

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZYXEL COMMUNICATIONS CORPORATION,

Petitioner,

v.

UNM RAINFOREST INNOVATIONS,

Patent Owner.

IPR2021-00734
Patent No. 8,265,096

**RESUBMISSION OF THE DECLARATION OF BRANIMIR VOJCIC, D.SC., IN
SUPPORT OF UNM RAINFOREST INNOVATIONS' PRELIMINARY RESPONSE**

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

QUALCOMM INCORPORATED,
Petitioner,

v.

UNM RAINFOREST INNOVATIONS,
Patent Owner.

PTAB Case No. IPR2021-00375
Patent No. 8,265,096 B2

**DECLARATION OF BRANIMIR VOJCIC, D.SC., IN SUPPORT OF
UNM RAINFOREST INNOVATIONS' PRELIMINARY RESPONSE**

I, Dr. Branimir Vojcic, under the penalty of perjury under the laws of the United States, declare that the following is true and correct based on the best of my ability.

Date: 21 April 2021

Signed:

Branimir Vojcic, Ph.D.

1. I have been retained by DiMuro Ginsberg, P.C., as an independent technical expert in the Inter Partes Review between UNM Rainforest Innovations (“UNM”), and Qualcomm Incorporated (“Qualcomm”), PTAB Case No. IPR2021-00375 involving U.S. Patent No. 8,265,096 (“the ’096 patent”).

2. I am being compensated for my work as a technical expert at my customary rate of \$675 per hour. My compensation does not in any way depend on the outcome of this review, and I have no personal interest in the outcome of this review.

I. QUALIFICATIONS

3. I am an expert in wireless technology and other telecommunications areas. I am an Emeritus Professor of Engineering and Applied Science at The George Washington University, where I have been a member of the faculty since September 1991. In addition, I have served as a consultant for a number of companies in the wireless communications industry in various technology areas. I have also served on numerous committees and as a reviewer and editor for several journals, conferences, and organizations.

4. I received my Diploma of Engineering, Master of Science, and Doctor of Science degrees in Electrical Engineering from the University of Belgrade in Yugoslavia in 1981, 1986, and 1989, respectively. The primary focus of my Doctor of Science studies was on Code Division Multiple Access (CDMA) and spread spectrum communications technologies.

5. In 1991, I joined The George Washington University as an Assistant Professor and was promoted to Associate Professor and Professor in 1997 and 2000, respectively. From 2001 to 2004, I served as Chairman of the Electrical and Computer Engineering Department at The George Washington University and retired in 2015. During my tenure at The George Washington University, I have taught many different courses on communications theory and networks, wireless communications, CDMA, and I have been a course director for a number of courses in communications. I have supervised students mostly in the areas of wireless communications and CDMA (including IS-95, CDMA2000, WCDMA/HSDPA/HSUPA) and OFDM/LTE and have been a thesis director for a number of Doctor of Science candidates, who now have successful careers in academia, industry, and government.

6. My research in the areas I just mentioned has been supported by the communications industry and various government agencies, such as the Advanced Research Project Agency (ARPA), the National Science Foundation (NSF), and the National Security Agency (NSA). Much of this research concerns communications theory, performance evaluation, modeling of wireless networks, multi-user detection, adaptive antenna arrays, and ad-hoc networks.

7. I have authored and co-authored a number of journal and conference papers, contributed to various books, and co-authored a textbook on CDMA, entitled

The CDMA2000 System for Mobile Communications, Prentice Hall, 2004. I have also served as a co-editor of a book on wireless communications, entitled *Multiaccess, Mobility, and Teletraffic in Wireless Communications*, Volume III, Kluwer Academic Publishers, Norwell, Massachusetts, 1998. My CV includes a detailed listing of my publications. See Attachment A.

8. I have also received awards for my work. For example, in 1995, I received the prestigious National Science Foundation Faculty Early CAREER Development Award. The award is given annually by the NSF to a select number of young professors nationwide to promote excellence in teaching and research.

9. I have served as a consultant for numerous companies in the wireless communications industry in technology areas, including the areas of 2G/3G/4G mobile technologies, Wireless LANs, new generation broadcast systems, advanced mobile satellite systems and other aspects of modern communication systems. I have also taught academic courses as well as short courses for the industry and government on various aspects of communications in the areas of 2G, 2.5G, 3G, and 4G cellular standards, such as CDMA2000 1xRTT, CDMA2000 Evolution Data Optimized (EVDO), Wideband Code Division Multiple Access (WCDMA), and LTE.

10. I am a Senior Member of the IEEE and was an Associate Editor for IEEE Communications Letters and the Journal on Communications and Networks. I have

served as a member of technical program committees, as a session organizer for many technical conferences and workshops, and as a reviewer of technical papers for many journals and conferences.

11. I am a co-inventor on about 20 patents; some representative examples include: U.S. Patent No. 6,523,147, entitled “*Method and Apparatus for Forward Error Correction Coding for an AM In-Band On-Channel Digital Audio Broadcasting System*,” U.S. Patent No. 8,595,590 B1, entitled “*Systems and Methods for Encoding and Decoding Check-Irregular Non-Systematic IRA Codes*,” and applications including “*Joint Source-Channel Decoding with Source Sequence Augmentation*,” U.S. 20140153654 A1, June 5, 2014, “*Systems and Methods for Advanced Iterative Decoding and Channel Estimation of Concatenated Coding Systems*,” U.S. 20140153625 A1, June 5, 2014, “*Advanced Decoding of High/Medium/Low Density Parity Check Codes*,” PCT/US13/72883, and International Application Number PCT/CA01/01488, entitled “*Multi-User Detector For Direct Sequence - Code Division Multiple Access (DS/CDMA) Channels*.”

12. Over the last several years, I have evaluated many, on the order of hundreds, of patents that are essential or potentially essential to wireless standards for various clients. These evaluations typically include, for example, analyzing whether the patent claims read on the relevant standard, considering the importance of the technological inventions claimed, analyzing how such claimed inventions

compare to other similar patents in the field, searching for and reviewing potential prior art, reviewing and analyzing the prosecution histories of patents relevant to potential claim construction, infringement, or related issues, reviewing and analyzing the working group documents related to the relevant standard in relation to the claimed invention, and considering whether there are available alternatives to the claimed inventions.

13. A copy of my CV is attached as Attachment A.

II. BASES OF OPINIONS

14. The basis and reasoning of my opinions include my education, training, and experience as an engineer, including my decades of experience in telecommunications. In the course of conducting my analysis and forming my opinions, I have considered the materials listed below:

- a. U.S. Patent No. 8,265,096 to Yan-Xiu Zheng, *et al.*, filed July 7, 2008 and issued on Sep. 11, 2012 and its file history;
- b. Qualcomm's Petition for Inter Partes Review, PTAB Case No. IPR2021-00375, and all its relevant technical exhibits;
- c. Declaration of Dr. Sumit Roy ("Roy") supporting Qualcomm's petition;
- d. U.S. Pub. No. 2009/0067377 A1 ("*Talukdar*");
- e. U.S. Pub. No. 2007/0155387 A1 ("*Li*");

- f. U.S. Pub. No. 2007/0104174 A1 (“*Nystrom*”);
- g. Certain materials from *STC.UNM v. Apple Inc.*, No. 1-20-cv-00351 (W.D. Tex. Apr. 9, 2020), including the Claim Construction Order, ECF No. 69;
- h. and any other materials referenced herein.

15. My opinions in this declaration are based on the understanding of a person of ordinary skill in the art at the time of the invention of the claims in the '096 patent.

16. In assessing the level of skill of a person of ordinary skill in the art, I have considered the type of problems encountered in the art, the prior solutions to those problems found in the prior art references, the rapidity with which innovations are made, the sophistication of the technology, the level of education of active workers in the field, and my own experience working with those of skill in the art at the time of the invention.

17. A person of ordinary skill in the art (“POSITA”) at the time of the filing of the '096 patent would typically have at least a MS Degree in Computer Engineering or Electrical Engineering, or equivalent work experience, along with at least 1 year of experience related specifically to wireless communications, including MIMO and OFDM.

18. I am very familiar with this level of skill. In the course of my decades of experience, I have supervised and worked with engineers in this field having at least the level of skill identified above.

III. LEGAL FRAMEWORK

A. Claim Construction

19. I understand that the words of a claim are generally given their ordinary and customary meaning, that is, the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention.

20. I understand that a claim term that does not use the word “means” is presumed not to be a means-plus-function term. I understand that a term that does not use the word “means” would be construed as a means-plus-function term if it does not describe structure to a POSITA. Conversely, I understand that if a term describes structure to a POSITA, it is not a means-plus-function term.

21. I understand that a patent has several components, including an abstract, drawings, a written description detailing different embodiments of the invention (*i.e.*, the specification), and numbered claims at the end of the patent. It is the numbered claims that define metes and bounds of the properties that the patentee has the right to exclude other from infringing.

B. Validity

22. I understand that a patent, once issued or granted, is entitled to a presumption of validity. However, this presumption can be overcome by clear and convincing evidence to the contrary. Validity is routinely challenged post-issuance, and courts often invalidate the patent, on the ground that the patent fails to meet one or more statutory requirements, *e.g.*, by claiming a non-patentable subject matter, such as an abstract idea, in violation of 35 U.S.C. § 101; by being not novel and anticipated by prior art under § 102; by being obvious in view of prior art under § 103; and/or lacking sufficient disclosures or being indefinite, in violation of § 112.

1. Anticipation

23. I understand that section 102 first defines “prior art” that would anticipate and, thus, invalidate the patent. The term “prior art” is a patent term of art for the technology that was known or used before the priority date of the patent, which is typically the filing date of the patent application. However, I understand that, to the extent a provisional patent application properly discloses and supports the claimed subject matter, the priority date of the claims is the filing date of the provisional application, which is considered the invention date. Thus, if the subject matter of the invention was already patented or described in a printed publication anywhere in the world before the invention claimed in the patent, such prior art would invalidate the patent. 35 U.S.C. § 102(a) (pre-AIA).

24. Anticipation is a technical defense. A patent claim is anticipated and therefore invalid under 35 U.S.C. §102, only if: a single prior art reference discloses, either expressly or inherently, each and every element of the claimed invention arranged exactly as they are arranged in the claim. If even a single element or step recited by the claim is not disclosed in exactly the same way, arranged as in the claim, there is no anticipation. In addition, the reference must enable one of skill in the art to practice an embodiment of the claimed invention without undue experimentation.

25. For an element to be present in a reference through inherency, the evidence must be clear and convincing that the missing element is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. That means that inherency cannot be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient. If, however, the disclosure is sufficient to show that the natural result flowing from the operation as taught would result in the performance of the questioned function, that disclosure could be inherent.

2. Obviousness

26. I understand that section 103 is broader than § 102 in a sense that § 103 forbids issuance of a patent even if “the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter

sought to be patented 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 person having ordinary skill in the art to which said subject matter pertains.” 35 U.S.C. § 103(a) (pre-AIA).

27. I understand that to measure obviousness under § 103, a court determines “the scope and content of the prior art,” ascertains “differences between the prior art and the claims at issue,” and resolves “the level of ordinary skill in the pertinent art.” *Graham v. John Deere Co.*, 383 U.S. 1, 17 (1966). Secondary considerations such as “commercial success, long felt but unsolved needs, failure of others . . . might be utilized to give light to the circumstances surrounding the origin of the subject matter sought to be patented.” *Id.* at 17-18; see *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 415 (2007) (“*Graham* set forth a broad inquiry and invited courts, where appropriate, to look at any secondary considerations that would prove instructive.”).

28. It is my understanding that the information that is used to evaluate whether an invention is new and not obvious is generally referred to as “prior art.” Prior art generally includes U.S. and foreign patents and U.S. and foreign printed publications (e.g., published patent applications (before issued as a patent), books, journal publications, presentation files, posters, articles on websites, product manuals, etc.) that existed before the earliest filing date (the “effective filing date”) of the claims in the patent. A patent will be prior art if it was filed before the effective filing date

of the claimed invention, while a printed publication will be prior art if it was publicly available before that date.

29. I understand that, in addition to the patents and printed publications, a product used in public or on sale in the U.S. more than one year prior to the effective filing date of a patent can be prior art to that patent. I understand that a product is considered “on sale” when (i) the product embodying the invention is offered for commercial sale, and (ii) the invention was ready for patenting. An invention is shown to be “ready for patenting” when there is proof of a reduction to practice or proof that prior to the critical date the inventor had prepared drawings or other descriptions of the invention that were sufficiently specific to enable a person skilled in the art to practice the invention.

30. It is my understanding that a claimed invention is not patentable if it would have been obvious to a person of ordinary skill in the field of the invention at the time the invention was made.

31. It is my understanding that the following standards govern the determination of whether a claim in a patent is obvious. I have applied these standards in my evaluation.

32. It is my understanding that to find a claim in a patent obvious, one must make certain findings regarding the claimed invention and the prior art. Specifically,

the obviousness question requires consideration of four factors (although not necessarily in the following order):

- a. the scope and content of the prior art;
- b. the differences between the prior art and the claims at issue;
- c. the knowledge of a person of ordinary skill in the pertinent art; and
- d. whatever objective factors indicating obviousness or non-obviousness may be present in any particular case.

33. It is my understanding that the obviousness inquiry should not be done in hindsight, but must be done using the perspective of a person of ordinary skill in the relevant art as of the effective filing date of the patent claim. The prohibition against using hindsight applies to both the invention and the identification of the problem that the invention solves.

34. It is my understanding that the obviousness inquiry may also consider certain objective indicia of non-obviousness. Such objective factors indicating obviousness or non-obviousness may include: commercial success of products covered by the patent claims; a long-felt need for the invention; failed attempts by others to make the invention; copying of the invention by others in the field; unexpected results achieved by the invention; praise of the invention by the infringer or others in the field; the taking of licenses under the patent by others; expressions

of surprise by experts and those skilled in the art at the making of the invention; and the patentee proceeded contrary to the accepted wisdom of the prior art.

35. It is my understanding that the fact finder must determine whether potential evidence of secondary considerations is relevant. With respect to evidence offered for each secondary consideration, the fact finders must ascertain whether there is a nexus between the claimed invention and the evidence establishing the secondary consideration (commercial success, industry praise, etc.) and determine the probative value of secondary-considerations evidence for rebutting a prima facie case of obviousness.

36. I understand that the obviousness analysis requires a comparison of the properly construed claim language to the prior art on a limitation-by-limitation basis. Obviousness relies on an expansive and flexible approach using common sense. Patents may not claim nothing more than combinations of known elements driven by non-innovative factors such as market demands. Only if a person of ordinary skill in the art can implement the claimed invention as a predictable variation of a known invention without undue experimentation, it is obvious. Also, “hindsight” reconstruction cannot be used to combine references together to reach a conclusion of obviousness.

37. It is my understanding that exemplary rationales that may support a conclusion of obviousness include:

- a. combining prior art elements according to known methods to yield predictable results;
- b. simple substitution of one known element for another to obtain predictable results;
- c. use of known techniques to improve similar devices (methods or products) in the same way;
- d. applying a known technique to a known device (method or product) ready for improvement to yield predictable results;
- e. “obvious to try,” *i.e.*, choosing from a finite number of identified, predictable solutions with a reasonable expectation of success;
- f. known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations would have been predictable to one of ordinary skill in the art; and
- g. some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

38. Thus, when considering a prior art reference for purposes of an obviousness analysis, the reference must be taken for everything it teaches.

39. I understand that a claim might 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 knowledge of one skilled in the art, including the common sense of one of skill in the art.

40. An obviousness evaluation can also be based on a combination of multiple prior art references. The prior art references themselves may provide a suggestion, motivation, or reason to combine, but other times the nexus linking two or more prior art references is simple common sense. I further understand that an 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.

41. I understand that practical and common-sense considerations should guide a proper obviousness analysis, because familiar items may have obvious uses beyond their primary purposes. A person of ordinary skill in the art looking to overcome a problem will often be able to fit the teachings of multiple publications together like pieces of a puzzle. An obviousness analysis, therefore, takes into account the inferences and creative steps that a person of ordinary skill in the art would employ under the circumstances.

42. I understand that a particular combination may be proven obvious merely by showing that it was obvious to try the combination. For example, when there is

a design need or market pressure to solve a problem and there are a finite number of identified, predictable solutions, a person of ordinary skill has good reason to pursue the known options within his or her technical grasp because the result is likely the product not of innovation but of ordinary skill and common sense which led to a reasonable expectation of success.

43. It is my understanding that the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. When a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or a different one.

44. I understand that when a patent simply arranges old elements with each performing the same function it had been known to perform and yields no more than one of ordinary skill in the art would reasonably expect from such an arrangement, the combination is obvious. A proper obviousness analysis focuses on what was known or obvious to a person of ordinary skill in the art, not just the patentee. Accordingly, 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.

45. In sum, it is my understanding that prior art teachings are properly combined where a person of ordinary skill in the art, 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, or any need or problem known in the relevant field at the time of the invention, can provide a reason for combining the elements of multiple prior art references in the claimed manner. But, as stated previously, I understand that “hindsight” reconstruction cannot be used to combine references together to reach a conclusion of obviousness.

IV. THE '096 PATENT (EX1001]

A. Technical Background

46. The invention of the '096 patent relates to methods for constructing frame structures in orthogonal frequency-division multiple access (OFDMA) systems. EX1001, 1:16-19. “Orthogonal Frequency Division Multiple Access (OFDMA) is a multiple access scheme for transmitting data in different subcarriers in a channel, wherein the data may come from different users and may be transmitted in disjoint subsets of sub-channels in a transmission bandwidth.” *Id.*, 1:22-24.

47. The '096 patent first describes the prior art. *Id.*, Figs 1 (illustrating an OFDMA frame structure under the IEEE 802.16 standard) and 2 (illustrating a placement of guiding signals (or pilot symbols) 24-1 for time-domain and frequency-domain OFDMA signals under the IEEE 802.16 standard).

48. “Referring to FIG. 2, upper and lower frequency bands may serve as guard bands 22-1 and 22-2, respectively, which may not be used to carry information.” *Id.* 1:61-63. “The placement of information may include a first part and a second part. For example, the first part of the placement includes a preamble 10'-1 having a fixed length, and the second part of the placement includes data and guard intervals between an upper row and a lower row of the data interlaced with the pilot symbols 24-1, represented by blocks marked with ‘X’.” *Id.*, 1:63-2:2.

49. Then, '096 patent illustrates problems faced by the prior art, including that: “[i]n some applications such placement of information may be inflexible to bandwidth scaling due to the fixed-length preambles 10'-1 and/or 10'-2 and the often unusable guard bands 22-1 and 22-2. Moreover, the placement may be susceptible to a Doppler effect in a high mobility scenario because the placement may be usually designed with a relatively large symbol period, which in turn may induce relatively short carrier spacing and less dense pilot symbol placement. Moreover, the limitation on pilot symbol placement may cause channel estimation error at a receiving end because of insufficient information provided for channel estimation.” *Id.*, 2:2-14.

50. The invention of the '096 patent directly addresses these problems. For example, the '096 patent discloses “a method for constructing a frame structure for data transmission, the method comprising generating a first section comprising data configured in a first format compatible with a first communication system,

generating a second section following the first section comprising data configured in a second format compatible with a second communication system, wherein the second format is different from the first format, generating at least one non-data section containing information describing an aspect of data in at least one of the first section and the second section, and combining the first section, the second section and the at least one non-data section to form the frame structure.” *Id.*, at 2:18-30. The patent further details other examples of its invention. *Id.*, 2:31-54, 2:55-67, 3:1-13, and 3:14-32.

51. The invention of the '096 patent enables “data of an old orthogonal frequency-division multiple access (OFDMA) system (hereinafter a legacy system) and data of a new OFDMA system to co-exist in an OFDMA frame by changing a frame structure of the OFDMA frame.” *Id.*, 4:21-25. The new system has the advantages of allowing larger bandwidth, higher mobility, and may use updated transmission technology while maintaining backward compatibility. *Id.*, 4:26-30.

B. Claim 1

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

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

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

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

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

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

C. Claim 2

2. The method of claim 1, wherein the non-data section comprises mapping information for at least one of the first section and the second section.

D. Claim 3

3. The method of claim 1, wherein the non-data section comprises at least one of a preamble, a frame control header 60 (FCH), a burst, and a map of at least one of the first section and the second section.

E. Claim 4

4. The method of claim 3, wherein the second section follows the first section in at least one of time sequence and frequency spectrum.

F. Claim 6

6. The method of claim 1, wherein each of the first section and the second section carries at least one of uplink and downlink data.

G. Claim 7

7. The method of claim 1, wherein the second section carries mapping information for data in the second section.

H. Claim 8

8. A method of constructing a frame structure for data transmission, the method comprising:

- a.** generating a first section comprising data configured in a first format compatible with a first communication system using symbols;
- b.** generating a second section following the first section, the second section comprising data configured in a second format compatible with a second communication system using symbols, wherein the first communication system's symbols and the second communication system's symbols co-exist in one transmission scheme and wherein the second communication system has pilot symbols that are denser than those in the first communication system;
- c.** generating at least one non-data section containing information describing an aspect of data in at least one of the first section and the second section; and
- d.** combining the first section, the second section and the at least one non-data section to form the frame structure.

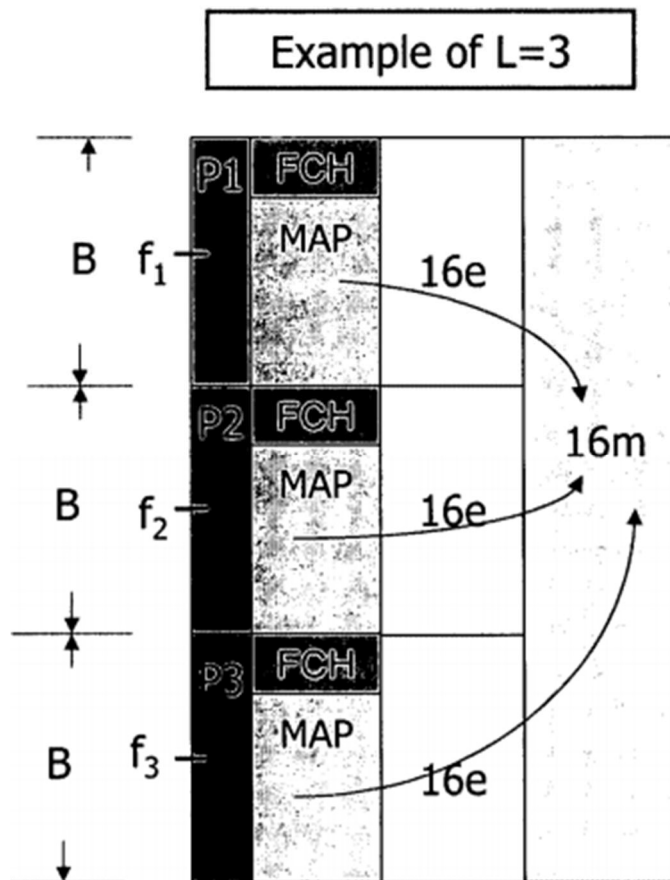
I. Priority Date – Based on Provisional Application dated 2007/07/11

52. The '096 patent derives priority from two related provisional applications. Specifically, provisional application No. 60/929,798, filed on Jul. 12, 2007, and provisional application No. 60/973,157, filed on Sep. 17, 2007. I have specifically reviewed the provisional application to determine whether the subject matter claimed in the '096 patent is disclosed therein. The following table explains in detail how the claimed subject matter is in fact disclosed in the original provisional patent application.

claim element	support in provisional No. 60/929,798
1. A method of constructing a frame structure for data transmission, the method comprising:	The provisional application discloses a method of constructing a frame structure for data transmission. The frame structure specifically supports the frame structure of 802.16m, while also ensuring backward compatibility with legacy systems. ¶ Backward compatibility • 802.16m shall be backward compatible with legacy system 802.16e • Systems based on IEEE 802.16m and 802.16e systems shall be able to operate on the same RF carrier, with the same channel bandwidth; and should be able to operate on the same RF carrier with different channel bandwidths. ¶ It is necessary to devise the frame structure of 802.16m frame supporting backward compatibility EX2002 ('096 Provisional) at 2. Exemplary frame structures are provided in the disclosure. EX2002 ('096 Provisional) at 3, 7.

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

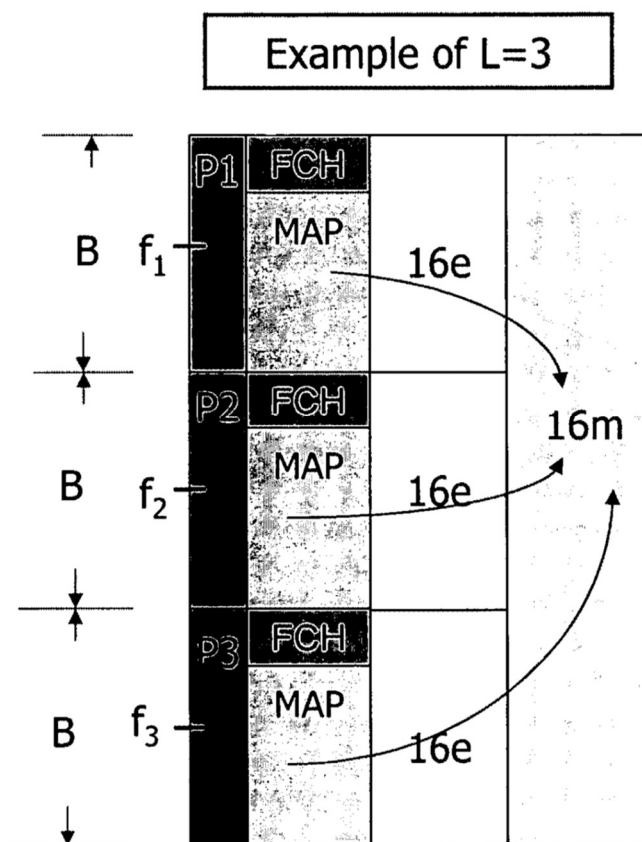
The provisional discloses a first section comprises data configured in a first format compatible with 802.16e:



EX2002 ('096 Provisional) at 2.

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

The provisional discloses a second section in a second format compatible with 802.16m, which follows the first section compatible with 802.16e in one transmission scheme.



EX2002 ('096 Provisional) at 3.

Structure A

- An OFDMA system with multiple zones

EX2002 ('096 Provisional) at 8.

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

The provisional discloses that the second format compatible with 802.16m is designed to support higher mobility, *i.e.*, speed at which the mobile unit is moving, and uses symbols that are shorter (*i.e.* the bandwidth is larger) than the symbols in 802.16e.

- ✦ New standard 802.16m is being developed for next generation wireless communication
 - Enhanced spectrum efficiency
 - Higher speed

EX2002 ('096 Provisional) at 2. Both, “spectrum efficiency” and “higher speed” are advantages of the second communication system. The former implies higher data speed, which clarifies the meaning of “higher speed” as referring to a higher velocity mobile unit.

- ✦ Frequency planning
 - Occupy the same band class as 802.16e
 - A 802.16m channel uses multiple (L) contiguous 802.16e channels
 - L BS's share the same 802.16m zone with L*B bandwidth (802.16e BW with B)

EX2002 ('096 Provisional) at 3.

A POSITA would have known at the time of the provisional application that by use of the following formulas a “shorter symbol period” can be shown for the second system.

N = number of subcarriers

K = number of samples in the cyclic prefix

$$T_s = \frac{N + K}{3B}$$

$$T_{sL} = \frac{N_L + K_L}{B}$$

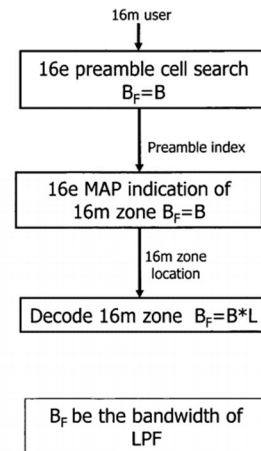
Where T_s is the symbol period of the second system and T_{sL} is the symbol period of the legacy system.

By explicitly disclosing that the bandwidth of the second system is larger, the provisional application clearly supports the claim requirement that the second system has a shorter symbol period.

Proposed structure A

Cell search by 16m user

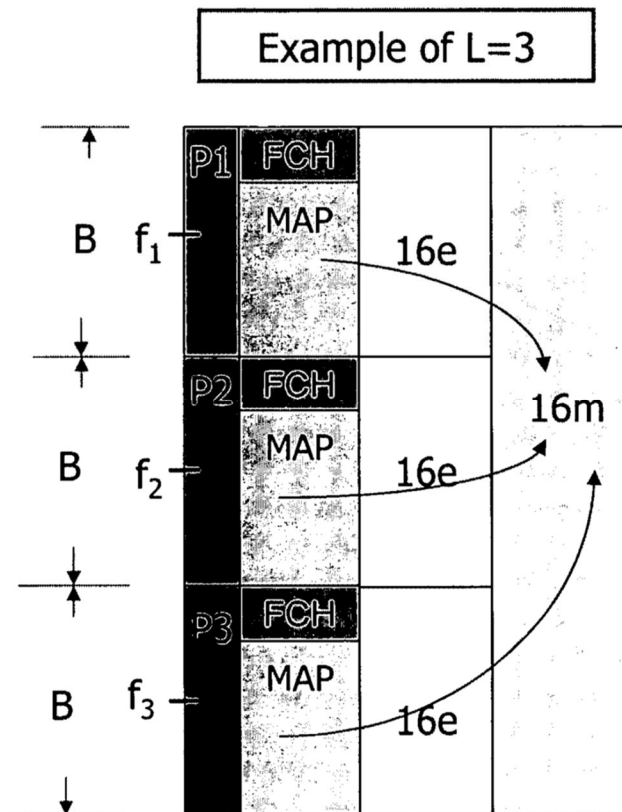
- Baseband BW of $L*B$
- Detect 16e preamble with BW of B
- Decode FCH/MAP to decide the location of 16m zone
- Retrieve 16m zone with BS with BW of $L*B$



EX2002 ('096 Provisional) at 4.

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

The provisional discloses legacy sections, *e.g.*, MAPs, which correspond to at least one non-data section containing information describing an aspect of data in at least one of the first section and the second section. The FCH (frame control header) and preambles (*e.g.*, P1, P2, P3) also comprise non-data sections.



EX2002 ('096 Provisional) at 3.

Cell search by 16m user

- Baseband BW of $L \cdot B$
- Detect 16e preamble with BW of B
- Decode FCH/MAP to decide the location of 16m zone

EX2002 ('096 Provisional) at 4.

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

The provisional discloses a composite frame, which combines 802.16e and 802.16m sections plus MAP, FCH, and preamble sections (Pi's).

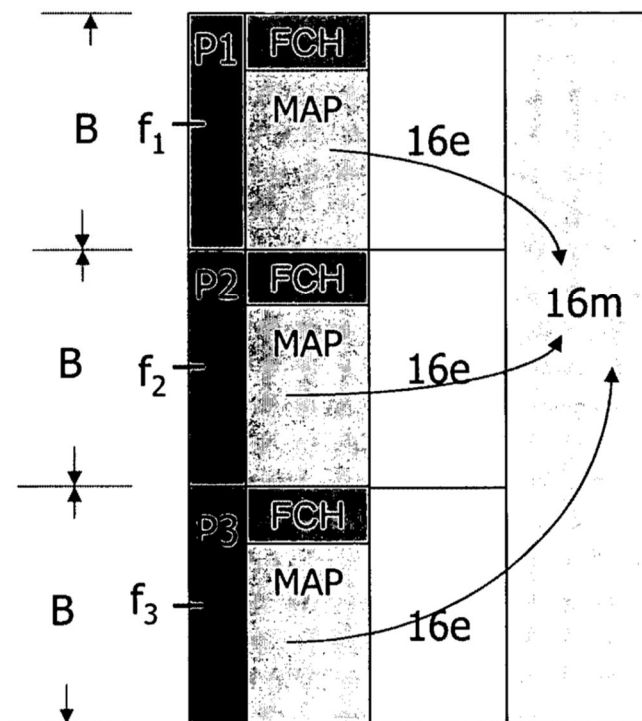
⚡ Backward compatibility

- 802.16m shall be backward compatible with legacy system 802.16e
- Systems based on IEEE 802.16m and 802.16e systems shall be able to operate on the same RF carrier, with the same channel bandwidth; and should be able to operate on the same RF carrier with different channel bandwidths.

⚡ It is necessary to devise the frame structure of 802.16m frame supporting backward compatibility

EX2002 ('096 Provisional) at 2.

Example of L=3

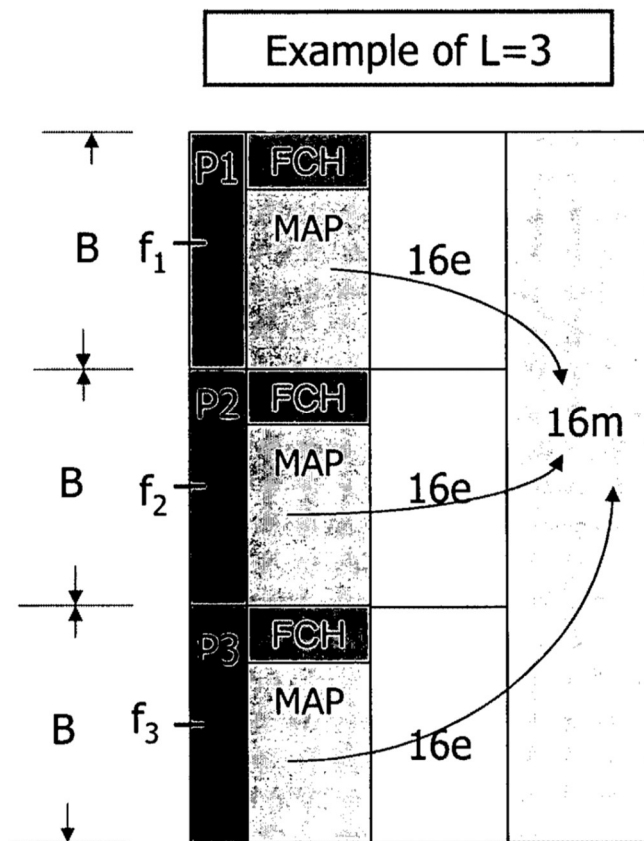


EX2002 ('096 Provisional) at 3.

2. The method of claim 1, wherein the non-data section comprises mapping information for at least one of the first section and the second section.	The provisional discloses a non-data section which comprises MAPs that represent mapping information. • Backward compatibility ○ 16e preamble/FCH/MAP are kept unchanged ○ Only new DL (UL) 16m zones are appended (resource allocation is done by BS cooperation) EX2002 ('096 Provisional) at 3. • 16m service detection ○ Detection of 16e preamble/FCH/MAP, or ○ Detection of 16m preamble/FCH/MAP EX2002 ('096 Provisional) at 6.
3. The method of claim 1, wherein the non-data section comprises at least one of a preamble, a frame control header (FCH), a burst, and a map of at least one of the first section and the second section.	The provisional discloses a non-data section which comprises at least one of a preamble, a frame control header (FCH), a burst, and a map of at least one of the first section and the second section. • Backward compatibility ○ 16e preamble/FCH/MAP are kept unchanged ○ Only new DL (UL) 16m zones are appended (resource allocation is done by BS cooperation) EX2002 ('096 Provisional) at 3.

4. The method of claim 3, wherein the second section follows the first section in at least one of time sequence and frequency spectrum.

The provisional discloses a second section in a second format compatible with 802.16m, which follows the first section compatible with 802.16e in one transmission scheme.



EX2002 ('096 Provisional) at 3.

6. The method of claim 1, wherein each of the first section and the second section carries at least one of uplink and downlink data.

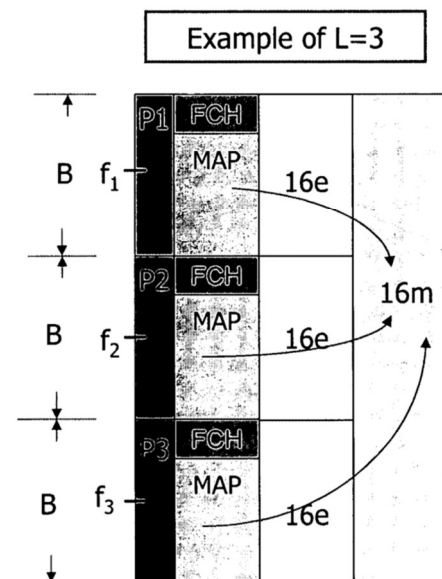
The provisional discloses a frame structure where each of the first section and the second section carries at least one of uplink and downlink data. For example, the provisional specifically discloses an OFDMA frame structure where multiple base stations transmit downlink (DL) 16e data in the first section using subcarriers with bandwidth B and in the second section transmit the DL 16m data by sharing the subcarriers on bandwidth B*L.

The provisional application refers to “16e” in the proposed structure A on page 3. A POSITA would understand that the “16e” section includes DL or UL data because these systems transmit in both directions. EX2002 ('096 Provisional) at 3.

The provisional also refers to “...[n]ew DL (UL) 16m zones are appended”. EX2002 ('096 Provisional) at 3. A POSITA would understand that these new DL (UL) 16m zones carry downlink and uplink data.

BS cooperation

- 16e BS's transmit 16e data using subcarriers with BW B of their own, while share subcarriers with BW B*L in 16m zone.



	EX2002 ('096 Provisional) at 3.
7. The method of claim 1, wherein the second section carries mapping information for data in the second section.	The provisional discloses a frame structure wherein the second section carries mapping information for data in the second section. ⌘ Backward compatibility • 16e preamble/FCH/MAP are kept unchanged • Adjust the duty cycle so that 16e subframes are shorten in a frame with the other unused portion left for 16m service • 16m data can be informed by 16e MAP. In case 16e signal can not provide information of 16m service, 16m preamble is optionally given to 16m user for cell search ⌘ BS cooperation • 16e/16m BS's share the same BW with TDMA-like approach • 16e zone can vanish if 16m preamble is given ⌘ 16m service detection • Detection of 16e preamble/FCH/MAP, or • Detection of 16m preamble/FCH/MAP EX2002 ('096 Provisional) at 6. ⌘ Example of a multi-standard frame option p1: 16e preamble p2: 16m preamble EX2002 ('096 Provisional) at 7.

8. A method of constructing a frame structure for data transmission, the method comprising:	<i>See</i> 1 preamble.
a. generating a first section comprising data configured in a first format compatible with a first communication system using symbols;	<i>See</i> 1a.
b. generating a second section following the first section, the second section comprising data configured in a second format compatible with a second communication system using symbols, wherein the first communication system's symbols and the second communication system's symbols co-exist in one transmission scheme and wherein the second communication system has pilot symbols that are denser than those in the first communication system;	<i>See</i> 1b. I understand that the District Court in <i>UNM Rainforest Innovations v. Apple Inc.</i> , No. 1-20-cv-00351 (W.D. Tex.) construed the claim term “pilot symbols that are denser than” as “more pilot symbols per unit time than, wherein a unit time is the symbol period of the first communication system.” EX1011 (Apple Claim Construction Order). Given that construction, the provisional discloses the limitation regarding pilot density by pointing to increased density (in the temporal dimension) as a natural result of reduced symbol period – as shown above. Further, the goal of achieving “higher speed” in conjunction with the proposed dual-system frame structure would suggest modifying density of pilots in one of the systems as a solution to the problem caused by increased Doppler shifting due to high speed.
c. generating at least one non-data section containing information describing an aspect of data in at least one of the first section and the second section; and	<i>See</i> 1d.

d. combining the first section, the second section and the at least one non-data section to form the frame structure.	See 1e.
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53. It is therefore my opinion that the challenged claims of the '096 patent are fully supported by the provisional patent applications from which it claims priority. A POSITA would have known all elements of the '096 inventions of claims 1-8 from the provisional disclosure. I understand that the priority of the '096 should thus be considered the filing date of the provisional application No. 60/929,798, which is Jul. 12, 2007.

V. CLAIM CONSTRUCTIONS

A. “*at least one of [...] and [...]*”

54. I understand that the litigants in *UNM Rainforest Innovations v. Apple Inc.*, No. 1-20-cv-00351 (W.D. Tex.) agreed that the claim term “at least one of [...] and [...]

” should be construed as “[...] and/or [...].” EX1011 (Apple Claim Construction Order). I have applied this construction.

B. “*symbol period*”

55. I understand that the litigants in *UNM Rainforest Innovations v. Apple Inc.*, No. 1-20-cv-00351 (W.D. Tex.) agreed that the claim term “symbol period” should be construed as “the time it takes to transmit one symbol.” EX1011 (Apple Claim Construction Order). I have applied this construction.

C. District Court Constructions

56. I understand that the Court in *UNM Rainforest Innovations v. Apple Inc.*, No. 1-20-cv-00351 (W.D. Tex.) construed a number of claim terms. EX1011 (Apple Claim Construction Order). I have applied the court’s constructions, which are replicated here.

Term	Construction
Whether the preambles for all asserted claims are limiting	Each preamble is limiting
“frame structure”	“a single structure comprising one or more frames, wherein each frame may have one or more subframes”
“symbol”	Plain-and-ordinary meaning, wherein the plain-and-ordinary meaning means “a transmissible unit of information”
“pilot symbols that are denser than”	“more pilot symbols per unit time than, wherein a unit time is the symbol period of the first communication system”
“[first & second] communication system”	Construction for “communication system”: Plain-and ordinary meaning, where the plain-and-ordinary meaning is “a combination of hardware and software that transmits and receives data according to one or more communications standards”
“wherein the first communication system’s symbols and the second communication system’s symbols co-exist in one transmission scheme”	Plain-and-ordinary meaning where the plain-and-ordinary meaning is “wherein symbols of the first communication system and symbols of the second communication system exist together in one transmission scheme”
“data” / “non-data”	Data: Plain-and-ordinary meaning Non-data: Plain-and-ordinary meaning
“support higher mobility than”	Not indefinite. “support higher relative velocity between a transmitter and a receiver than”

VI. VALIDITY ANALYSIS

57. I understand that Qualcomm argues the following grounds of obviousness:

Ground	Allegation of Invalidity	Claims
1	35 U.S.C. § 103 based on <i>Talukdar</i> and <i>Li</i>	1-4, 6-7
2	35 U.S.C. § 103 based on <i>Talukdar</i> and <i>Nystrom</i> (EX1017)	8

58. Below is my analysis of the asserted prior art references and my opinion as to what they do and do not disclose.

A. Talukdar is Not Prior Art

59. My understanding is that the earliest possible priority date of *Talukdar* is Aug. 15, 2007, based on the filing date of its provisional application No. 60/956,031. This date is later than the priority date of the '096 patent. Based on my review of provisional application No. 60/929,798, filed on Jul. 12, 2007, as detailed in *Section IV.I. entitled "Priority Date – Based on Provisional Application dated 2007/07/11"* *infra*, the challenged claims of the '096 patent are fully supported by the provisional application. In my opinion, *Talukdar* is thus not prior art to the '096 patent.

B. The Combination Of Talukdar And Li Does Not Disclose Or Suggest All Elements Of Claims 1-4, 6, And 7.

1. Claim 1

a) 1b: “generating a second section following the first section, the second section comprising data configured in a second format compatible with a second communication system using symbols, wherein the first communication system’s symbols and the second communication system’s symbols co-exist in one transmission scheme”

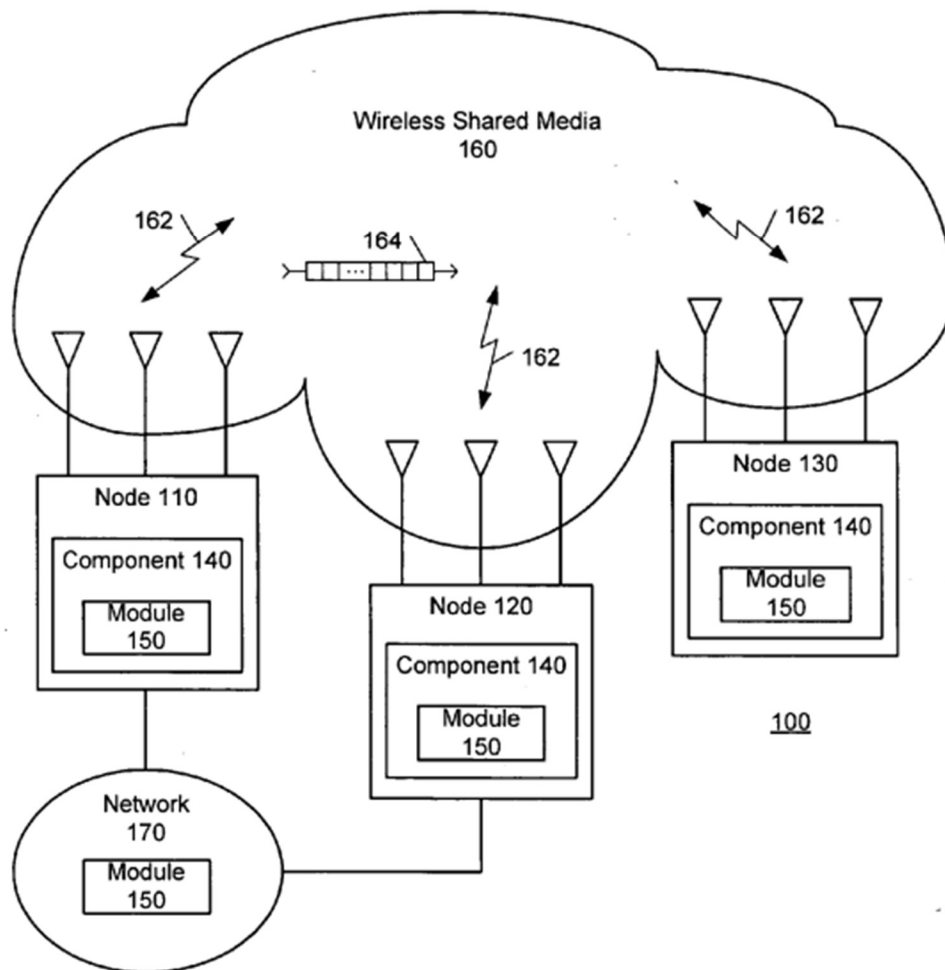
60. Regarding limitation 1b, in paragraph 123, Dr. Roy states that *Li* disclosed that “the first communication system’s symbols and the second communication system’s symbols co-exist[ed] in one transmission scheme.” I disagree with this conclusory and incorrect statement, for which there is no support in *Li*.

61. A POSITA would understand the limitations of claim 1 to require that each one transmission scheme corresponds to one frame transmission. Dr. Roy agrees (“both 802.16(e) and 802.16(m) used OFDM/OFDMA symbols and were part of one transmission scheme (same frame).”). EX1002¶122. A POSITA would also understand that one transmission scheme (same frame) includes a 1st and 2nd segments, respectively, carrying symbols of the 1st and 2nd communication systems, that correspond to at least somewhat different radio protocols, such as 802.16e and 802.16m, two versions of the WiMAX protocol, as described in various embodiments of the ’096 patent. EX1001, 1:16-35.

62. *Li* allows that Network 170 in Fig. 1 below may include nodes 110, 120, and 130, *e.g.*, access point, base station, or Node B, etc., such that each node may

possibly correspond to a different communication system, *e.g.*, Wi-Fi, cellular, etc. See *e.g.* EX1016¶¶26-27. *Li* does not disclose anywhere that any particular of these nodes may include multiple communication systems and communicate with two or more sets of subscribers where the subscribers in the two sets use different communication systems.

FIG. 1



EX1016, Fig. 1.

63. Indeed, in embodiments of Figs. 3-7, in which *Li* describes how slow and fast users could use different symbol durations, all descriptions are always in the context of only one communications system, 802.16e, as shown by the excerpts below.

FIGS. 3-7 more specifically describe, for example, a frame structure and the arrangement of the communications system 100 and/or node 110 to generate the frame structure. For example, FIG. 3 illustrates a frame 300 according to the current IEEE 802.16e draft standard for which the Subcarrier spacing is constant for all Subscribers in the cell.

EX1016¶33.

FIG. 5 illustrates the time-frequency location of a fast subscriber of an embodiment for Band AMC of 802.16e. In an embodiment, a Subscriber is first categorized as to its speed.

EX1016¶36.

FIG. 6 illustrates the time-frequency location and grouping of multiple fast Subscribers of an embodiment. The frequency-time Zones of the fast Subscriber symbols according to the 802.16e draft standard are usually scattered in each frame as illustrated in frame 600 by fast subscribers 610-630.

EX1016¶40.

64. That is, in *Li*, all subscribers, slow and fast, are operating within the context of a single communication standard, 802.16e, contrary to Dr. Roy's statement.

65. Also in paragraph 123, Dr. Roy again mischaracterizes *Li*, by describing that Fig.5 in *Li* discloses one frame with long and short symbols:

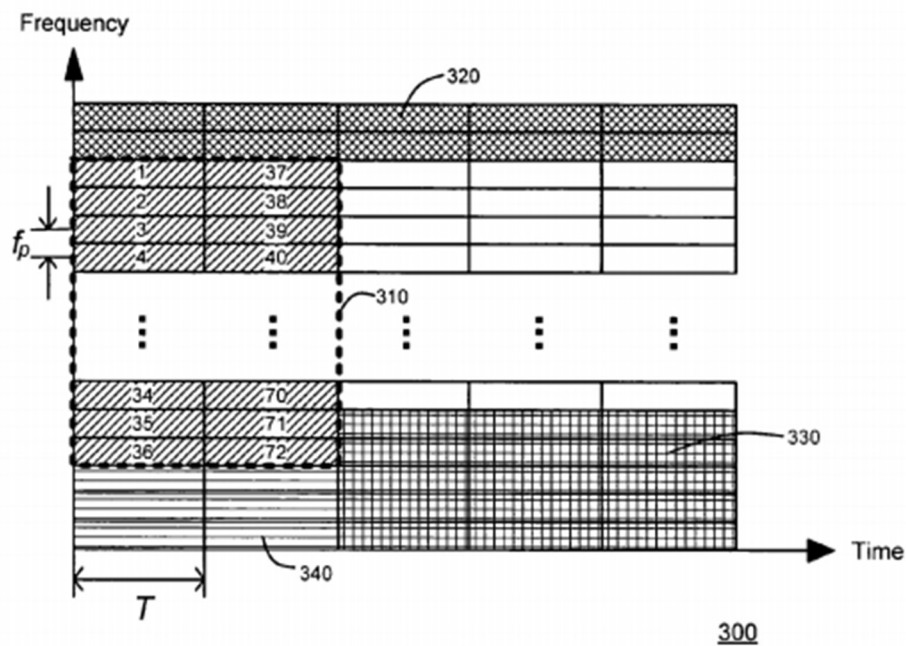
Referring to Figure 5 of *Li*, *Li* disclosed one embodiment in which a frame included symbols for a slower subscriber station with a symbol

period of T , and symbols for a faster subscriber station with a symbol period half as long, $T/2$: ‘In an embodiment, the communications system 100 and/or node 110 *assigns the even OFDM subcarriers (e.g., $N/2$ nonadjacent subcarriers) to a fast subscriber and shortens the symbol duration from T to $T/2$.*’)

EX1002¶123 (emphasis in original). I disagree with Dr. Roy’s characterization, as detailed below.

66. Embodiments in *Li* disclose that one individual frame has a fixed—*i.e.* the same—symbol duration and subcarrier spacing throughout the frame, as shown by the excerpts below.

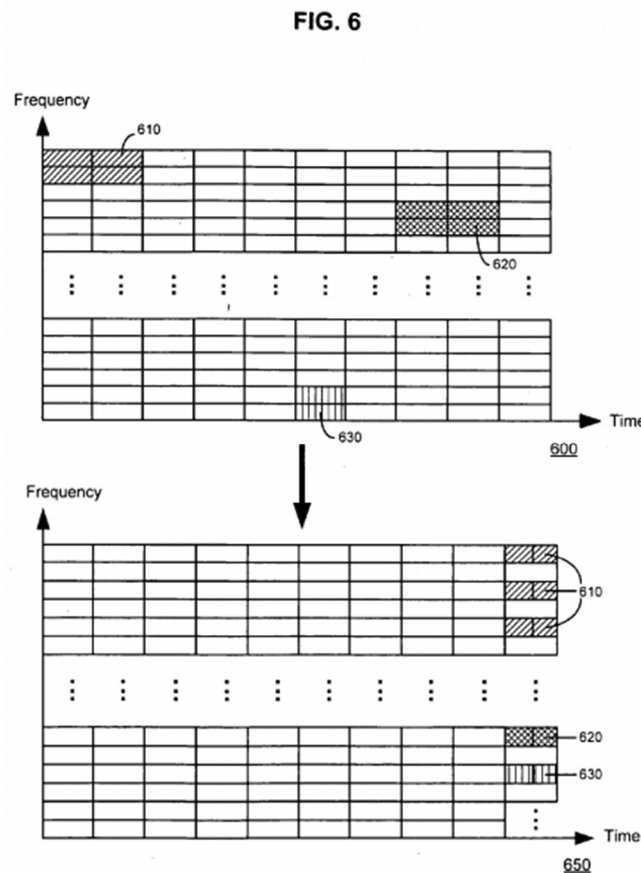
FIG. 3



EX1016, Fig. 3.

FIGS. 3-7 more specifically describe, for example, a frame structure and the arrangement of the communications system 100 and/or node 110 to generate the frame structure. For example, FIG. 3 illustrates a frame 300 according to the current IEEE 802.16e draft standard for which the subcarrier spacing is constant for all subscribers in the cell. Each block of frame 300 represents one QAM symbol carried by one subcarrier to a subscriber and different fill patterns represent the frequency-time zones assigned to multiple subscribers. For example, subscribers 310-340 have frequency-time zones assigned as illustrated. Furthermore, the frequency-time zones have been assigned to the subscribers 310-340 regardless of their speed. Said alternatively, while some subscribers may be mobile and other subscribers may be stationary, that distinction does not determine the frequency-time zone to which the subscribers 310-340 respective symbols are assigned.

EX1016¶33.



EX1016, Fig. 6.

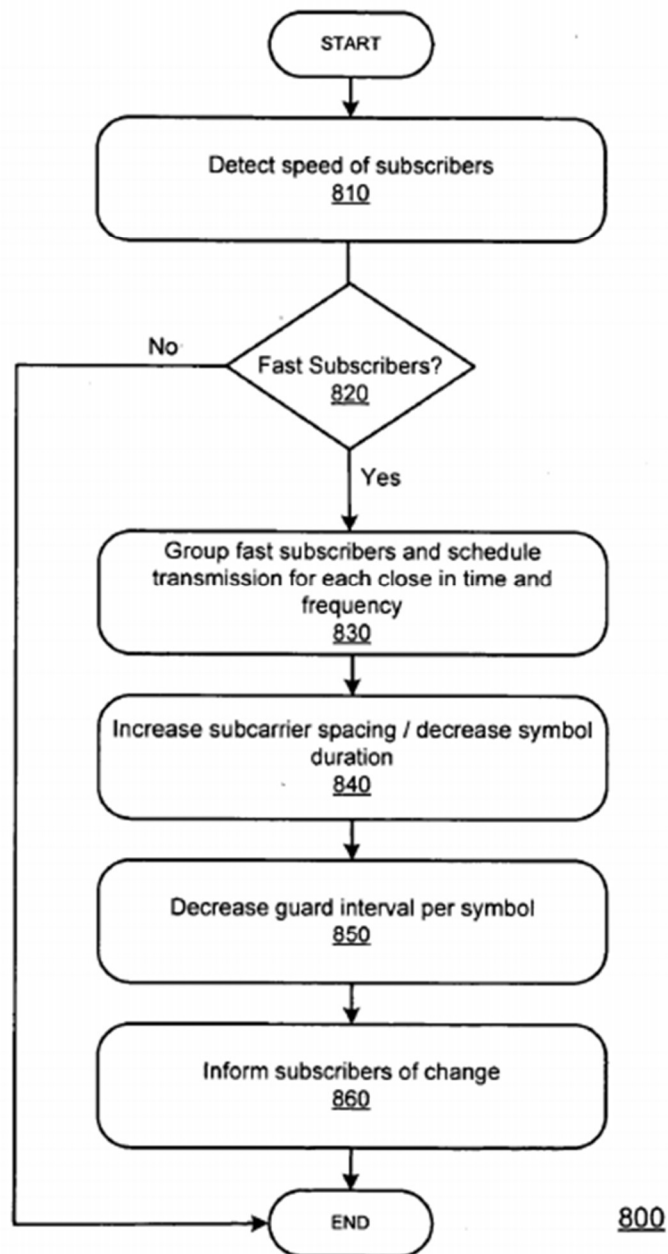
FIG. 6 illustrates the time-frequency location and grouping of multiple fast subscribers of an embodiment. The frequency-time zones of the fast subscriber symbols according to the 802.16e draft standard are usually scattered in each frame as illustrated in frame 600 by fast subscribers 610-630.

EX1016¶40.

67. Nowhere in the description of Fig. 5 of *Li*, cited by Dr. Roy and characterized by him as representing one frame with long and short symbols, is disclosed that it is one frame with two segments with long and short symbols. In addition to citations provided above, it is also clear, from Fig. 8 and the corresponding description of Fig. 8 replicated below, that fast users are grouped in one frame. What Fig. 5 symbolically shows is actually two frames corresponding to two time intervals such that in the first time interval/frame, slow users are scheduled and subsequently in next time interval/frame, fast users are scheduled.

68. Figure 8 supports this interpretation:

FIG. 8



EX1016, Fig. 8.

FIG. 8 illustrates one embodiment of a logic flow. FIG. 8 illustrates a logic flow 800 in accordance with one embodiment. At 810, the speed of a subscriber is detected. The subscriber speed can be

detected by measuring the Doppler spread of the subscriber's OFDMA uplink signal, the delay spread of the OFDMA uplink signal, the intercarrier interference, or a combination thereof. The subscriber can thereafter be classified at 820 as a fast subscriber or a slow subscriber based on its speed compared to a threshold speed or speed relative to other subscribers. Thereafter for a fast subscriber, at 830 the subscriber is grouped with other subscribers of the same speed classification. For example, if the subscriber is classified as a fast subscriber, transmission to the fast subscriber can be scheduled closely (e.g., close or adjacent portions of the OFDM frame in time-frequency). For fast subscribers, at 840 the subcarrier spacing for the transmission is increased and the OFDM symbol duration is decreased. Further, at 850, the guard interval for each shortened OFDM symbol is itself shortened. As noted, the OFDM signal for the fast subscribers may have a shorter delay spread enabling the guard interval for each symbol thereof to be shortened. As a result, the total guard interval for transmission to a fast subscriber with shorter symbol length and increased subcarrier spacing would be substantially the same. Accordingly, the transmission to the fast subscriber would have substantially the same data rate as transmissions to slow subscribers. Finally, at 860 all subscribers are informed of the change to the subcarrier spacing and symbol duration. For example, a downlink frame header or pilot location may be used to inform the subscribers when and where the change starts.

EX1016¶42.

69. Thus, as shown above, Dr. Roy mischaracterized *Li*, which only discloses long and short symbols, respectively, for slow and fast moving users, but only within one communication system, 802.16e. Moreover, long symbols belong to one frame and short symbols to another frame.

70. I similarly disagree with Dr. Roy's statements in paragraph 124 that "[a] POSA would have understood Figure 5 of *Li* to depict an OFDM frame, comprising

a number of subcarriers (shown as elements on the frequency axis) and extending across some number of symbols (shown as elements on the time axis),” as I explained above. EX1002¶124.

71. I also disagree with Dr. Roy’s statements in paragraph 124 that “[a] POSA would have found it obvious to incorporate this teaching, of a frame that included symbols for slower moving stations (each a “first communication system”) and faster-moving stations (each a “second communication system”) into *Talukdar* in connection with 1[c], as discussed below” based on explanations I provided above. The explanations Dr. Roy provided are based on multiple mischaracterizations of *Li*, as elaborated above, and a POSITA would not understand the reference in that way.

72. Further, in my opinion, a POSITA would not find it obvious to combine the teachings in *Li* into *Talukdar* because *Li* is a single communications system, and uses separate frames for slow and fast users with long and short symbols, respectively, and as such is incompatible with *Talukdar*. Dr. Roy did not explain how these incompatibilities would be resolved with a redesign of *Talukdar*, which, in my opinion, would be a non-trivial undertaking. In my opinion Dr. Roy thus failed to show that *Li* cures the deficiencies of *Talukdar* in regard to this claim element.

b) 1c: “the second format is compatible with the second communication system configured to support higher mobility than the first communication system”

73. I disagree with Dr. Roy’s speculative analysis in paragraph 126. *Talukdar* does not disclose high and low mobility. Dr. Roy’s citation to *Ahmadi* (EX1018) does not cure *Talukdar*’s deficiency. EX1002¶125. *Ahmadi* merely references that the next generation WiMAX systems (IEEE 802.16m) generally aimed at supporting high mobility and low latency applications: “Embodiments of the invention may enable the next generation of mobile WiMAX systems (e.g., based on IEEE 802.16m standard) to efficiently support substantially high mobility and low latency applications” EX1018¶27. *Ahmadi* provides no detail beyond that general statement of the purpose of the next generation WiMAX system that would disclose or suggest to a POSITA the detailed claim limitation of the ’096 patent.

74. In paragraph 127, Dr. Roy states that this claim element is obvious based on *Talukdar* alone, because “a POSA would have found it obvious to try generating a hybrid frame configured in any one of these limited ways”. EX1002¶127. I disagree. Dr. Roy is using impermissible hindsight and is essentially using the ’096 patent itself as a roadmap to arrive to his obviousness proposition, *i.e.*, the invention of the ’096 patent. In my opinion, Dr. Roy’s opinion regarding obviousness of this claim limitation is not correct based on the limited disclosure in *Talukdar*. A significantly more detailed disclosure would have been required to allow a POSITA

to arrive at and realized the importance of this inventive feature without knowledge of the '096 invention itself.

75. To address the deficiencies of *Talukdar*, Dr. Roy again brings certain teachings of *Li*. However, in paragraphs 128-138, Dr. Roy is relying on the same mischaracterizations of *Li* which I have addressed above in relation to limitation 1.b and fully incorporate here by reference. EX1002¶¶128-138. I again disagree with his analysis for several reasons.

76. First, in paragraph 128 Dr. Roy makes a conclusory statement without proper support that “[e]ach of *Li*’s faster-moving subscriber stations was a ‘second communication system configured to support higher mobility than’ *Li*’s fixed or slower-moving subscriber stations, which were each ‘[a] first communication system.’” EX1002¶128. I disagree. As shown above, in *Li* both slow and fast subscribers used the same communication system, 802.16e.

77. Likewise, I disagree with Dr. Roy’s statement that “[a]s with *Talukdar* alone, *Talukdar* in combination with *Li* thus rendered obvious the part of 1[c] that recites ‘wherein: the second format is compatible with the second communication system configured to support higher mobility than the first communication system.’” EX1012¶129. As I explained above, this part of limitation 1.c is not obvious in view of *Talukdar* alone, nor by the combination of *Talukdar* and *Li* without the improper use of hindsight. Moreover, if one brings the fast moving 802.16e user into the

second part of the frame in *Talukdar*, then *Talukdar* (combined with *Li*) would have the same communication system, 802.16e in both parts of the frame, and the relevant part of limitation 1.c could not be met.

78. Dr. Roy, in paragraph 133, again mischaracterizes *Li* (“*Li* therefore disclosed a ‘second communication system configured to support higher mobility than the first communication system’—a mobile subscriber station that was faster-moving than a fixed or slower moving mobile station—and *Li* further disclosed that the symbols used by the faster stations had a shorter symbol period than those used by the slower stations.”). EX1002¶133. I again disagree for the reasons I explained above, *i.e.*, that both low and high mobility users employ the same system, 802.16e.

79. In paragraph 135 Dr. Roy, repeats these arguments that I disagreed with, and concludes “a POSA would have understood *Li*’s disclosure as providing an express teaching, suggestion, or motivation to modify *Talukdar* by using shorter symbol periods for faster-moving 802.16(m) remote units.” EX1002¶135. I disagree for the same reasons I explained in response to his paragraphs 127-128 and 133.

80. Likewise, in paragraphs 136-138 Dr. Roy recycles the same theories about obviousness of 1.c by combination of *Talukdar* and *Li*, that fail, as I have already explained above.

81. Consequently, for the same reasons, I also disagree with Dr. Roy's conclusion in paragraph 138: "Modifying *Talukdar* to incorporate the identified teachings of *Li* would have involved combining known techniques—incorporating faster-moving mobile stations and using shorter symbol periods, taught by *Li*, and the frame construction process taught by *Talukdar*—and a POSA could have effected the combination by simply using a symbol period $T/2$ for the faster-moving stations (again as taught by *Li*).” EX1002¶138.

82. Therefore, in my opinion, Dr. Roy failed to show that *Talukdar* alone, or *Talukdar* in combination with *Li*, teaches or suggests limitation 1.c of the '096 patent.

2. Claim 2

83. Dr. Roy addresses Claim 2 in paragraphs 144-146. EX1002¶¶144-146. Claim 2 is patentable and not disclosed or suggested by the combination of *Talukdar* and *Li* because it depends on Claim 1, and I showed above that Dr. Roy failed to demonstrate that Claim 1 is unpatentable.

3. Claim 3

84. Dr. Roy addresses Claim 3 in paragraphs 147-148. EX1002¶¶147-148. Claim 3 is patentable and not disclosed or suggested by the combination of *Talukdar* and *Li* because it depends on Claim 1, and I showed above that Dr. Roy failed to demonstrate that Claim 1 is unpatentable.

4. Claim 4

85. Dr. Roy addresses Claim 4 in paragraphs 149-151. EX1002¶¶149-151. Claim 4 is patentable and not disclosed or suggested by the combination of *Talukdar* and *Li* because it depends on Claims 3 and 1, and I showed above that Dr. Roy failed to demonstrate that Claim 1 is unpatentable.

5. Claim 6

86. Dr. Roy addresses Claim 6 in paragraphs 152-153. EX1002¶¶152-153. Claim 6 is patentable and not disclosed or suggested by the combination of *Talukdar* and *Li* because it depends on Claim 1, and I showed above that Dr. Roy failed to demonstrate that Claim 1 is unpatentable.

6. Claim 7

87. Dr. Roy addresses Claim 7 in paragraphs 154-155. EX1002¶¶154-155. Claim 7 is patentable and not disclosed or suggested by the combination of *Talukdar* and *Li* because it depends on Claim 1, and I showed above that Dr. Roy failed to demonstrate that Claim 1 is unpatentable.

C. The Combination Of Talukdar and Nystrom Does Not Disclose Or Suggest All Elements Of Claim 8

1. Claim 8

a) “the second communication system has pilot symbols that are denser than those in the first communication system”

88. In paragraph 157, Dr. Roy states that “*Nystrom* disclosed a ‘second communication system [with] pilot symbols that are denser than those in the first

communication system' by describing mobile stations that used denser pilot patterns in the time and/or frequency dimension.” EX1002¶157. I disagree with this statement as it is a mischaracterization of *Nystrom*. All embodiments are in the context of one communications system. And Dr. Roy did not point/cite to any such first and second communication systems, he only provided a conclusory and incorrect statement.

89. In paragraph 162, Dr. Roy states that

A POSA would have been motivated to incorporate *Nystrom*'s teaching of using denser pilot symbols into *Talukdar* because *Nystrom* disclosed that this better compensated for the effects of Doppler shift and fading experienced by faster moving remote units (such as those in *Talukdar*'s wireless system) and thus provided a teaching, suggestion, or motivation to apply this technique in the context of *Talukdar*'s system. *Nystrom* taught that mobile stations traveling at higher speeds experienced higher Doppler shift and fading in time and/or frequency. *Nystrom* at [0004].

EX1002¶162. I disagree for multiple reasons. It is a mischaracterization of *Nystrom* at [0004]. See EX1017¶4.

90. First, the only part of par. 4 in *Nystrom* discussing the channel characteristic is shown in the excerpt below. It is known in the art that users may experience “different channel characteristics due to fading in both time and frequency,” and also that users travelling at different speeds may experience different Doppler shifts. *Nystrom* does not disclose at par. 4 (or anywhere) that “mobile stations traveling at higher speeds experienced higher Doppler shift and

fading in time and/or frequency,” as stated by Dr. Roy. EX1002¶162. A POSITA would understand that moving speed does not affect fading in frequency, *i.e.*, the frequency selectivity.

In a cellular multi user, multi-carrier wireless communications system, the base station must accommodate many users that each experiences different channel characteristics due to fading in both time and frequency. Furthermore, different users travel at different speeds and thus experience different Doppler shifts.

EX1017¶4.

91. Second, I disagree with Dr. Roy’s statement that

A POSA would have been motivated to incorporate *Nystrom*’s teaching of using denser pilot symbols into *Talukdar* because *Nystrom* disclosed that this better compensated for the effects of Doppler shift and fading experienced by faster moving remote units (such as those in *Talukdar*’s wireless system) and thus provided a teaching, suggestion, or motivation to apply this technique in the context of *Talukdar*’s system.

92. In my opinion, a POSITA would not have been motivated to incorporate *Nystrom*’s teaching into *Talukdar* based on Dr. Roy’s mischaracterization of *Nystrom*. If anything, a POSITA would have considered if there is a motivation to incorporate *Nystrom*’s teaching into *Talukdar* based on correct reading of *Nystrom* and integral teaching of *Nystrom*. And integral teaching of *Nystrom* is best summarized by the embodiment in Fig. 1, shown by the excerpts below (red annotations correspond to high speed and blue annotations to low speed). Dr. Roy also cited to and used this embodiment but tried to extract only a part of an integral

teaching, relevant to fast moving users, suitable to support his theory. From this teaching in *Nystrom*, a POSITA would conclude that for fixed users with high delay spread in the first segment of the frame in *Talukdar* corresponding to 802.16e, pilots which are dense over frequencies would be appropriate, and in the second segment of the frame for 802.16m users, which may not even be mobile users, pilots dense over time would be appropriate. That is, there is no basis to suggest that the density of pilots in the second segment would be higher than in the first segment. Actually, it could be the opposite, depending on the delay spreads for fixed (or low speed) users and Doppler spreads, *i.e.*, velocity, for mobile users.

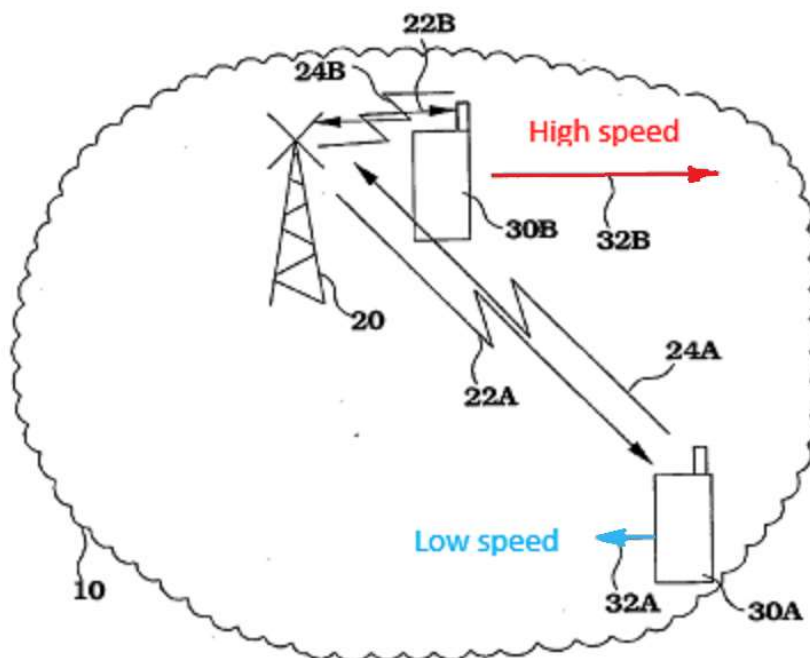


Fig. 1

EX1017, Fig. 1 (emphasis added).

User equipment **30A** is located at a relatively large distance from the access point **20**, but the speed **32A** (illustrated as an arrow) of the user equipment **30A** is small. User equipment **30b** is located closer to the access point **20**, but has a high speed **32B** (also illustrated as an arrow). The user equipment **30A** may have a relatively high need for repetitive pilots in the frequency dimension, since the propagation conditions for the different carriers may differ considerably over the bandwidth in case of multi-path propagation with large delay spread. However, the radio conditions are probably quite slowly varying with time due to the small speed of user equipment **30A**. The user equipment **30B** is close to the access point, and a pilot on one frequency can probably be used for channel estimations for many neighboring carriers. However, the radio conditions are probably changing rapidly in time, whereby frequent pilots in time dimension are required.

EX1017¶29 (emphasis added).

93. A more comprehensive description of the integral teaching in *Nystrom* regarding the delay spread and Doppler spread in relation to the pilot density is provided in the description of the embodiment show in Fig. 5A as shown in the excerpt below. A POSITA would understand that the small/large delay spread corresponds to low/high frequency selectivity, requiring low/high pilot density over frequency. A POSITA would also understand that small/large Doppler spread (or equivalently velocity) corresponds to low/high time selectivity, requiring low/high pilot density over time.

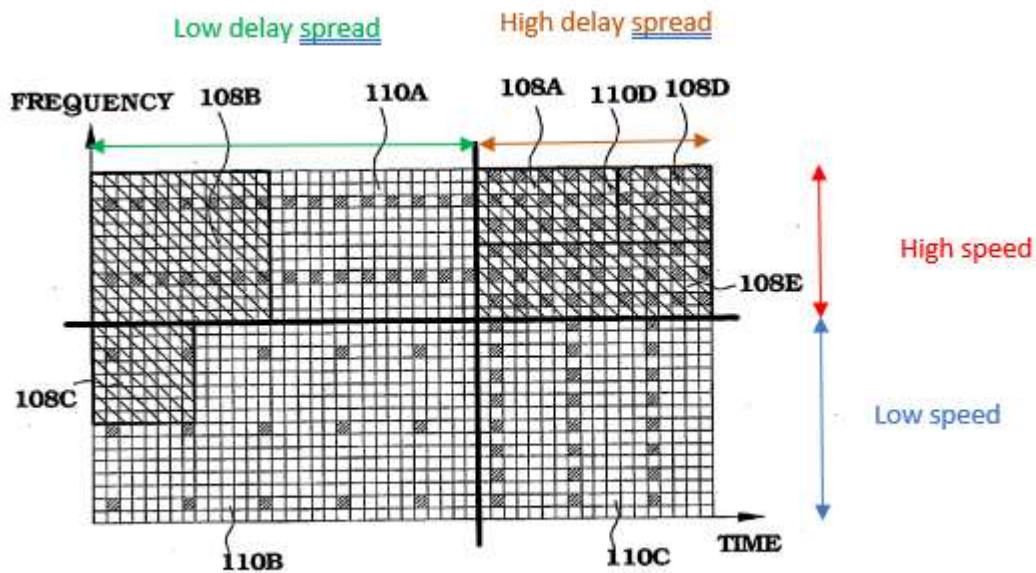


Fig. 5A

EX1017, Fig. 5A (emphasis and annotations added).

In the situation in FIG. 5A, there are pilot structures suitable for typically four combinations of Doppler and delay spread. In part 110A, the pilot structure is intended for a large Doppler and low delay spread. In part 110B, the pilot structure is intended for a low Doppler and low delay spread. In part 110C, the pilot structure is intended for a low Doppler and high delay spread. In part 110D, the pilot structure is intended for a high Doppler and high delay spread.

EX1017¶42.

94. From the disclosure in *Nystrom* summarized in the excerpts above, a POSITA would understand several things that were ignored by Dr. Roy.

95. First, a POSITA would understand that the methods suggested in *Nystrom* are on a per user basis; based on measurements and scheduling on a per user basis depending on the measured radio conditions. *Talukdar's* frame structure, on the other hand, is based on a per system basis, 802.16e and/or 802.16m, and there are

no facilities for measurements for adaptive real-time pilot structure and flexible scheduling as in *Nystrom*. In addition, in *Nystrom*, there are no first and second segments in a frame, corresponding to the first and second communication system. *Nystrom*'s disclosure/system is therefore incompatible with *Talukdar*'s system. Bringing *Nystrom*'s teaching into *Talukdar* would require a significant non-obvious redesign of *Talukdar* that Dr. Roy failed to address.

96. Second, even if we accept that the per user features in *Nystrom* could be imported into *Talukdar*'s system without the required redesign as indicated above, a POSITA would be faced with a fixed pilot density design for the first segment (fixed 802.16e user) and the second segment (mobile 802.16m) users. The actual fixed pilot design, using *Nystrom*'s teaching would require a very comprehensive study that would take into account multiple criteria such as the range of delay spread for most users, the range of user speeds for most of mobile users, the overall diversity gains provided by the radio design (including channel coding, diversity, MIMO, etc.), the ratio of pilot overhead to useful data capacity, *i.e.*, resources dedicated for pilots and useful data, etc. The solution to such a design problem is not obvious, and it could further turn out that the first segment would have a higher density of pilots in the first segment in *Talukdar*. Dr. Roy has not shown or even addressed how such a redesign could be obvious, and in my opinion, it would not be. Instead, Dr. Roy took an overly simplistic approach by using the '096 patent as a road map,

extracting a partial feature from *Nystrom*, ignoring *Nystrom*'s integral teaching, and ignoring the incompatibilities between *Nystrom* and *Talukdar*.

97. For these reasons, in my opinion, Dr. Roy failed to show that Claim 8 of the '096 patent is unpatentable over *Talukdar* alone or over a combination of *Talukdar* and *Nystrom*.

VII. CONCLUSION

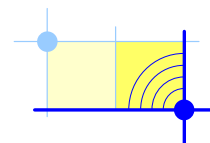
98. My opinions are subject to change or revision. I may acquire additional opinions regarding arguments Petitioner or its expert may present, information I may receive in the future, or additional work I may perform. With this in mind, based on the analysis I have conducted and for the reasons set forth herein, I have preliminarily reached the conclusions and opinions in this declaration.

99. In the event of a hearing or trial in this matter, I may create and/or use various exhibits for the purposes of demonstrating my testimony as discussed in this declaration. I have not yet created, directed the creation of, or selected the particular demonstrative exhibits for this purpose.

100. For at least the reasons stated herein, it is my expert opinion that Petitioner's references do not disclose all elements of any claim of the '096 patent. Defendant's expert witness fails to establish a prima facie case of obviousness. My review of the references, the combinations of references, and the materials I have considered leave me with the opinion that the patent claims are valid over the prior

art. In reaching my opinions, and in stating the basis of my opinions, I have provided representative reasons why the asserted claims are not disclosed by the cited references. I may have not provided every reason why the asserted claims are not invalid over the references (including combinations) as many are self-evidently trivial and make-weight. I therefore reserve the right to supplement my opinion and provide other bases for my opinions, as necessary, particularly in light of new arguments or information that becomes available to me during this proceeding.

ATTACHMENT A



Branimir Vojcic
CURRICULUM VITAE

President, 2010-Present
Xplore Wireless LLC
9610 Savannah Crossing Ct
Vienna, VA 22182

Board member at LN2 DB, LLC, 2011-2020
Partner at Fowler Radio Group, LLC, 2011-2020

Education

Doctor of Science Degree in Electrical Engineering (1989)

Thesis: "Performance of a class of digital transmission schemes in a fading dispersive channel with jamming", Faculty of Electrical Engineering, University of Belgrade, Yugoslavia.

Graduate Studies in Communications (1986/1987)

One year program, The George Washington University, Washington, DC.

Master of Science Degree in Electrical Engineering (1986)

Thesis: "Some possibilities of the ionospheric index of solar activity R_{12} prediction from the point of view of long term ionospheric radio wave propagation conditions prediction", Faculty of Electrical Engineering, University of Belgrade, Yugoslavia.

Dipl. Eng Degree in Electrical Engineering (1980)

Five year program, Faculty of Electrical Engineering, University of Belgrade, Yugoslavia.

Experience

Academic Experience:

George Washington University (from 2000 to 2015), Professor in the Department of Electrical and Computer Engineering (now an Emeritus Professor)

George Washington University (from 2001 to 2004), Chairman, Department of Electrical and Computer Engineering.

George Washington University (from 1997 to 2000), Associate Professor in the Department of Electrical Engineering and Computer Science.

Technology Consulting:

CTA Incorporated (Orbital Sciences Corp.)
Delphi Communications
TerreStar Networks, Inc.
Federal Communication Commission
Hughes Network Systems
iBiquity Digital
LCC International
Lucent Technologies
Lockheed Martin
Motorola,

George Washington University (from 1991 to 1997), Assistant Professor in the Department of Electrical Engineering and Computer Science.

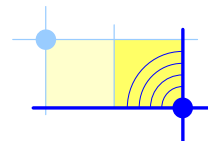
University of Belgrade (from 1988 to 1991), Research Associate (part time)

Industry and Government Experience:

Ministry of Defense, Yugoslavia (from 1981 to 1991), including leave of absence for studying), Research engineer

Novel
Orbcom
RKF Engineering
Sirius Satellite
Telecommunications Associates
Critical Alert
TV Answer
XtremeSpectrum

Business and Legal Consulting:



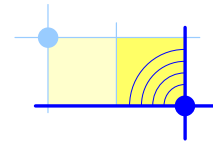
Finnegan, Henderson, Farabow, Garrett
&Dunner LLP
Hogan & Hartson LLP,
KSI Inc, and Antton & Associates
Bechtel Telecom
Wilson, Sonsini, Goodrich, and Rosati

King & Spalding
Ropes & Gray
Kirkland & Ellis
Latham & Watkins
Dovel & Lunner
Munger, Tolles & Olson
Mayer Brown
Dechert

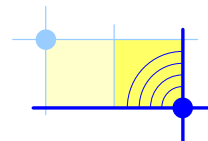
Wilmer Hale

Expert Witness Experience:

1. Expert for Finnegan (for Interdigital) in ITC case Interdigital vs Samsung, 2008 (testified in deposition and in trial)
2. Expert for Finnegan (for Interdigital) in ITC case Interdigital vs Nokia, 2009 (testified in deposition and in trial)
3. Expert for Finnegan (for WiAV) in WiAV versus Nokia, Motorola and Sony-Ericsson, Souther District of California, 2011 (testified in deposition, settled)
4. Expert for McCarter & English (GoldenBridge Technology Inc) in GoldenBridge Technology Inc versus Apple, District of Delaware 2013 (testified in deposition)
5. Expert for Finnegan (for SPH) in SPH vs Nokia, Motorola, Sony-Ericsson et. al., Southern District of California 2012 (testified in deposition, settled)
6. Expert for Finnegan (for Creative Kingdom) in Creative Kingdom vs Nintendo, ITC, 2012 (testified in deposition and in trial)
7. Expert for Finnegan (for Linex) in Linex vs Apple, HP, Aruba Networks, Meru Networks, Ruckus Wireless, ITC, 2012 (testified in deposition)
8. Expert for Finnegan (for HTC) in HTC vs Apple, ITC, 2012 (testified in deposition and in trial)
9. Expert for Finnegan (for Realtek) in LSI vs Realtek 2013, ITC (testified in deposition and in trial)
10. Expert for McCool, Smith & Hennigan (for GoldenBridge Technology Inc) in GBT vs Apple in 2014, Norther District of California (testified in deposition and trial)
11. Expert for Wilson Sonsini (for Interdigital) in ITC 337-TA-868 Investigations, in Interdigital vs Samsung, Huawei, Nokia and ZTE, ITC, 2014 (testified in deposition)
12. Expert for Reed & Scardino (for Mobile Telecommunications Technologies LLC) in Civil Action No. 2:12-cv-308-JRG, Eastern District of Texas, in Mobile Telecommunications Technologies LLC vs Clearwire Corporation, 2014 (testified in deposition, settled)
13. Expert for Reed & Scardino (for Mobile Telecommunications Technologies LLC) in Civil Action in Eastern District of Texas, Mobile Telecommunications Technologies LLC vs SprintNextel Corp, Samsung Telecommunications America, LLC and Apple, Inc, Case No. 2:13-cv-258-JRG-RSP, 2014 (settled).
14. Expert Witness for Wilson Sonsini (for Interdigital), in Arbitration between Interdigital Communications and Huawei, International Court of Arbitration, International Chamber of Commerce, 2015. (testified in arbitration/trial)
15. Expert Witness for Reed & Scardino (for Mobile Telecommunications Technologies LLC) in Civil Action in Eastern District of Texas, Mobile Telecommunications Technologies LLC vs T-Mobile USA, Inc., Case No. 2:13-cv-886-JRG-RSP, 2015 (settled in 2015).
16. Expert Witness for Reed & Scardino (for Mobile Telecommunications Technologies LLC) in Civil Action in Eastern District of Texas, Mobile Telecommunications Technologies LLC vs Leap Wireless International, Inc. and Cricket Communications, Inc., CIVIL ACTION NO. 2:13-CV-885-JRG-RGP (testified in deposition), 2015.



17. Expert Witness for McKool & Smith (for Ericsson) in Ericsson versus Apple ITC Investigation No. 337-TA-953(testified in deposition, settled before trial in 2015) .
18. Expert Witness for Munger, Tolles & Olson (for Ericsson) in Apple versus Ericsson, Case No. 3:15-cv-00154 JD in Northern District of California (settled in 2015).
19. Expert Witness for Reed & Scardino (for Mobile Telecommunications Technologies LLC) in Civil Action in Eastern District of Texas, Mobile Telecommunications Technologies LLC vs AT&T Mobility, Inc. and Cricket Communications, Inc., Case No. 2:14-cv-00897-JRG-RSP, (testified in deposition, settled in 2016).
20. Expert Witness for Reed & Scardino (for Mobile Telecommunications Technologies LLC) in Civil Action in Eastern District of Texas, Mobile Telecommunications Technologies LLC vs Samsung, Inc., Case No. 13-cv-259, (testified in deposition, settled in 2016).
21. Expert for Finnegan (for LG) in LG Electronics, Inc. vs. Cellular Communications Equipment LLC, Inter Partes Review of U.S. Patents No. 8,868,060 and 8,848,556 (submitted declarations, Inter Partes Review).
22. Technology Expert for Dechert (for Intellectual Ventures), Intellectual Ventures vs AT&T / T-Mobile in Civil Action No. 13-cv-1631-LPS (submitted technology evaluation report, deposition), in 2016.
23. Expert Witness for Russ, August and Kabat (for SPH) in SPH America vs AT&T Mobility, Sprint Spectrum, Blackberry Limited, Huawei Technologies, ZTE, et al., in Case No. 3:13-cv-2318-CAB-KSC, Case No. 3:13-cv-2319-CAB-KSC, Case No. 3:13-cv-2320-CAB-KSC, and related cases (in 2014 submitted declaration, deposition).
24. Expert Witness for Mayer Brown, for Internation Arbitration between LG Electronics, Inc. and Nokia, testified in arbitration, January 2017.
25. Expert Witness for Reed & Scardino in EON Corp. vs Apple, Inc., CASE NO. 3:14-cv-05511-WHO, Northern District of California, presented a technology tutorial, settled in 2017.
26. Expert for Hoyng Rokh Monigen, Declaration in case Phillips vs ASUS, Amsterdam, Netherlands, District Case of the Hague, no testimony January, 2017.
27. Expert Declaration re Appln. U.S. Patent No.: RE44,507 for Sugrue Mion (SPH America), February 2017.
28. Expert Witness for Reed & Scardino in Customedia vs Dish Network, Civil Action No. 2:16-cv-00129-JRG, Eastern District of Texas, Expert report and deposition in 2017.
29. Expert Witness for Rus, August and Kabat (for Vivato Tech) in Vivato Technologies vs Rukus, Case No. 2:17-cv-02961-AG(JCGx), Claim Construction Declaration in 2018.
30. Expert Witness for Mayer Brown (for Hitachi Maxell) in Hitachi Maxell vs Huawei and Hitachi Maxell vs ZTE, Case No. 5:16-cv-00179-RWS, claim construction declaration in 2017, settled.
31. Expert Witness for Mayer Brown (for Hitachi Maxell) in Hitachi Maxell vs Huawei and Hitachi Maxell vs ZTE, Case No. 5:16-cv-00179-RWS, Expert Declaration and Supplemental Declaration in 2017 and 2018, settled.
32. Expert Witness for Mayer Brown (for Hitachi Maxell) in Hitachi Maxell vs Huawei and Hitachi Maxell vs ZTE, Case No. 5:16-cv-00178-RWS, Expert Reports, multiple IPR declarations and depositions in 2018 and 2019, settled.
33. Expert Witness for Mayer Brown (for Maxell) in Maxell vs ASUSTEK, Case No. 18-cv-01788-VC, claim construction declaration in 2018.
34. Expert Witness for Wilson Sonsini (for Interdigital) in ASUS COMPUTER vs Interdigital, Case No.: 15-cv-1716 (BLF) , Expert report in 2018.
35. Expert for Rus, August and Kabat (for Vivato) in XR Communications, dba Vivato Technologies vs Petitioners (RUCKUS WIRELESS, INC.; ARRIS SOLUTIONS, INC.; ARRIS ENTERPRISES, LLC; NETGEAR, INC.; AND BELKIN INTERNATIONAL, INC), Case IPR2018-01016 Patent No. 6,611,231. Declaration in October, 2018.
36. Expert Declaration for Hoyng Rokh Monigen, Declaration in case Phillips vs Wiko,



- Amsterdam, Netherlands, District Case of the Hague, December, 2018.
37. Expert Declaration for Hoyng Rokh Monigen, Declaration in case Phillips vs ASUS, Amsterdam, January, 2019.
 38. Expert for Robins Kaplan (for INVT SPE, LLC) in Apple and ZTE (USA) vs INVT, Case: IPR2018-01477, multiple IPR declarations in 2018.
 39. Expert for Robins Kaplan (for INVT SPE, LLC) in HTC vs INVT, Case: IPR2018-01581, IPR declaration in 2018.
 40. Expert for Robins Kaplan (for INVT SPE, LLC) in (Apple, ZTE, HTC and Samsung vs INVT) ITC Investigation No. 337-TA-1138, Expert Reports re Infringements and Validity and a claim construction declaration in 2019.
 41. Expert for Feiberg Day in (for Uniloc 2017 LLC) vs Microsoft, Case No: 8-19-cv-00428-AG(JDEX), etc., Central District of California, 2019.
 42. Expert for Feiberg Day in (for Uniloc 2017 LLC) vs Verizon, Case No: 2-18-cv-00513-JRG, Eastern District of Texas, 2019.
 43. Expert for Finnegan Henderson, Declaration re Ex-Parte Reexamination for TLC Communications, 2019.
 44. Expert for Mayer Brown in Maxel LTD v. Apple Inc, Case No.5:19-cv-00036-RWS, Eastern District of Texas, Expert reports and deposition, 2019-2021, settled in 2021.
 45. Expert Affidavits, Expert for Wilson Sonsini in Interdigital Corp. vs Xiaomi, C.S. (COMM) No. 295 of 2020, High Court of Delhi at New Delhi, 2020-

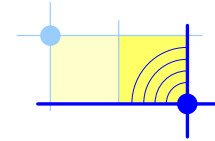
Teaching and/or Course Director at GWU

ECE12 Signals and Systems	ECE246 Digital Communications
ECE143 Communications Engineering I	ECE247 Communications Systems
ECE144 Communications Engineering II	ECE248 Computer Networks I
ECE148 Simulation of Communications Systems	ECE249 Computer Networks II
ECE203 Stochastic Processes in Engineering	ECE253 Mobile Communications
ECE219 Computational Methods in Electr.Eng.	ECE257 Multiuser Communications
ECE241 Information Theory	ECE259 Wireless Networks
ECE243 Communication Theory I	ECE348 The Internet: Design and Implem.
ECE244 Communication Theory II	

Grants Received

Research

1. *Wireless Information Network for Airport Surface Traffic Automation Using GPS* (11/1/92-12/31/92), PI, Martin Marietta
2. *Wireless Information Network for Airport Surface Traffic Automation Using GPS - Network Topology and Frequency Band Considerations* (2/1/93-12/31/93), PI, Martin Marietta
3. *Spectral Shaping for Improved Capacity in Multiple Access Communications* (12/1/93-11/30/94), PI, University Facilitating Fund
4. *Research in Simulation of Communications Systems* (5/1/94-12/31/94), PI, Elanix
5. *Research in Multiuser Detection and Innovative Approaches in Teaching* (7/1/95-6/30/98), PI, NSF Faculty Early CAREER Development Award
6. *Integration of DBS into Digital Battlefield using Commercial LEO Systems* (10/1/95-9/30/98), PI for GWU, with Orbital Sciences Corp. (lead organization) and ALOHA Networks Inc. ARPA (GLOMO Program)
7. Research Experience for Undergraduates, Supplemental Grant from NSF (7/1/96-6/30/98)
8. *Multiuser Detection for IS-95 Air Interface* (1/1/97-12/31/97), NORTEL



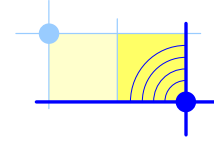
9. *Multuser Detection for Next Generation CDMA* (6/1/98-12/31/98), NORTEL
10. *Multuser Detection for Next Generation CDMA* (6/1/99-12/31/99), NORTEL NETWORKS
11. *A Novel Packet Radio Network Architecture* (1/1/00-12/31/03), National Science Foundation
12. *Digital Signal Characterization*, (5/1/2000-4/30/2001), National Security Agency
13. *Multuser Detection for 3G*, (6/1/2000-5/31/2001), NORTEL NETWORKS
14. *Ad-Hoc Networks*, (6/1/2000-5/31/2001), NORTEL NETWORKS
15. *Bitpipe*, (2/1/02-3/31/04), National Security Agency
16. *Routing in Ad-Hoc Networks Using CSI Information* (8/13/2002-2/12/2003), Innovative Concepts Inc
17. *Ad-Hoc Networks*, (6/1/2002-8/31/2004), NORTEL NETWORKS
18. Modeling and Simulation of Spectral and Spatial Efficiency ..., (12/15/2004-06/15/2005), US Army (with RKF Engineering)

Software grants/gifts

1. SPW and BONEs (CADENCE)
2. OPNET (MIL-3)
3. SystemView (ELANIX, Inc.)

Professional Activities

- Senior Member of IEEE.
- Past Vice Chairman, Communications Society of the Washington and Northern Virginia Chapter of IEEE.
- Past Associate Editor of the IEEE Communications Letters
- Guest Editor, Journal on Communications and Networks, Special Issue on UWB Communications
- Chair, Technical Program, IEEE Communication Theory Workshop 1996, San Destin, FL.
- Chair, Technical Program, IRSS'97, Washington, DC.
- Chair, Technical program, MMT'98, Washington, DC.
- Member, Communication Theory Committee of the IEEE Communication Society.
- Member, Technical and Organizing Committee
 - International Symposium on Spread Spectrum Systems and Techniques 1988, Belgrade, Yugoslavia.
 - IEEE Communication Theory Workshop 1993, Marathon, FL.
 - 1st International Workshop on Mobility Management, GMU, Fairfax, VA, 1994.
 - Globecom 2007
- Member, Program Committee, Workshop on Mobility Management, Paris, 1996.
- Member, Program Committee, Workshop on Mobility Management, Melbourne, 1997.
- Member, Program Committee of CTMC 1999
- Technical Program Committee for MMT'02, Rennes, France, June 2002
- Member, Technical Scientific Program Committee of the 4th IEEE Conference on Mobile and Wireless Communications Networks, Stockholm, Sep. 2002.
- Technical representative of the IEEE Communication Society to MILCOM'96, Reston, VA.
- Session Chair:
 - International Symposium on Spread Spectrum Systems and Techniques, 1988.
 - IEEE Communication Theory Workshop, 1993.
 - MILCOM'96
 - Computer Communications Workshop, 1996
 - ISIT'98
 - IEEE Communication Theory Workshop, 2000.
- Technical reviewer:
 - IEEE Transactions on Communications
 - IEEE Journal on Selected Areas in Communications
 - IEEE Transactions on Circuits and Systems
 - IEEE Transactions on Vehicular Technology



- European Transactions on Telecommunications and Related Technologies
- Wireless Personal Communications (An International Journal)
- National Science Foundation
- Member of the Communications, Vehicular Technology and Signal Processing Societies and Information Theory Group of the IEEE.
- Member of the US Section of URSL.

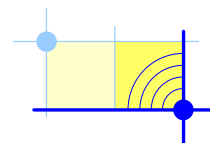
Awards

1. Best Paper Award at ACM MSWiM'99: F. Alagoz, A. AlRustamani, D. Walters, B. Vojcic and R. Pickholtz, "On the effects of adaptive forward error correction mechanism in direct broadcast satellite networks", MSWiM'99, August 1999, Seattle, WA.
2. National Science Foundation Young Faculty Early CAREER Development Award in 1995.
3. Radio TV Belgrade (Yugoslavia) Annual Award for the Best Paper in 1990 for the paper: B.R. Vojcic and R.L. Pickholtz, "Performance of coded direct sequence spread spectrum in a fading dispersive channel with pulsed jamming", IEEE J. on Sel. Areas in Commun., vol. 8, NO. 5, pp. 934-942, 1990.

Patents (sample)

B Vojcic – US Patents

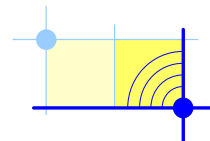
9,455,861	US	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.
9,391,643	US	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.
9,461,863	US	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.
8,792,594	US	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to methods for channel state estimation relying on forward error correction.
9,838,154	US	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to a system for augmenting a source message bit sequence with a synchronization sequence to facilitate better source decoding
9,191,256	US	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to methods for iteratively decoding Hybrid Digital radio signals.
9,698,941	US	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to methods for iteratively decoding Hybrid Digital radio signals.



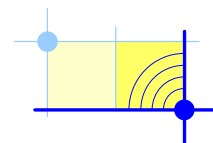
8,595,590	US	Systems and methods for encoding and decoding of check-irregular non-systematic IRA codes	Utility patent relating to systems for decoding check-irregular non-systematic irregular repeat accumulate codes.
8,943,383	US	Systems and methods for encoding and decoding of check-irregular non-systematic ira codes	Utility patent relating to systems for encoding check-irregular non-systematic irregular repeat accumulate codes.
9,509,341	US	Systems and methods for encoding and decoding of check-irregular non-systematic IRA codes	Utility patent relating to systems for encoding check-irregular non-systematic irregular repeat accumulate codes
8,948,272	US	Joint source-channel decoding with source sequence augmentation	Utility patent relating to a system for augmenting a source message bit sequence with a synchronization sequence to facilitate better source decoding

B Vojcic – Foreign Patents

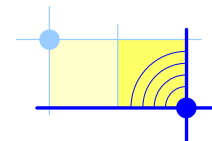
Publication No.	Nation	Title	Description
AU2001030786	Australia	Method and apparatus for forward error correction coding for an am in-band on-channel digital audio broadcasting system	
AU2002214853A	Australia	Multi-user detector for direct sequence - code division multiple access (ds/cdma) channels	
2956304	China	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.
3212039	China	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to methods for channel state estimation relying on forward error correction.
CN000001478330A	China	Multi-user detector for direct sequence-code division multiple access (DS/CDMA) channels	
CN105122654 (A)	China	Systems and methods for encoding and decoding of check-irregular non-systematic ira codes	
CN105122655 (A)	China	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	
CN105144598 (A)	China	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	



CN1478330	China	Multi-user detector for direct sequence-code division multiple access (DS/CDMA) channels	
EP1329032 (A2)	Europe	MULTI-USER DETECTOR FOR DIRECT SEQUENCE - CODE DIVISION MULTIPLE ACCESS (DS/CDMA) CHANNELS	
EP2926460	Europe	SYSTEMS AND METHODS FOR ENCODING AND DECODING OF CHECK-IRREGULAR NON-SYSTEMATIC IRA CODES	
EP2926461 (A2)	Europe	JOINT SOURCE-CHANNEL DECODING WITH SOURCE SEQUENCE AUGMENTATION	
EP2926462	Europe	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.
EP2926468	Europe	SYSTEMS AND METHODS FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEMS	
EP3447924	Europe	SYSTEMS AND METHODS FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEMS	
DE000060125570T2	Germany	MEHRBENUTZERDETEKTOR FÜR DIREKTSEQUENZ-KODEMULTIPLEX-VIELFACHZUGRIFFKANÄLE	
6096921	Japan	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.
6096922	Japan	Systems and methods for encoding and decoding of check-irregular non-systematic IRA codes	Utility patent relating to systems for encoding check-irregular non-systematic irregular repeat accumulate codes.
6215955	Japan	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to methods for channel state estimation relying on forward error correction.
6396977	Japan	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.



JP002017077012A	Japan	ADVANCED ITERATIVE DECODING OF CONCATENATED CODING SYSTEM AND SYSTEM AND METHOD FOR CHANNEL EVALUATION	
JP002018164288A	Japan	SYSTEM AND METHOD FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEM	
10-1758737	South Korea	Systems and methods for encoding and decoding of check-irregular non-systematic IRA codes	Utility patent relating to systems for encoding check-irregular non-systematic irregular repeat accumulate codes.
KR102015122121A	South Korea	SYSTEMS AND METHODS FOR ENCODING AND DECODING OF CHECK-IRREGULAR NON-SYSTEMATIC IRA CODES	
KR102015123781A	South Korea	SYSTEMS AND METHODS FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEMS	
KR102015125921A	South Korea	SYSTEMS AND METHODS FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEMS	
KR102017059018A	South Korea	SYSTEMS AND METHODS FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEMS	
KR20190032635 (A)	South Korea	Systems and methods for advanced iterative decoding and channel estimation of concatenated coding systems	Utility patent relating to systems for high, medium, and low-density parity check coding.
TW511345B	Taiwan	Method and apparatus for forward error correction coding for an AM in-band on-channel digital audio broadcasting system	
WO2001035555		METHOD AND APPARATUS FOR FORWARD ERROR CORRECTION CODING FOR AN AM IN-BAND ON-CHANNEL DIGITAL AUDIO BROADCASTING SYSTEM	



WO2002033838A3		MULTI-USER DETECTOR FOR DIRECT SEQUENCE - CODE DIVISION MULTIPLE ACCESS (DS/CDMA) CHANNELS	
WO2014089087		SYSTEMS AND METHODS FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEMS	
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Publication No.	Nation	Title	Description
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1020197007897	South Korea	SYSTEMS AND METHODS FOR ADVANCED ITERATIVE DECODING AND CHANNEL ESTIMATION OF CONCATENATED CODING SYSTEMS	

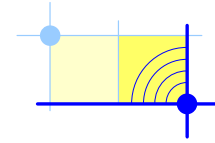
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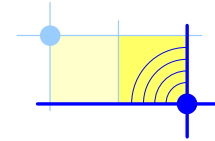
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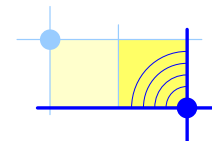
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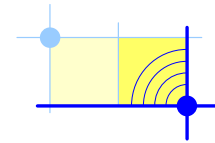
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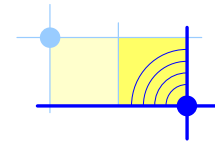
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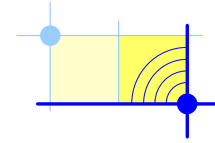
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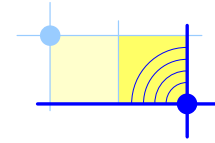
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81. J. Wu, B. Vojcic, and Z. Wang "Cross-entropy Based Symbol Selection and Partial Iterative Decoding for Serial Concatenated Convolutional Codes". *The 42nd Conf. on Info. Sciences and Systems (CISS 2008)*, Princeton, NJ, Mar. 2008.
82. J. Wu and B. Vojcic, "Partial Iterative Equalization and Channel Decoding", *IEEE Int. Conf. Acoust., Speech, Signal Processing (ICASSP2009)*, Taipei, Taiwan, pp. 2657-2660, Apr., 2009.
83. J. Wu and B. Vojcic, "Near-capacity Performance Soft Output Sphere Decoding Based on Short List Detection and Metrics Combining," *The 43rd Conf. on Info. Sciences and Systems (CISS 2009)*, Baltimore, MD, Mar. 2009.
84. J. Wu and B. Vojcic, "Combining Iterative SOVA and Log-MAP algorithms for Turbo Decoding", *The 43rd Conf. on Info. Sciences and Systems (CISS 2009)*, Baltimore, MD, Mar. 2009.
85. Jinhong Wu, Branimir R. Vojcic, and Jia Sheng. "Stopping criteria for iterative decoding based on mutual information." *Signals, Systems and Computers (ASILOMAR), 2012 Conference Record of the Forty Sixth Asilomar Conference on*. IEEE, Pacific Grove, CA, pp. 183-187, Nov. 2012.
86. B. Vojcic, H. Dogan, W. Lee, S. Papaharalabos, and F. Shayegh, "Advances in HD Radio—Improving Coverage and Reception Quality", *Proc. 67th NAB Broadcast Engineering Conference*, 8 Apr. 2013, Las Vegas, Nevada.
87. B. Vojcic and S. Papaharalabos, "Irregular Non-Systematic Repeat-Accumulate Codes for Digital Broadcasting Applications", accepted for IEEE International Broadcast Symposium 2014.

Symposium/Workshop Papers:

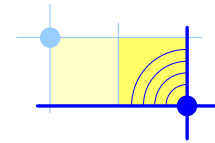
1. R.L. Pickholtz and **B.R. Vojcic**, "Issues in microcellular communications - CDMA versus TDMA ", Symposium on Worldwide Advances in Communications Networks, George Mason University, Fairfax, 1992.
2. **B.R. Vojcic** and R.L. Pickholtz, "Performance of direct sequence spread spectrum in a fading dispersive channel with jamming", Proc. International Symposium on Spread Spectrum Techniques, Belgrade 1988.
3. R.L. Pickholtz and **B.R. Vojcic**, "TDMA/CDMA comparisons", Government Land Mobile Radio and Personal Communications Symposium, MITRE Corporation, McLean, VA, 1992.
4. **B.R. Vojcic**, R.L. Pickholtz and L.B. Milstein, "Performance of DS-CDMA with imperfect power control over a LEOS channel" (Invited Paper), Communication Theory Workshop, Marathon, Florida, 1993.
5. **B.R. Vojcic**, R.L. Pickholtz and L.B. Milstein, "CDMA sharing for mobile satellite communications", Communication Theory Workshop, Marathon, Florida, 1993.
6. **B.R. Vojcic**, "Transmitter precoding for synchronous multiuser communications", Workshop on Mobility Management, George Mason University, Fairfax, VA, Oct. 9, 1994.
7. **B.R. Vojcic**, "CDMA for low earth orbiting satellite communications", (Invited paper) Microwave Theory Workshop, Historic Electronics Museum, Baltimore, MD, Oct. 1994.
8. W.M. Jang and **B. Vojcic**, "Transmitter precoding in synchronous multiuser communications over multipath channels", Symposium on Interference Rejection and Signal Separation 1996, New Jersey Institute of Technology, Newark, March 1996.
9. **B. Vojcic**, "The role of data link layer in multiuser communications", (Invited paper), Communication Theory Workshop 1996, San Destin, April 1996.
10. **B.R. Vojcic**, A. Damjanovic, R.L. Pickholtz and J. Damjanovic, "Spread ALOHA versus CDMA", Computer Communications Workshop 1996, Reston, VA, Sep. 1996.
11. **B.R. Vojcic**, "Information theoretic aspects of multiuser detection", Proc. of IRSS'97, The George Washington University, Washington, DC, March 1997.
12. M. Honig and **B.R. Vojcic**, "Packet DS-CDMA with with adaptive interference suppression and soft decoding", Information Theory Workshop, UCSD, San Diego, Feb. 1998.
13. **B.R. Vojcic** and Y. Shama, "Soft output detection for coded multiuser systems", Information Theory Workshop, UCSD, San Diego, Feb. 1998.



14. F. Alagoos, A. Al-Rustamani, **B. Vojcic**, R. Pickholtz and D. Walters, "Adaptive resource allocation and management for direct broadcast satellites", BAS'98 Computer Networks Symposium, Turkey, 1998.
15. A. Damjanovic and **B. Vojcic**, "Coding/spreading tradeoffs in DS CDMA systems with linear multiuser detection", 2nd Annual UCSD Conference on Wireless Communications, Mar. 1999, San Diego.
16. F. Alagoos, A. AlRustamani, **B. Vojcic**, R. Pickholtz and D. Walters, "Adaptive resource allocation and rate control for heterogeneous traffic on DBS links", Proc. Of the Fourth Workshop on Multiple Access, Mobility and Teletraffic for Wireless Communications, The George Washington University, Oct. 1998, Washington, DC.
17. D. Walters, **B. Vojcic**, F. Alagoz, A. AlRustamani, and R. Pickholtz, "Management of Heterogeneous Traffic Loading in DBS Networks", Proceedings of SPIE, vol. 3709, Florida, USA, April 1999.
18. F. Alagoos, A. AlRustamani, D. Walters, **B. Vojcic** and R. Pickholtz, "On the effects of adaptive forward error correction mechanism in direct broadcast satellite networks", Proc. of MSWiM'99, August 1999, Seattle, WA.
19. A. AlRustamani and **B. Vojcic**, "Greedy multiuser detection", IEEE Communication Theory Workshop, Greenleaf, FL, May 2000.
20. A. Damjanovic and **B. Vojcic**, "Turbo multiuser detection", IEEE Communication Theory Workshop, Greenleaf, FL, May 2000.
21. F. Alagoz, **B. Vojcic** and A. AlRustamani, "Approximation on the aggregate MPEG Video Traffic and Their Impact on Admission Control", Proc. of the Fifth Symposium on Computer Networks, Ankara, Turkey, June 2000.
22. **B. Vojcic** and R. Pickholtz, "Greedy Detection", IEEE Communication Theory Workshop, April 2001.
23. **B. Vojcic**, R. Pickholtz and M. Souryal, "Capacity Improvement in Ad-Hoc Networks due to CSI Based Routing", IEEE Communication Theory Workshop, April 2001.
24. J. Damjanovic, **B. Vojcic**, "Turbo Multiuser Detection for MIMO Rayleigh Fading Channels", Proc. of 3GIS, Athens, Greece, July 2001.
25. K. Pepe and **B. Vojcic**, "Cellular Multihop Networks and the Impact of Routing on the SNIR and Total Power Consumption", Proc. of MMT'02, Rennes, France, June 2002.
26. **B. Vojcic**, "Multiple Access Issues for UWB Communications", Invited Talk, IEEE Communication Theory Workshop 2003, Phoenix, April 2003.
27. Jinghao Xu, B. Peric, and B. Vojcic, "Energy-aware and Link-adaptive Routing Metrics for Ultra Wideband Sensor Networks", invited paper, Networking with Ultra Wide Band and Workshop on Ultra Wide Band for Sensor Networks 2nd International Workshop, Rome, July 2005.
28. Michael Souryal, Branimir Vojcic, Performance of Amplify-and-Forward and Decode-and-Forward Relaying with Turbo Codes, WICAT Workshop 2005, NYU, New York.
29. B. Vojcic, D. Matheson and H. Clark, "Network of Mobile Networks, Hybrid Terrestrial-Satellite Radio", Satellite and Space Communications, IWSSC 2009, Sep. 2009.
- 30.

Invited Presentations:

1. **B.R. Vojcic**, R.L. Pickholtz and L.B. Milstein, "Spectrum sharing for LEOS with code division multiple access", FCC Negotiated Rulemaking for MSS Above 1.6 GHz, Washington, D.C., 1993.
2. **B.R. Vojcic**, R.L. Pickholtz and L.B. Milstein, "Capacity considerations for co-coverage co-frequency satellite-based systems employing spread spectrum techniques", Documents of Radiocommunications Study Group, USWG 8D, Washington, D.C. 1993.
3. **B.R. Vojcic**, L.B. Milstein and R.L. Pickholtz, "The effect of dual satellite diversity on the total capacity of multiple band-shared CDMA LEOS systems", Documents of Radiocommunications Study Group, USWG 8D, Washington, D.C. 1993.
4. **B.R. Vojcic**, "CDMA for mobile satellite communications", presentation given to the Communications Society of the IEEE, Washington and Northern Virginia Chapter, George Washington University, Washington, DC, Sep. 1994.
5. **B.R. Vojcic**, "DS CDMA for satellite communications", IEEE Microwave Theory Lecture Series, Maryland University, Feb. 1995.
6. **B.R. Vojcic**, "DS CDMA - a perspective", David Sarnoff Research Center, Princeton, Aug. 1995.



7. **B.R. Vojcic**, "New results in multi-stage detection", New Jersey Institute of Technology, Newark, Dec. 1995.
8. R.L. Pickholtz and **B.R. Vojcic**, "Multiuser detection in wireless communications", NORTEL, Ottawa, Canada, Aug. 1996.
9. **B. Vojcic**, "Spread ALOHA versus CDMA - A comparison" The George Washington University, Washington, DC, Oct. 1996.
10. **B. Vojcic**, "CDMA versus Spread ALOHA", George Mason University, Fairfax, VA, Oct. 1996.
11. **B.R. Vojcic**, "On coding/spreading tradeoffs in multiuser communications", UCSD, San Diego, Feb. 1998.
12. **B.R. Vojcic**, "On coding/spreading tradeoffs in multiuser communications", QUALCOM, Inc., San Diego, Feb. 1998.
13. **B.R. Vojcic**, "Multiuser detection and interference cancellation – Overview and potential", LCC, McLean, VA, May 2000.
14. **B.R. Vojcic**, "Greedy Multiuser Detection", Nortel Networks, Germantown, MD, June 2001.
15. M. Souryal, **B. Vojcic**, R. Pickholtz, "Fading is good in ad-hoc networks," Soprano Seminar, GMU, Fairfax, VA, June 15, 2001.
16. **Prof. B. Vojcic**, Prof. R. Pickholtz, Invited pannel presentation "3G - Mission Impossible?", 3GIS, Athenes, Greece, July 2001.
17. **B.R. Vojcic**, "Greedy Detection with Applications" Polytechnic Institute of New York, NY, Feb. 2002.
18. M. Souryal, **B. Vojcic**, R. Pickholtz, "Interference model for ad hoc wireless networks with M-QAM DS-CDMA signals," Soprano Seminar, GWU, Washington, DC, January 9, 2002.
19. **B.R. Vojcic**, "3G-Mission Impossible, 4G-Terra Incognita", TechExpo, GWU, Ashburn, VA, April 2002.
20. **B.R. Vojcic**, "1xEV-DO/DV: Multiuser Diversity", LCC International, , McLean, VA, Oct 2002
21. **B.R. Vojcic**, "Adaptive Multi-Hop Ad-Hoc Access technologies", Nortel Networks, Ottawa, April 2003.
22. **B.R. Vojcic**, "Probability and Stochastic Processes in Communications", Federal Communications Commission, Oct. 2005.