “one subchannel” in frequency and a “slot” in time. Ex-1005, [0058]; Ex-1008, 532, §8.4.3.1.

136. Further, as I previously discussed, *supra*, both Kim and IEEE802.16-2004 disclose that each “**subchannel**” includes a set of **subcarriers**. For example, Kim discloses an example of a subchannel containing a set of **16 subcarriers** within a group of “**3 OFDM symbols.**” Ex-1005, [0060], Fig. 6 (below, annotated).



Ex-1005, Fig. 6 (annotated)

137. Also, IEEE802.16-2004 specifies that “subcarriers are divided into **subsets** of **subcarriers**, each subset is termed a subchannel.” Ex-1008, 530 (§8.4.2.2).

138. As I previously discussed, *supra*, both Kim and IEEE802.16-2004 disclose that each time **slot** consists of a group of OFDM symbols. For example, Kim discloses that “one slot comprises one or more OFDM **symbols**.” Ex-1005, [0014]. Further, IEEE802.16-2004 specifies that an “OFDMA **slot**” consists of “two OFDMA symbols” in the mode of “partial usage of subchannels” (PUSC). Ex-1008, 532 (§8.4.3.1).

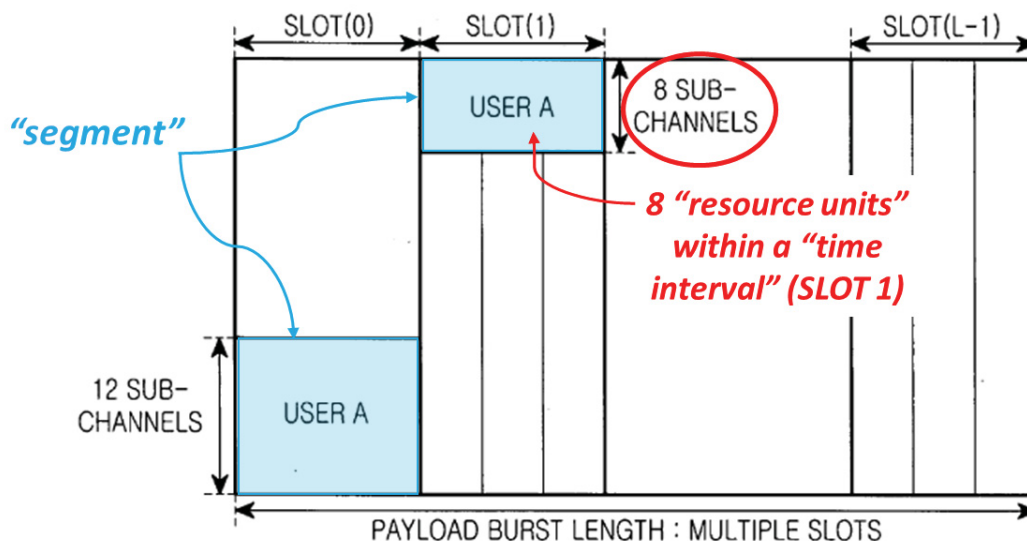
139. Therefore, in disclosing a subchannel which contains multiple subcarriers and a slot which contains multiple OFDM symbols (the frequency-domain subchannel and time-domain slot forming the claimed “*resource unit*”), the Kim-

IEEE802.16-2004 network allocates a resource unit which contains “*a set of frequency subcarriers*” in “*a group of OFDM symbols.*”

[1.6] where $N=2, 4, \text{ or } 8$; and

140. As I previously discussed for claim feature [1.4], *supra*, the Kim-IEEE802.16-2004 network allocates resources based on multiples (the claimed “ N ”) of a “channel resource” which is a “minimum possible data allocation unit” (the claimed “*resource unit*”) within a single time slot (the claimed “*time interval*”).

141. Specifically, as discussed for claim feature [1.4], *supra*, Kim provides an example in which “a user A transmits ... an OFDM symbol through **8 subchannels** in a second slot SLOT(1)” such that “the **number NSCH,1 of subchannels** in the second slot SLOT(1) is **8.**” Ex-1005, [0063], Fig. 7 (below, annotated).



Ex-1005, Figure 7 (annotated)

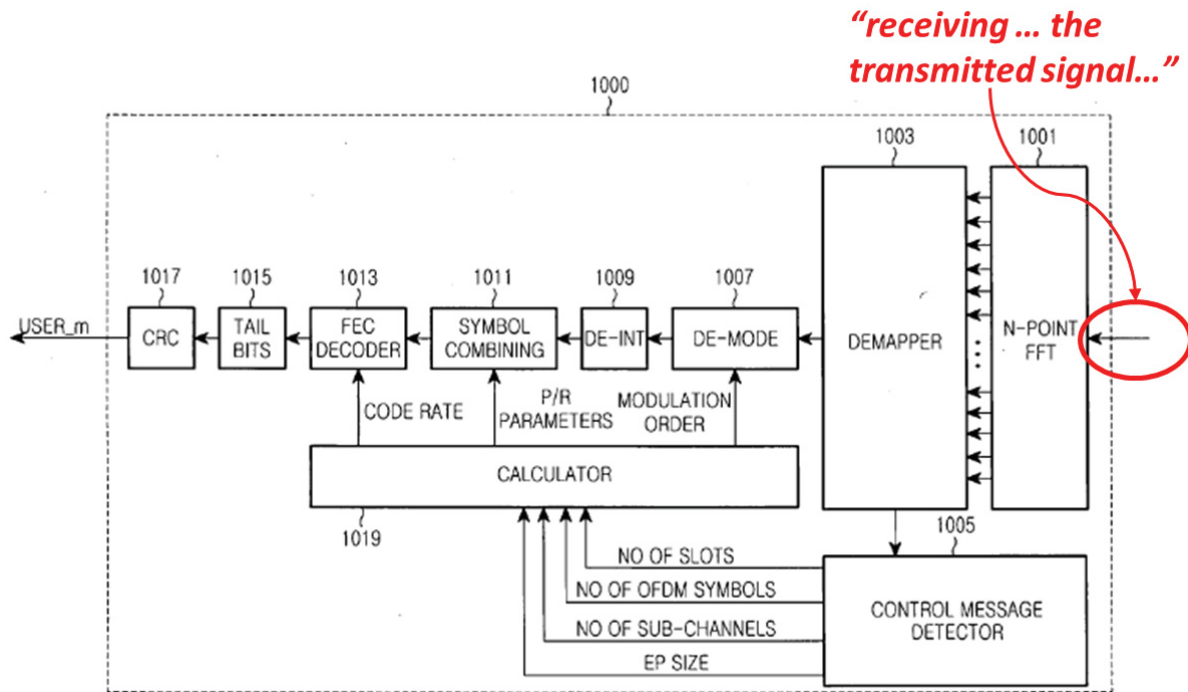
142. Therefore, because the Kim-IEEE802.16-2004 network provides an example of allocating **8** subchannels (the claimed “*resource units*”) within a time slot (the claimed “*time interval*”), a POSITA would have understood that the Kim-IEEE802.16-2004 network allocates a resource segment comprising N time-frequency resource units within a time interval, “*where N=2, 4, or 8.*”

143. As I previously discussed for claim feature [1.4], *supra*, this is consistent with the '450 patent itself. In particular, neither the language of claim feature [1.4] of the '450 patent nor the written description of the '450 patent requires that the claimed “segment” must consist of **only** (and no more than) “N time-frequency resource units within a time interval.” Instead, claim feature [1.4] uses the open-ended claim language “*comprising N time-frequency resource units within a time interval.*” As explained for claim feature [1.4], this is disclosed at least by Kim’s allocation of a resource segment to user A (in Figure 7) which comprises “12 subchannels in a first slot SLOT(0)” (an example of the claimed “*N time-frequency resource units within a time interval*”) and “**8 subchannels** in a second slot SLOT(1)” (another example of the claimed “*N time-frequency resource units within a time interval*”) Ex-1005, [0063], Fig. 7. Furthermore, because claim feature [1.6] uses the alternative language “where N=2, 4, **or** 8,” the claim feature is disclosed by Kim’s allocation of “**8 subchannels** in a second slot SLOT(1).” Ex-1005, [0063], Fig. 7.

144. Moreover, a POSITA would have found that allocating 2, 4, or 8 subchannels to a user would have been obvious as a mere **design choice**. In particular, Kim explains that “the **number** of ... **subchannels** allocated to each user or mobile station is **variable** according to a **channel condition** and the **amount** of **data**.” Ex-1005, [0019]. Therefore, a POSITA would have understood that, for a relatively low amount of data, it would have been obvious to allocate 2 subchannels, and allocated 4 subchannels for twice the amount of data, and allocated 8 for quadruple the amount of data. Kim’s variable assignment of subchannels is consistent with IEEE802.16-2004, which provides that “a transmitter may be assigned **one or more subchannels**” per slot. Ex-1008, 530 (§8.4.2.2), 533 (§8.4.3.4). Therefore, a POSITA would have found it obvious, and a matter of mere design choice, that the Kim-IEEE802.16-2004 network allocates a resource segment which includes a “variable” number of N resources unit, where N can be “one or more,” such as 2, 4, or 8.

[1.7] receiving by the mobile station the transmitted signal; and

145. Kim discloses operations performed by a “**receiver**” of a mobile station. Ex-1005, [0071]-[0073], [0078]-0083], Fig. 10 (below). In particular, Kim explains that “FFT 1001 in the receiver detects” a frame in “a **received RF signal**.” Ex-1005, [0078], Fig. 10 (below, annotated).



Ex-1005, Figure 10 (annotated)

146. Kim further explains that “[e]ach **mobile station**, or **receiver**, should first determine whether a **signal transmitted** by a base station is a signal transmitted to the mobile station itself” and “[t]he mobile station performs demodulation and decoding only on the **signal transmitted** to the mobile station itself, thereby restoring its user data.” Ex-1005, [0072].

147. Therefore, the Kim-IEEE802.16-2004 network implements transmission of signals from a base station to a mobile station which involves “*receiving by the mobile station the transmitted signal.*”

[1.8] recovering by the mobile station the information from the received signal based on the starting time-frequency coordinate and N in conjunction with the identifier assigned to the mobile station.

148. As I previously discussed in §§VI.C(1) and (2), *supra*, the Kim-IEEE802.16-2004 network includes various information in Kim's "CTRL part" ("control message") of each frame, which allows a mobile station to correctly receive data in the frame. Ex-1005, [0072]. Specifically, as discussed, the Kim-IEEE802.16-2004 network implements such control information as part of a "DL-MAP" message within the frame, as specified in the IEEE 802.16 standard. Therefore, when a mobile station in the Kim-IEEE802.16-2004 network receives a frame, the mobile station decodes the DL-MAP message to acquire this control information, which allows the mobile station to determine whether information in the frame is intended for the mobile station and, if so, to recover that information with knowledge of the location and size (number of subchannels) of the resource allocated for the information.

(i) ***"recovering by the mobile station the information from the received signal based on the starting time-frequency coordinate..."***

149. As discussed for claim feature [1.3] and in §VI.C(2), *supra*, the control information in the DL-MAP message includes an "OFDMA symbol offset" and "subchannel offset" (collectively, the claimed "*starting time-frequency coordinate*") for resources assigned to a user. Ex-1008, 558 (end of §8.4.5.3),

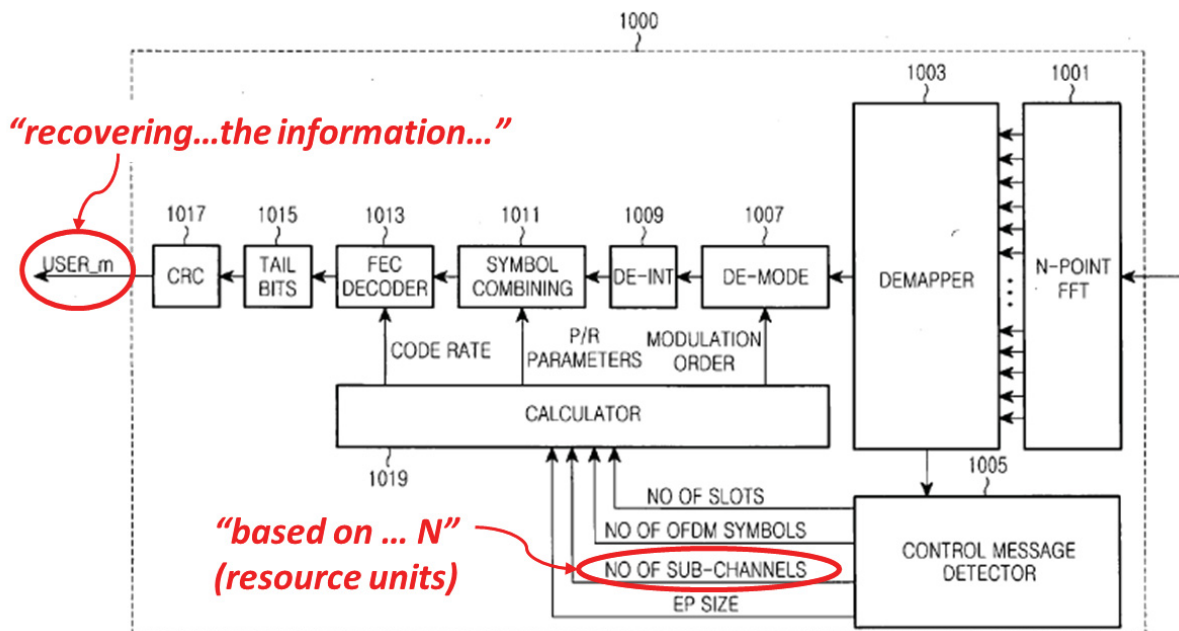
Table 275. As discussed for claim feature [1.3] and in §VI.C(2), above, the Kim-IEEE802.16-2004 network utilizes the “OFDMA **Symbol offset**” and “**subchannel offset**” (as specified in IEEE802.16-2004) to implement Kim’s “location information” which (as Kim explains) identifies the location of “user data” multiplexed in a frame. Ex-1005, [0073], [0075], [0081]-[0082]; Ex-1008, 558 (end of §8.4.5.3), Table 275. Therefore, as disclosed in Kim, upon receiving the “control message,” mobile station “detects **location information** in a multiplexed frame of data” which allows the mobile station to **decode** the “**user data**” from the frame. Ex-1005, [0081]-[0082]. Thus, in the Kim-IEEE802.16-2004 combination, the mobile station uses the starting time-frequency coordinate (e.g., the “OFDMA Symbol offset” and “subchannel offset” (as specified in IEEE802.16-2004)) to locate the user data within the frame and start the process of recovering the information from the received signal.

(ii) “... *and N...*”

150. As I previously discussed, Kim discloses that the “CTRL” part (“control message”) in each frame includes information regarding “the **number** of **subchannels**” of the user data. Ex-1005, [0075], [0081]. Using this information, Kim’s mobile station is able to “perform data demodulation and decoding” of the user data. Ex-1005, [0076], *see also* [0082]. This is consistent with IEEE802.16-2004, which specifies that the “DL-MAP” message in each frame includes the

parameter “No. Subchannels” which indicates the “**number of subchannels** with subsequent indexes, used to carry the burst.” Ex-1008, 558, Table 275.

151. Kim discloses that “control message detector 1005...detects...the **number of subchannels**...from the control message 1130.” Ex-1005, [0081]. Based on the detected **number of subchannels**, Kim’s receiver performs demodulation and decoding steps to recover the user data, as shown in Figure 10 (below, annotated). Ex-1005, [0081], [0082], Fig. 10;



Ex-1005, Figure 10 (annotated)

152. Kim’s “calculator 1019 detects a modulation order, a code rate, an MPR value, and a puncturing/repetition parameter,” based on the detected **number of subchannels**, referred to in Kim as “ $N_{SCH,k}$ ” which “denotes the number of subchannels allocated to a kth slot” (in addition to other parameters, such as “the

number of slots” referred to in Kim as “ N_{slot} ” over which the number of subchannels per slot are added; “the number of modulation symbols allocated to channel resource comprised of one slot and one subchannel referred to in Kim at “ N_{MS} ”; and the “EP size” which is the “encoder packet” size). Ex-1005, [0018], [0058], [0063], [0081], Equation (5), Fig. 10.

153. Then, “demodulator 1007 demodulates the input traffic data according to the modulation order received from the calculator 1019” and “FEC decoder 1013 decodes the input traffic symbols according to the code rate received from the calculator 1019.” Ex-1005, [0082]. As a result, the receiver 1000 of the mobile station “**outputs the decoded information as user data.**” Ex-1005, [0082].

154. With this background, in the Kim-IEEE802.16-2004 combination, the mobile station recovers the information from the signal using both the starting time-frequency coordinate (e.g., the “OFDMA Symbol offset” and “subchannel offset” (as specified in IEEE802.16-2004)) and N (e.g., the number of subchannels (as specified by Kim)). Specifically, as discussed at claim feature [1.8](i), the Kim-IEEE802.16-2004 mobile station uses the starting time-frequency coordinate (e.g., the “OFDMA Symbol offset” and “subchannel offset” (as specified in IEEE802.16-2004)) to locate the start of the user data within the frame. Then, the Kim-IEEE802.16-2004 mobile station uses N (e.g., the number of subchannels (as specified by Kim)) to determine the full extent of the user data that

begins at the starting time-frequency coordinate. Finally, with the start and full extent of the user data known, the Kim-IEEE802.16-2004 mobile station is able to perform decoding operations to recover the information in the received signal.

(iii) “... *in conjunction with the identifier assigned to the mobile station.*”

155. As discussed for claim feature [1.1] and in §VI.C(1), *supra*, the control information in the DL-MAP message also includes a “connection ID (CID)” (the claimed “*identifier*”) which is assigned to the mobile station. Recovery of information in the Kim-IEEE802.16-2004 network occurs in conjunction with the identifier in at least two ways. First, in the Kim-IEEE802.16-2004 network, recovery of information occurs in conjunction with the identifier because the identifier is used to determine whether or not a received frame contains data intended for the mobile station. Second, in the Kim-IEEE802.16-2004 network, recovery of information also occurs in conjunction with the identifier because decryption of the data (using a security association identifier, which is equal to the identifier) is required for recovering information. As to the first way the Kim-IEEE802.16-2004 network renders obvious this limitation, as discussed for claim features [1.1], [1.3] and in §§VI.C(1) and (2), *supra*, Kim explains that “each mobile station first **detects** the **CTRL part** from the frame 1220 to **determine whether** its **own data** has been transmitted, and **decodes** its own **data** ... if its own data has been transmitted.” Ex-1005, [0083]. The ability to determine “whether

its own data has been transmitted” is provided by the “CID” (as specified by IEEE802.16-2004), which would allow Kim’s mobile station to **determine whether data** received in a frame is **intended** for the mobile station, as disclosed in Kim. Ex-1005, [0072] (“[t]he mobile station **performs demodulation and decoding** only on the **signal** transmitted to the mobile station itself, thereby **restoring its user data.**”). Indeed, IEEE802.16-2004 explains that the “CID” is utilized to determine whether data in a frame is intended for a particular station. Ex-1008, 67 (§6.1, first paragraph, “[t]he SSs check the CIDs in the received PDUs and retain only those PDUs addressed to them.”).

156. IEEE802.16-2004 specifies that the CID is part of the “**MAC PDU header**” which is received by the subscriber station (SS) in its DL burst. Ex-1008, 733 (§11.13.2, first paragraph); 71 (Figure 18); 72 (Figure 19); 73 (Table 5). A POSITA would have found it obvious that the CID in the MAC PDU header would have been used by the SS to determine that the MAC PDU payload information is indeed destined for the SS. In this way, the Kim-IEEE802.16-2004 network transmits (in the header of the MAC PDU in the DL burst) the **CID** which is used by the SS to **recover** the information contained within the MAC PDU payload, in conjunction with the location information of the DL burst.

157. In addition, as to the second way the Kim-IEEE802.16-2004 network renders obvious this limitation, IEEE802.16-2004 specifies the **CID** also serves as

a “security association identifier” (SAID)” which is an “identifier shared between the base station (BS) and subscriber station that uniquely **identifies a security association (SA)**” of the subscriber. Ex-1008, 46 (definition 3.48), 308 (§ 7.1.3, fourth paragraph, “[t]he SAID of any SS’s Primary SA shall be **equal to** the Basic **CID** of that SS”). IEEE802.16-2004 explains that the SAID (i.e., the CID) is necessary for the SS to identify the security association (SA) in order to **recover** the MAC PDU payload because “**encryption** is always applied to the MAC PDU payload.” Ex-1008, 307 (§7.1.1), 308 (§7.1.3).

158. Because a determination that data received in a frame is intended for the mobile station (using the CID) is a prerequisite for the mobile station to begin recovering information from the frame, and/or because decryption of the data (using the SAID, which is equal to the CID) is required for recovering that information, a POSITA would have understood that the recovery of information from a received signal in the Kim-IEEE802.16-2004 combination occurs “***in conjunction with the identifier assigned to the mobile station the mobile station.***” Specifically, the Kim-IEEE802.16-2004 network demodulates, decodes, and outputs data from a received signal by using the “OFDMA symbol offset” and “subchannel offset” of a resource allocated to user data (the claimed “***the starting time-frequency coordinate***” of a “***segment***”), and the “number of subchannels” allocated to the user data (the claimed “***N***”), in conjunction with the **CID** (the

claimed “*identifier assigned to the mobile station*”). Therefore, a POSITA would have understood that the mobile station in the Kim-IEEE802.16-2004 network recovers “*the information from the received signal based on the starting time-frequency coordinate and N in conjunction with the identifier assigned to the mobile station.*”

B. Claims 2-6

[2.0] The method of claim 1, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.

159. Prior art knowledge of a “*starting OFDM symbol*” for resource allocation is acknowledged in the Background Section of the ’450 patent itself, which explains that according to the existing IEEE 802.16 standard, “resource allocation is identified in the **time domain** scale with a **start symbol offset** (8 bits).” Ex-1001, 1:60-66. Therefore, a POSITA would have understood prior art knowledge that a resource allocation is identified in time by a **start symbol offset** (the claimed “*starting OFDM symbol*”). Indeed, a POSITA would have found resource allocation using a starting OFDM symbol as being part of a POSITA’s general knowledge, as evidenced by the Background of the ’450 patent, and would have found use of a starting OFDM symbol to have been an obvious solution and design choice based on this general knowledge.

160. Such prior art knowledge is further evidenced in Kim and IEEE802.16-2004. As discussed for claim feature [1.3], *supra*, the Kim-IEEE802.16-2004 network

identifies the location of a “data region” (the claimed “*segment*”) which is allocated to a “burst” of information for Kim’s “user data” by using a “*starting time-frequency coordinate*” in which the “*starting time ... coordinate*” is an OFDMA symbol specified by IEEE802.16-2004’s “**OFDMA symbol offset.**” Ex-1008, 558 (end of §8.4.5.3), Figures 215, 218; Ex-1005, [0073], [0075], [0081]-[0082]. IEEE802.16-2004 explains that this is “[t]he offset of **the OFDMA symbol** in which the **burst starts**, measured in OFDMA symbols from beginning of the downlink frame.” Ex-1008, 558 (end of §8.4.5.3).

161. Therefore, a POSITA would have found obvious that “*the starting time-frequency coordinate*” in the Kim-IEEE802.16-2004 network “*indicates a starting OFDM symbol of the segment of time-frequency resource.*”

[3.0] The method of claim 1, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.

162. As discussed for claim feature [4.0], *infra*, the Background Section of the ’450 patent acknowledges that the prior art IEEE 802.16 standard specifies “resource allocation is identified ... in the **frequency domain** scale with a **start logical subchannel offset** (6 bits).” Ex-1001, 1:60-66. The ’450 patent further explains that “**subcarriers** can be arranged into **groups** called **subchannels.**” Ex-1001, 4:57-59. Therefore, a POSITA would have understood prior art knowledge that a resource allocation is identified in frequency by a starting group of

subcarriers. Indeed, resource allocation using a starting subcarrier would have been part of a POSITA's general knowledge, as evidenced by the Background of the '450 patent, and a POSITA would have found use of a starting subcarrier an obvious solution and design choice based on this general knowledge.

163. Such prior art knowledge is further evidenced in Kim and IEEE802.16-2004. As discussed for claim feature [1.3], *supra*, the Kim-IEEE802.16-2004 network identifies the location of a "data region" (the claimed "*segment*") which is allocated to a "burst" of information for Kim's "user data" by using a "*starting time-frequency coordinate*" in which the "*starting ... frequency coordinate*" is a subchannel specified by IEEE802.16-2004's "**subchannel offset.**" Ex-1008, 558 (end of §8.4.5.3), Figures 215, 218; Ex-1005, [0073], [0075], [0081]-[0082]. IEEE802.16-2004 specifies the "[s]ubchannel offset" is "[t]he **lowest index OFDMA subchannel** used for carrying the **burst**, starting from subchannel 0." Ex-1008, 558 (end of §8.4.5.3). Further, as discussed for claim feature [3.0], *supra*, each **subchannel** of the Kim-IEEE802.16-2004 network consists of **multiple subcarriers**. Ex-1005, [0060], Fig. 6 (showing a subchannel containing 16 subcarriers); Ex-1008, 530 (§8.4.2.2, describing that "subcarriers are divided into **subsets** of **subcarriers**, each subset is termed a **subchannel**").

164. Therefore, as discussed for claim feature [4.0], *infra*, because each resource *segment* of the Kim-IEEE802.16-2004 network has "*a starting time-frequency*

coordinate” which indicates a starting subchannel, and because each subchannel consists of multiple subcarriers, a POSITA would have understood that, in the Kim-IEEE802.16-2004 network, “*the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.*”

165. Moreover, IEEE802.16-2004 specifies that the **subcarriers** in each subchannel are indexed by a “**subcarrier index**” for that particular subchannel. Ex-1008, 602 (§8.4.6.1.2.2.2, defining the parameter “*subcarrier(n,s)*” as the “**subcarrier index of subcarrier n in subchannel s .**”). Therefore, because subcarriers in each subchannel are **indexed** in the subchannel, a POSITA would have understood that each subchannel has a **starting subcarrier** (e.g., the subcarrier with a **starting subcarrier index** in the subchannel).

166. Thus, a POSITA would have found obvious that each resource *segment* of the Kim-IEEE802.16-2004 network has “*a starting time-frequency coordinate*” which “*indicates a starting subcarrier of the segment of time-frequency resource*” (namely, the subcarrier with the starting “subcarrier index” in the subchannel specified by the “subchannel offset” of IEEE802.16-2004).

[4.0] The method of claim 1, wherein the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.

167. As discussed for claim feature [3.0], *supra*, prior art knowledge of a “**starting group of subcarriers**” for resource allocation is acknowledged in the Background Section of the ’450 patent itself, which explains that according to the existing IEEE 802.16 standard, “resource allocation is identified ... in the frequency domain scale with a **start logical subchannel offset** (6 bits).” Ex-1001, 1:60-66. The ’450 patent further explains that “**subcarriers** can be arranged into **groups** called **subchannels**.” Ex-1001, 4:57-59. Therefore, a POSITA would have understood as part of their prior art knowledge that a resource allocation is identified in frequency by a **starting group of subcarriers**. Indeed, a POSITA would have understood resource allocation using a starting group of subcarriers as being part of a POSITA’s general knowledge, as evidenced by the Background of the ’450 patent, and would have found use of a starting group of subcarriers to have been an obvious solution and design choice based on this general knowledge.

168. Such prior art knowledge is further evidenced in Kim and IEEE802.16-2004. As discussed for claim features [1.3] and [3.0], *supra*, the Kim-IEEE802.16-2004 network identifies the location of a “data region” (the claimed “**segment**”) which is allocated to a “burst” of information for Kim’s “user data” by using a “**starting time-frequency coordinate**” in which the “**starting ... frequency coordinate**” is a subchannel specified by IEEE802.16-2004’s “**subchannel offset**.” Ex-1008, 558 (end of §8.4.5.3), Figures 215, 218; Ex-1005, [0073], [0075], [0081]-[0082].

IEEE802.16-2004 specifies the “[s]ubchannel offset” is “[t]he **lowest index OFDMA subchannel** used for carrying the **burst**, starting from subchannel 0.”

Ex-1008, 558 (end of §8.4.5.3). Further, as discussed for claim feature [3.0], *supra*, each **subchannel** of the Kim-IEEE802.16-2004 network consists of **multiple subcarriers**. Ex-1005, [0060], Fig. 6 (showing a subchannel containing 16 subcarriers); Ex-1008, 530 (§8.4.2.2, describing that “subcarriers are divided into **subsets of subcarriers**, each subset is termed a **subchannel**”).

169. Therefore, because each resource *segment* of the Kim-IEEE802.16-2004 network has “*a starting time-frequency coordinate*” which indicates a starting subchannel, and because each subchannel consists of multiple subcarriers, a POSITA would have understood that, in the Kim-IEEE802.16-2004 network, “*the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.*”

[5.0] The method of claim 1, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.

170. As discussed for claim feature [1.4], above, the Kim-IEEE802.16-2004 network allocates *resource units*, where each resource unit is defined by a single subchannel (in frequency) and a single slot (in time). In addition, as I explain below, the Kim-IEEE802.16-2004 network applies *modular coding* to the resource

units because the Kim-IEEE802.16-2004 network implements modulation and coding schemes that utilize **integer multiples** of a basic **resource unit**.

171. Kim describes a system that determines “a modulation scheme and a code rate **based on a block size**” that “provides **various block sizes** for **error correction codes**.” Ex-1005, [0053], [0054]. In particular, each “**block** has a different **number of subchannels** for **each slot**” (i.e., the block has a different number of the claimed “*resource units*”). Ex-1005, [0062].

172. Kim explains that the “**code rate**” of an error correction code depends on the “number of subchannels for each slot” (i.e., the number of the claimed “*resource units*”). Ex-1005, [0062]. To determine the code rate, a user first “calculates an **MPR** [Modulation order Product code Rate] for each multiaccess user **according to the number of subchannels** (or subcarriers) allocated to each multiaccess user, the **number of slots** (or OFDM symbols) and an EP [encoding packet] size allocated to each multiaccess user.” Ex-1005, [0067], *see also* [0029]. As a result, Kim explains that, “when the block has a **different number of subchannels for each slot**” then “the **MPR should be modified** as shown in Equation (5).” Ex-1005, [0062]. Then, “based on the MPR” each user determines a “modulation order” (MO) and, “[o]nce a modulation order is determined in this process, a **code rate R** of an **error correction code** is determined as a ratio of the MPR to the modulation order (MO).” Ex-1005, [0067]. Having determined the modulation

order (MO) and code rate (R), Kim describes that an “**FEC encoder 905 encodes user data** at a code rate having a value determined by the modulation order and code rate.” Ex-1005, [0069]. Kim’s coding is applied from a table of “modulation orders and code rates” which are “pre-calculated for all possible combinations” of MPRs. Ex-1005, [0070].

173. Therefore, Kim describes a *modular coding* scheme that “provides various block sizes for error correction codes” where the “**code rate**” of Kim’s error correction code depends on the “**number of subchannels** for each slot” (i.e., the number of the claimed “*resource units*”). Ex-1005, [0062].

174. Similarly, IEEE802.16-2004 discloses the same concept of an “MPR” which is calculated based on the **number of subchannels** allocated to a “burst.” Ex-1008. §8.4.9.2.3.5.6 “Modulation order of DL traffic burst”). IEEE802.16-2004 discloses examples of “FEC Code types” which specify different modulation schemes (e.g., QPSK, QAM, QPSK) and coding schemes (e.g., Convolutional Code “CC” or Block Turbo Code “BTC” or Convolutional Turbo Code “CTC”). Ex-1008, Table 363 (below, annotated).

Table 363—DCD burst profile encodings—WirelessMAN-OFDMA

Name	Type (1 byte)	Length	Value (variable length)
FEC Code type	150	1	0 = QPSK (CC) 1/2 14 = QPSK (CTC) 3/4 1 = QPSK (CC) 3/4 15 = 16-QAM (CTC) 1/2 2 = 16-QAM (CC) 1/2 16 = 16-QAM (CTC) 3/4 3 = 16-QAM (CC) 3/4 17 = 64-QAM (CTC) 2/3 4 = 64-QAM (CC) 2/3 18 = 64-QAM (CTC) 3/4 5 = 64-QAM (CC) 3/4 19 = 64-QAM (CTC) 5/6 6 = QPSK (BTC) 1/2 20 = QPSK (ZT CC) 1/2 7 = QPSK (BTC) 3/4 or 2/3 21 = QPSK (ZT CC) 3/4 8 = 16-QAM (BTC) 3/5 22 = 16-QAM (ZT CC) 1/2 9 = 16-QAM (BTC) 4/5 23 = 16-QAM (ZT CC) 3/4 10 = 64-QAM (BTC) 2/3 or 5/8 24 = 64-QAM (ZT CC) 2/3 11 = 64-QAM (BTC) 5/6 or 4/5 25 = 64-QAM (ZT CC) 3/4 12 = QPSK (CTC) 1/2 26..255 = <i>Reserved</i> 13 = QPSK (CTC) 2/3
DIUC Mandatory exit threshold	151	1	0–63.75 dB CINR at or below where this DIUC can no longer be used and where this change to a more robust DIUC is required, in 0.25 dB units. See Figure 81.
DIUC Minimum entry threshold	152	1	0–63.75 dB The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required, in 0.25 dB units. See Figure 81.

Ex-1008, Table 363 (annotated)

175. Therefore, IEEE802.16-2004 specifies, consistent with Kim, that the “**encoding** block size shall **depend** on the **number of subchannels** allocated” (i.e., the number of the claimed “*resource units*”). Ex-1008, 589 (§8.4.9.2, 2nd paragraph). Furthermore, IEEE802.16-2004 describes a “subchannel concatenation rule” in which “concatenation of a number of subchannels” can be performed “in order to make larger blocks of coding.” Ex-1008, 589 (§8.4.9.2, 2nd and 3rd paragraphs).

176. Therefore, because the Kim-IEEE802.16-2004 network implements modulation and coding schemes that utilize an integer **multiple** of **subchannels**

per slot (i.e., integer multiples of the claimed “**resource unit**”), a POSITA would have understood that, in the Kim-IEEE802.16-2004 network, “**modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.**”

177. This is consistent with the ’450 patent. Although the ’450 patent specification does not use the term “**modular coding**,” the ’450 patent describes modulation and coding schemes that utilize “**modular resources.**” Ex-1001, 6:45-62. In particular, the ’450 patent describes different modulation and coding schemes (MCSs) using integer multiples of a basic “resource unit.” Ex-1001, 6:31-34, Table 1 (showing four different modulation and coding schemes, indexed by MCSI numbers 1 through 4, using different integer multiples of a basic resource unit), *see also* 6:45-55.

[6.0] The method of claim 5, wherein a repetition coding is further applied to the time-frequency [sic] resource units.

178. The ’450 patent acknowledges, in its Background Section, that the IEEE 802.16 standard specifies “2 bits are used to indicate the coding **repetition.**” Ex-1001, 2:6-7. Therefore, a POSITA would have understood prior art knowledge of “**repetition coding.**” Indeed, a POSITA would have understood repetition coding as being part of a POSITA’s general knowledge, as evidenced by the Background

of the '450 patent, and would have found use of repetition coding to have been an obvious solution and design choice based on this general knowledge.

179. Such prior art knowledge is further evidenced in Kim and IEEE802.16-2004. As discussed for claim feature [5.0], the Kim-IEEE802.16-2004 network applies FEC coding to multiples of a resource unit (the claimed “***modular coding***”). In addition, the Kim-IEEE802.16-2004 network further applies **repetition coding** to the encoded data. Ex-1005, [0010], [0069], [0070]. For example, Kim discloses a “symbol **repetition** & puncturing part” which “performs symbol **repeating** and puncturing on the FEC-encoded data.” Ex-1005, [0010], [0069]. Kim explains that “a puncturing/**repetition** parameter” is determined according to “the modulation order and code rate” (which is determined based on the number of subchannels, i.e., the number of “***resource units***,” as discussed for claim feature [5.0], *supra*), and then “symbol **repetition**” is performed based on the puncturing/repetition parameter. Ex-1005, [0069], FIG. 9 (below, annotated to show encoding operations in a transmitter).

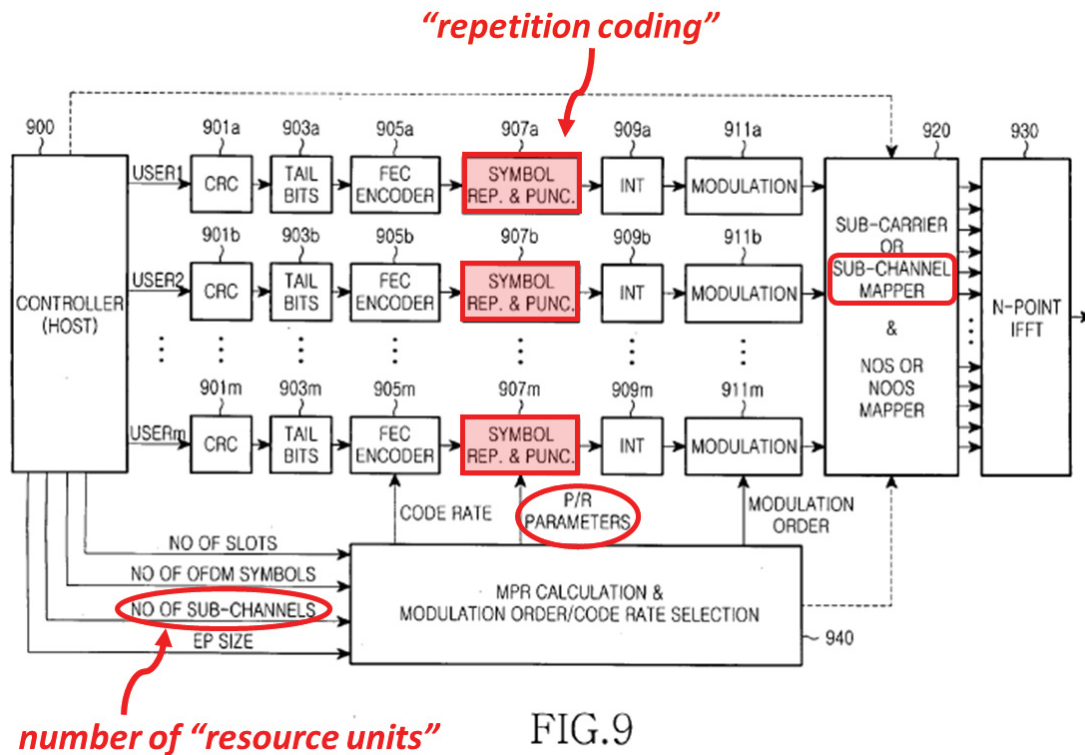


FIG.9

Ex-1005, Fig. 9 (annotated)

180. Kim explains that the “symbol **repetition**” then determines the final code rate of the encoding scheme. For example, Kim explains that, “[i]f a 2-times symbol **repetition** parameter is delivered and a code rate is $\frac{1}{3}$, the final code rate becomes $\frac{1}{6}$.” Ex-1005, [0070].

181. In addition, IEEE802.16-2004 specifies that, according to the IEEE 802.16 standard, “**repetition coding**” is indicated by a “**repetition coding indication**” carried in the DL-MAP message, which “[i]ndicates the **repetition code** used **inside** the allocated **burst**” (e.g., repetition coding of 2, 4, or 6). Ex-1008, 558, lines 16-17, Table 275 (below, annotated).

Table 275—OFDMA DL-MAP_IE format

Syntax	Size	Notes
DL-MAP_IE() {		
DIUC	4 bits	
if (DIUC == 15) {		
Extended DIUC dependent IE	<i>variable</i>	See subclauses following 8.4.5.3.1
} else {		
if (INC_CID == 1) {		The DL-MAP starts with INC_CID = 0. INC_CID is toggled between 0 and 1 by the CID-SWITCH_IE() (8.4.5.3.7)
N_CID	8 bits	Number of CIDs assigned for this IE
for (n=0; n< N_CID; n++) {		
CID	16 bits	
}		
}		
OFDMA Symbol offset	8 bits	
Subchannel offset	6 bits	
Boosting	3 bits	000: normal (not boosted); 001: +6dB; 010: -6dB; 011: +9dB; 100: +3dB; 101: -3dB; 110: -9dB; 111: -12dB;
No. OFDMA Symbols	7 bits	
No. Subchannels	6 bits	
<u>Repetition Coding Indication</u>	<u>2 bits</u>	<u>0b00 – No repetition coding</u> <u>0b01 – Repetition coding of 2 used</u> <u>0b10 – Repetition coding of 4 used</u> <u>0b11– Repetition coding of 6 used</u>

Ex-1008, Table 275 (annotated)

182. Therefore, because the Kim-IEEE802.16-2004 network applies repetition coding to a number of subchannels per slot (i.e., the claimed “*resource units*”), a

POSITA would have understood that, in the Kim-IEEE802.16-2004 network, “*a repetition coding is further applied to the time-frequency [sic] resource units.*”

C. Claim 7

[7.P1] A mobile device in a wireless packet system

183. See [1.P1], *supra*. In addition, Kim’s system is designed to transmit “**packet** data” by implementing “a **packet** transmission service.” Ex-1005, Abstract, [0017].

[7.P2] using a frame structure of multiple frames for transmission,

184. See [1.P2], *supra*.

[7.P3] each frame comprising a plurality of time intervals,

185. See [1.P3], *supra*.

[7.P4] each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and

186. See [1.P4], *supra*.

[7.P5] each OFDM symbol containing a plurality of frequency subcarriers, the mobile device configured to:

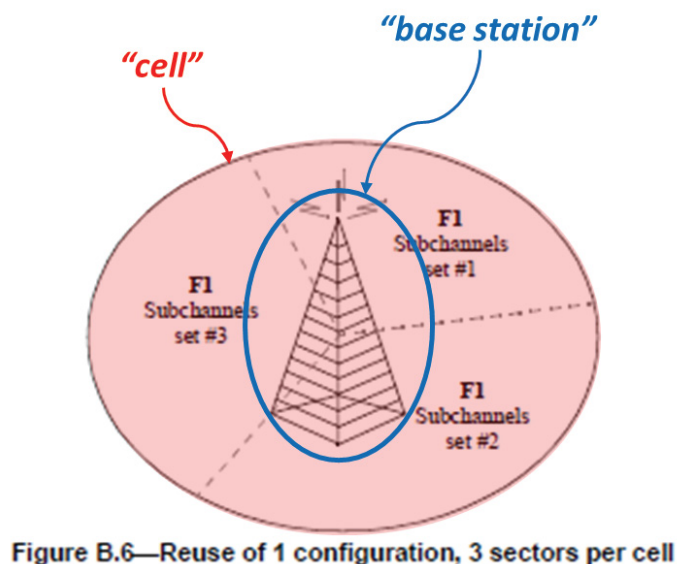
187. See [1.P5], *supra*.

[7.1] receive an identifier from a base station in a cell in which the mobile device is operating; and

188. See [1.1], *supra*. For example, as discussed for claim feature [1.1] and § VI.C(1), *supra*, the Kim-IEEE802.16-2004 mobile station **receives**, from a base station, a “DL-MAP” message (as specified in IEEE802.16-2004) in the “CTRL

part” (control message) of Kim’s frame, which includes a “**connection identifier (CID)**.” Ex-1005, Abstract, [0017]; Ex-1008, Table 275, Figure 218, 43 (definition 3.13).

189. In addition, IEEE802.16-2004 discloses a typical scenario of “base station” in a “**cell**” that includes “configuration of the **base station** sectors.” Ex-1008, 851, Figure B.6 (below, annotated). The concept of a “**cell**” in which a base station and mobile devices operate was well-known in the field of wireless communication, and specifically in IEEE 802.16-based networks, prior to the Critical Date of the ’450 patent.



Ex-1008, Figure B.6 (annotated)

[7.2] receive a signal containing information from the base station over a segment of time-frequency resource,

190. See [1.2], *supra*.

[7.3] the segment having a starting time-frequency coordinate and

191. See [1.3], *supra*.

[7.4] the segment comprising N time-frequency resource units within a time interval,

192. See [1.4], *supra*.

[7.5] each unit containing a set of frequency subcarriers in a group of OFDM symbols,

193. See [1.5], *supra*.

[7.6] where N=2, 4, or 8; and

194. See [1.6], *supra*.

[7.7] recover the information from the received signal using the starting time-frequency coordinate and N in conjunction with the received identifier.

195. See [1.7] and [1.8], *supra*.

D. Claims 8-12

[8.0] The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.

196. See [2.0], *supra*.

[9.0] The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.

197. See [3.0], *supra*.

[10.0] The mobile device of claim 7, wherein the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.

198. See [4.0], *supra*.

[11.0] The mobile device of claim 7, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.

199. See [5.0], *supra*.

[12.0] The mobile device of claim 11, wherein a repetition coding is further applied to the time-frequency [sic] resource units.

200. See [6.0], *supra*.

E. Claim 13

[13.P1] A base station in a wireless packet system

201. See [1.P1] and [7.P1], *supra*.

[13.P2] using a frame structure of multiple frames for transmission,

202. See [1.P2], *supra*.

[13.P3] each frame comprising a plurality of time intervals,

203. See [1.P3], *supra*.

[13.P4] each time interval comprising a plurality of orthogonal frequency division multiplexing (OFDM) symbols, and

204. See [1.P4], *supra*.

[13.P5] each OFDM symbol containing a plurality of frequency subcarriers, the base station configured to:

205. See [1.P5], *supra*.

[13.1] provide an identifier to a mobile device in the cell;

206. See [1.1] and [7.1], *supra*.

[13.2] allocate a segment of time-frequency resource for carrying information to the mobile device,

207. See [1.2], *supra*.

[13.3] the segment having a starting time-frequency coordinate and

208. See [1.3], *supra*.

[13.4] the segment comprising N time-frequency resource units within a time interval,

209. See [1.4], *supra*.

[13.5] each unit containing a set of frequency subcarriers in a group of OFDM symbols,

210. See [1.5], *supra*.

[13.6] where N=2, 4, or 8; and

211. See [1.6], *supra*.

[13.7] transmit a signal containing the information to the mobile device in a manner that allows the mobile device to recover the information using the starting time-frequency coordinate and N in conjunction with the provided identifier.

212. See [1.7] and [1.8], *supra*.

F. Claims 14-18

[14.0] The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting OFDM symbol of the segment of time-frequency resource.

213. A See [2.0], *supra*.

[15.0] The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting subcarrier of the segment of time-frequency resource.

214. See [3.0], *supra*.

[16.0] The base station of claim 13, wherein the starting time-frequency coordinate indicates a starting group of subcarriers of the segment of time-frequency resource.

215. See [4.0], *supra*.

[17.0] The base station of claim 13, wherein modular coding is applied to the time-frequency resource units in the segment of time-frequency resource.

216. See [5.0], *supra*.

[18.0] The base station of claim 17, wherein a repetition coding is further applied to the time-frequence [sic] resource units.

217. See [6.0], *supra*.

VIII. CONCLUSION

218. For all the reasons I have noted in the foregoing paragraphs, the Challenged claims of the '450 Patent are obvious in view of the references discussed above.