UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

COMMSCOPE TECHNOLOGIES LLC.
Petitioner

v.

DALI WIRELESS, INC.
Patent Owner

Case IPR_____
U.S. Patent No. 9,197,358
Issued: Nov. 24, 2015
Filed: May 14, 2013

DECLARATION OF DR. ANTHONY ACAMPORA

In Support of Inter Partes Review of U.S. Patent No. 9,197,358

Table of Contents

I. INTRODUCTION 1

II. SUMMARY OF OPINIONS 1

III. QUALIFICATIONS 3

IV. MATERIALS CONSIDERED 9

V. RELEVANT LEGAL PRINCIPLES 11

A. Effective Filing Date 11

B. Person of Ordinary Skill in the Art 12

C. Claim Construction Standard 13

D. Construing Terms of '358 Patent 14

1. Interpretation of "a [first / second] communications unit" (claims 7, 15) 14

2. Other claim terms 15

E. Anticipation and Obviousness Law 17

1. Anticipation 17

2. Obviousness 17

VI. THE '358 PATENT 21

A. Technology Background 21

1. Distributed Antenna Systems 21

2. The Problem Addressed by the '358 Patent 31

3. Known Techniques for Mitigating ICI 32

a. Distributed Antenna Systems 32

b. Frequency Reuse Techniques 34

B. The alleged invention: combining DAS and frequency reuse techniques for mitigating inter-cell inference 42

C. The '358 Patent Specification 43

1. The first embodiment 45
2. The second embodiment 50
D. The Challenged Claims of the '358 Patent 60
G. Prosecution History 66
H. Prior IPR proceedings on the '358 patent 72
VII. The Prior Art 73
A. Public availability of printed publications including Xu and Ericsson 73
B. Primary References 74
1. Xu 74
2. Ericsson 80
3. Stratford 83
C. Secondary references and other background DAS prior art 85
a. Schwartz 88
b. Stapleton 91
c. Sabat 92
d. Huawei 93
VIII. GROUNDS 95
A. Ground 1: Xu anticipates claims 7, 8, 9 and 11 95
1. Claim 7 95
a. Element 7A 97
b. Element 7B 98
c. Element 7C 100
d. Element 7D 105
2. Claim 8 110
3. Claim 9 113
4. Claim 11 114
B. Ground 2: Xu alone or in combination Schwartz renders obvious claims 8, 15, 20 and 21 115

1. Claim 8 115
2. Claim 15 126
3. Claim 20 138
4. Claim 21 139

C. Ground 3: Xu in combination with Schwartz and Huawei renders obvious claims 17 and 18 140

D. Ground 4: Ericsson anticipates claims 7, 9 and 11. 145

1. Claim 7 146
   a. Element 7A 147
   b. Element 7B 148
   c. Element 7C 149
   d. Element 7D 152
2. Claim 9 155
3. Claim 11 155

E. Ground 5: Ericsson alone or in combination with Schwartz renders claims 7, 8, 9, 11, 15, 17, 18, 20 and 21 obvious 156

1. Claim 7 158
   a. Element 7A 159
   b. Element 7B 168
   c. Element 7C 169
   d. Element 7D 171
2. Claim 8 174
3. Claim 9 182
4. Claim 11 183
5. Claim 15 184
   a. Element 15A 185
   b. Element 15B 186
   c. Element 15C 194

d. Element 15D 197
6. Claim 17 200
7. Claim 18 200
8. Claim 20 201
9. Claim 21 202
F. Ground 6: Ericsson in combination with Stratford renders claims 7, 8, 9, 11, 15, 17, 18, 20 and 21 obvious 203
1. Claim 7 204
a. Element 7A 205
b. Element 7B 220
c. Element 7C 221
d. Element 7D 223
2. Claim 8 226
3. Claim 9 237
4. Claim 11 237
5. Claim 15 238
a. Element 15A 239
b. Element 15B 240
c. Element 15C 250
d. Element 15D 252
6. Claim 17 255
7. Claim 18 255
8. Claim 20 256
9. Claim 21 257
G. Ground 7: Stratford in combination with Ericsson renders claims 7, 8, 9, 11, 15, 17, 18, 20 and 21 obvious 258
1. Claim 7 260
a. Element 7A 260

b. Element 7B.....261
c. Element 7C.....265
d. Element 7D.....276
2. Claim 8.....277
3. Claim 9.....279
4. Claim 11.....281
5. Claim 15.....283
a. Element 15A.....284
b. Element 15B.....284
c. Element 15C.....286
c. Element 15D.....289
6. Claim 17.....292
7. Claim 18.....294
8. Claim 20.....296
8. Claim 21.....297

I, Anthony Acampora, Ph.D., declare as follows.

I. INTRODUCTION

1. I have been retained by Petitioner, CommScope Technologies LLC, ("CommScope" or "Petitioner") to provide expert opinions in connection with a petition for inter partes review before the United States Patent and Trademark Office. I understand that this declaration involves my expert opinions and expert knowledge related to U.S. Patent No. 9,197,358 ("the '358 Patent"), titled "Method and System for Soft Frequency Reuse in a Distributed Antenna System," and its field of endeavor.

2. I have been asked to provide my independent technical review, analysis, insights, and opinions regarding the '358 Patent and the references that form the basis for the grounds of unpatentability set forth in the Petition for Inter Partes Review of the '358 Patent. The statements made herein are based on my own knowledge and opinions.

II. SUMMARY OF OPINIONS

3. To Summarize the opinions stated herein, it is my opinion that the claims of the '358 patent are invalid based on the following grounds:

Grounds	Claims
Ground 1: Xu anticipates:	Claims 7, 8, 9 and 11
Ground 2: Xu alone or in combination Schwartz renders obvious:	Claims 8, 15, 20 and 21
Ground 3: Xu in combination with Schwartz and Huawei renders obvious:	Claims 17 and 18
Ground 4: Ericsson anticipates:	Claims 7, 9 and 11
Ground 5: Ericsson alone or in combination with Schwartz renders obvious:	Claims 7, 8, 9, 11, 15, 17, 18, 20 and 21
Ground 6: Ericsson in combination with Stratford renders obvious:	Claims 7, 8, 9, 11, 15, 17, 18, 20 and 21
Ground 7: Stratford in combination with Ericsson renders obvious:	Claims 7, 8, 9, 11, 15, 17, 18, 20 and 21

III. QUALIFICATIONS

4. I received my Bachelor of Science, Master of Science, and Doctor of Philosophy degrees, all in Electrical Engineering, from the Polytechnic Institute of Brooklyn in 1968, 1970, and 1973, respectively. Both my Master's thesis and my Ph.D. dissertation involved theoretical aspects of electromagnetic wave propagation in plasma and gaseous media. From June 1968 through September 1988, I was employed at AT&T Bell Laboratories in various engineering, research, and managerial positions, all in the general area of telecommunications.

5. My initial work at Bell Laboratories (1968-1974) involved high power radar design and development, and signal design and processing for extraction of pertinent information from radar target returns, both focused on anti-ballistic missile defense applications. A modern radar system operates by transmitting carefully designed radio signals toward a target, and processing the reflected radio signals arriving back at the radar, to determine target location, velocity, and key features. For ballistic missile defense applications, it is also important to distinguish real warheads from decoys.

6. My next assignment at Bell Laboratories (1974-1981) was in the Radio Research Laboratory, an organization responsible for basic research, where I was involved in new discovery and proposals involving novel approaches for communication satellite systems. Communication satellites are radio systems,

often world-wide in scope, intended to enable wireless communications among terrestrial users from a platform of one or more Earth-orbiting satellites. My contributions to the communication satellite state-of-the-art included (1) strategies to efficiently encode and recover digital information sent to and from the satellites via high capacity radio beams; (2) novel systems and on-board satellite switching approaches that use multiple radio beams (so-called spot beams), each focused on a small portion of Earth, to vastly increase the capacity of a communication satellite by enabling the radio spectrum to be re-used among the spot beams; (3) strategies to acquire and maintain synchronization of radio signals sent to and from a satellite; and (4) a novel approach to overcome the effects of rain-induced attenuation of the radio beams that dynamically assigns available radio resources to those spots on Earth where rain attenuation is instantaneously most severe.

7. I was promoted to Supervisor of the Data Theory Group at Bell Laboratories in 1981, with responsibility for exploratory development of local area data networks. These are packet-switching networks intended to enable very high speed computer, voice, and video communications via on-demand capture of a shared transmission channel. Several new approaches were suggested and studied.

8. In 1984, I was promoted to Head of the Network Systems Research Department (one of several departments within the Radio Research Laboratory, later to become the Communications Systems Research Laboratory, at Bell

Laboratories) with responsibility for new architectures for packet switching and multiwavelength optical networks, wireless networks for broadband local access, and integrated voice/data wireless networks. Contributions included (1) a system architecture for using a raster of focused radio beams to deliver broadband service to a large number of buildings from a central location within a city; (2) a novel packet switching architecture for Internet-like wide area packet networks; and (3) a wide area multimedia networking strategy to enable access to the enormous information-bearing capacity potential of optical fiber cabling.

9. I was promoted to Director of the Transmission Technology Laboratory in 1987, a group of approximately 80 people with broad charter for exploratory development of (1) transmission and switching systems for next-generation Internet-like packet-based networks and (2) applications for digital signal processing in telecommunications.

10. I left AT&T Bell Laboratories in September 1988 to become Professor of Electrical Engineering and Director of the Center for Telecommunications Research at Columbia University. Here, my responsibilities were three-fold: (1) education of students in the field of telecommunications, (2) pursuit of a program of independent research in the area of telecommunications, and (3) management of a National Science Foundation Engineering Research Center devoted to many aspects of telecommunications and founded for the

express purpose of improving American economic competitiveness through research, education, and transfer of relevant technical findings from academia to the telecommunications industry. Research programs at the Center for Telecommunications Research were focused on multiwavelength fiber optical networks, wireless communications, image and video communications, network management and control, and underlying photonic and electronic devices and materials. Contributions included (1) laboratory implementation and feasibility demonstration of the world's first multiwavelength packet switched optical network; (2) new approaches for randomly accessing a shared radio channel; (3) strategies for enabling rapid handoff among radio cells in a high capacity cellular network; (4) a rigorous understanding of multiwavelength optical network capabilities and limitations; and (5) algorithms for the efficient resource management and control of packet based multimedia networks.

11. In August 1995, I left Columbia University to become Professor of Electrical and Computer Engineering and Director of the Center for Wireless Communications at the University of California, San Diego (UCSD). Again, my responsibilities were threefold: (1) education of students in the field of wireless communications, (2) pursuit of a program of independent research in the area of wireless communications, and (3) management of an industrially funded research center devoted exclusively to wireless communications. Contributions included (1)

strategies for allowing the use of so-called "smart" antennas in cellular-based packet radio networks; (2) a proposal for a new city-wide network based on a wireless mesh-based approach using either focused wireless beams of light or focused radio beams, intended to deliver broadband services to buildings and/or to connect wireless radio cells with the world-wide fiber-optic backbone network; and (3) mobility management strategies for high speed packet-based wireless networks. The second of these contributions has served as the technical foundation for at least two new venture-backed telecommunications equipment companies, one of which I co-founded.

12. In December 1999, I resigned as Director of the Center for Wireless Communications to pursue full-time research and education as a Professor of Electrical and Computer Engineering at UCSD, and on January 1, 2008, I became Professor of Electrical and Computer Engineering, Emeritus, Recalled to Research, maintaining an active research program.

13. At UCSD, I have taught courses on (1) probability, (2) random processes, and (3) wireless networks. My current research is focused on (1) broadband wireless networks for local access to homes, schools, and businesses; (2) wireless spaces to enable ubiquitous voice, data, and video wireless communications within buildings, and (3) so-called ad-hoc (self-organizing) networks of wireless sensor nodes for business and homeland security applications.

14. Over the course of my career, I have published (individually or with collaborators) over 170 original papers in scholarly journals and professional conference proceedings, and I am the named inventor or co-inventor on 40 U.S. patents.

15. I wrote one of the world's first textbooks devoted to broadband telecommunications, entitled An Introduction to Broadband Networks. I have lectured extensively on telecommunications in general and wireless communications in particular, and I have regularly attended, and continue to attend, numerous world-wide professional conferences. I have chaired several major telecommunications conferences, and I have chaired numerous professional conference technical sessions. I read the technical literature extensively, and subscribe to several leading journals in the field of telecommunications in general and wireless communications in particular. Over the years, I have delivered many 3 to 5 day intensive short courses on telecommunications and wireless communications to professional audiences of practicing engineers and others. In 1988, I was elected to the grade of Fellow of the Institute of Electrical and Electronics Engineers, cited for contributions to high capacity digital satellite systems and broadband local communication networks.

16. I am being compensated for my time at the rate of $725 per hour for time spent on this matter. I have no interest in the outcome of this proceeding.

IV. MATERIALS CONSIDERED

17. My technical review, analysis, insights, and opinions are based on my experience and other qualifications discussed above, as well as my study of relevant materials.

18. I have reviewed and am familiar with the '358 patent specification, claims, and prosecution history.

19. I have also reviewed and am familiar with each exhibit cited herein. I confirm that to the best of my knowledge the accompanying exhibits are true and accurate copies of what they purport to be, and that an expert in the field would reasonably rely on them to formulate opinions such as those set forth in this declaration.

Exhibit No.	Exhibit Description
1001	U.S. Patent No. 9,197,358
1002	Prosecution History of U.S. Patent No. 9,197,358
1003	[Present] Declaration of Dr. Anthony Acampora
1004	*Curriculum Vitae* of Dr. Anthony Acampora
1005	Xinyi Xu et al., "Imperfect Digital-Fiber-Optic-Link-Based Cooperative Distributed Antennas with Fractional Frequency Reuse in Multicell Multiuser Network," IEEE TRANSACTIONS ON VEHICULAR TECHNOLOGY, VOL. 60, NO. 9, pp. 4439-49, November 2011 ("Xu")
1006	Huawei, "Further Analysis of Soft Frequency Reuse Scheme" 3GPP TSG-RAN WG1 #42, R1-050841, London, UK (August 29 – September 2, 2005) ("Huawei")
1007	Ericsson, "Inter-cell Interference Handling for E-UTRA" 3GPP TSG-RAN WG1 #42, R1-050764, London, UK (August 29 – September 2, 2005) ("Ericsson")
1008	U.S. Patent No. 6,353,600 to Schwartz et al. ("Schwartz")

1009	U.S. Patent No. 6,785,558 to Stratford et al. ("Stratford")
1010	U.S. Patent Application Publication No. 2012/0039254 to Stapleton et al. ("Stapleton")
1011	U.S. Patent Application Publication No. 2006/0094470 to Wake et al. ("Wake")
1012	U.S. Patent Application Publication No. 2010/0128676 to Wu ("Wu")
1013	U.S. Patent Application Publication No. 2005/0157675 to Feder et al. ("Feder")
1014	U.S. Patent Application Publication No. 2009/0180426 to Sabat et al. ("Sabat")
1015	[Intentionally Blank]
1016	Provisional Application No. 61/649,143, filed on May 18, 2012 ("Provisional Application")
1017	Utility Patent Application No. 13/894,309, filed on May 14, 2013 (later granted as the '358 patent) ("Utility Application")
1018	Red-line comparing the Provisional Application (Ex. 1016) to the Utility Application (Ex. 1017)
1019	Masaaki Fujii, "User Scheduling for Distributed-Antenna Zero-Forcing Beamforming Downlink Multiuser MIMO-OFDM Systems," IEICE Transactions on Communications, Vol. E93-B, No. 9, pp. 2370-2380 (September 2010) ("Fujii")
1020	Patent Owner's Infringement Contentions asserting the '358 patent against Corning's SpiderCloud E-RAN System submitted in litigation between Patent Owner and Corning, *Dali Wireless, Inc. v. Corning Optical Communications, LLC*, No. 3:20-cv-06469-EMC (N.D. Cal.)
1021	Patent Owner's Infringement Contentions asserting the '358 patent against CommScope's OneCell product submitted in litigation between Patent Owner and CommScope, *Dali Wireless, Inc. v. AT&T Corp., et al.*, No. 2:22-cv-00012-RWS-RSP (E.D. Tex.).
1022	Declaration of Sylvia Hall-Ellis, Ph.D.
1023	Petition for *Inter Partes* Review of U.S. Patent No. 9,197,358, *Corning Optical Communications LLC v. Dali Wireless, Inc.*, IPR2021-00492, Paper 2 (PTAB Feb. 22, 2021)

1024	Patent Owner's Preliminary Response, *Corning Optical Communications LLC v. Dali Wireless, Inc.*, IPR2021-00492, Paper 6 (PTAB Jun. 9, 2021)
1025	PTAB Decision Denying Institution of *Inter Partes* Review, *Corning Optical Communications LLC v. Dali Wireless, Inc.*, IPR2021-00492, Paper 8 (PTAB Sep. 7, 2021)
1026	Claim Construction Order in litigation between Patent Owner and Corning asserting the '358 patent, *Dali Wireless, Inc. v. Corning Optical Communications LLC*, No. 3:20-cv-06469-EMC (N.D. Cal. Jul. 19, 2021)
1027	Pengfei Ren et al., "A Novel Inter-Cell Interference Coordination Scheme for Relay Enhanced Cellular Networks," 2011 IEEE VEHICULAR TECHNOLOGY CONFERENCE (VTC), San Francisco, California, US (September 5 – 8, 2011) ("Ren")
1028	Final Written Decision of *CommScope Technologies LLC v. Dali Wireless Inc.*, IPR2018-00571, Paper 53 (PTAB August 12, 2019) ("'473 patent IPR")

V. RELEVANT LEGAL PRINCIPLES

A. Effective Filing Date

20. I understand that claims of a patent have an "effective filing date" and that obviousness is considered based on the prior art as of that date.

21. The utility application for '358 patent (application No. 13/894,309) was filed on May 14, 2013 ("Utility Application"). The Utility Application claims priority to a Provisional Application No. 61/649,143, filed on May 18, 2012 ("Provisional Application").

22. For the purpose of this proceeding, I have been asked to use May 18, 2012 as the effective filing date for challenged claims 7, 8, 9, 11, 15, 17, 18, 20 and 21.

B. Person of Ordinary Skill in the Art

23. I have been informed that a person of ordinary skill in the art ("POSA") is a person who is presumed to have complete knowledge of the relevant prior art and who would think along the lines of conventional wisdom in that art. The person of ordinary skill in the art has ordinary creativity and does not have extraordinary skill, e.g., is not an expert. I have been informed that factors to consider in determining the level of ordinary skill in the art include the educational level of workers in the field, the types of problems addressed in the art, prior-art solutions to such problems, how quickly innovations are made, and the complexity of the technology.

24. The '358 patent relates to wireless communication systems. Generally speaking, the '358 patent is directed to wireless communication systems, distributed antenna systems, and techniques for mitigating Inter-Cell Interference ("ICI"). *See* Ex. 1001 at Title, 1:16-32, 6:25-28. In view of the factors mentioned above and the discussion of the technical background herein, it is my opinion that a person of ordinary skill in the art of the '358 patent would have had a bachelor's degree in electrical engineering and a minimum of 3-4 years of industry experience in wireless communications networks and engineering, including some knowledge of or experience with distributed antenna systems. An individual with a master's

degree in electrical engineering would require less industry experience (e.g., 1-2 years).

25. I note that this is the level of ordinary skill in the art adopted by the Board when it addressed a previous petition for IPR relating to the '358 patent. Ex. 1025 at 9. Also, my opinions herein would not change if the level of skill in the art were found to be what the petitioner or patent owner had advanced in the prior IPR proceeding. *See id.* For example, whether the person of ordinary skill in the art would have "some knowledge or experience" with DAS vs "some knowledge and experience" with DAS is not significant enough to alter my opinions herein.

26. Throughout my declaration, even if I discuss my analysis in the present tense, I am always making my determinations based on what a POSA would have known at the time of the invention.

C. Claim Construction Standard

27. I have been instructed by counsel on the law regarding claim construction and patent claims, and understand that a patent may include two types of claims—independent claims and dependent claims. An independent claim stands alone and includes only the features it recites. A dependent claim can depend from an independent claim or another dependent claim. I understand that a

dependent claim includes all the features that it recites in addition to all of the features recited in the claim from which it depends.

28. In an *inter partes* review proceeding such as this, I understand the claim of a patent shall be construed using the same claim construction standard that would be used to construe the claim in a civil action. I understand this includes construing the claim in accordance with the ordinary and customary meaning of such claim as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. For completeness, I understand this standard is different from the prior "broadest reasonable interpretation" standard that was used in certain earlier inter partes review proceedings.

29. I understand an appropriate dictionary definition may provide evidence explaining the ordinary and customary meaning as would be understood by a person of ordinary skill in the art.

30. I understand that if there are specific statements in the specification that define the invention with respect to a term, those statements are strong evidence of a definition for the term.

D. Construing Terms of '358 Patent

1. Interpretation of "a [first / second] communications unit" (claims 7, 15)

31. A "communications unit" can include multiple separate remote antenna units or DRUs. *See, e.g.*, Ex. 1001 at 3:46 ("The first communications

unit can include a central DRU and a plurality of peripheral DRUs disposed adjacent the central DRU."); 4:29-30 ("The first communications unit can include a plurality of DRUs…"); 4:43-46 ("The first communications unit can include a first plurality of digital remote units and the second communications unit comprises a second plurality of digital remote units."); 5:49-60 ("In an implementation of this architecture, which is described herein, the antennas are distributed in a hexagonal cell such that the central antenna is responsible for serving a special area using multiple frequency bands (e.g., all of the frequency bands) while the remaining antennas utilize only a subset of the frequency bands based on a frequency reuse factor."); Fig. 2; 9:48-59; 10:43-49 ("In an embodiment in which multiple DRUs are utilized per cell, the horizontal stripe geographical area in Cell 1 is associated with the outer DRUs in the communications unit illustrated as eNB0 in FIG. 2 (i.e., DRUs 1-6) and the grey geographical area in Cell 1 is associated with the central DRU in the communications unit illustrated as eNB0 in FIG. 2 (i.e., DRU0).").

2. Other claim terms

32. In view of the prior art applied in my analysis, I do not expect the meaning of other terms in the challenged claims (7, 8, 9, 11, 15, 17, 18, 20, and 21) to be disputed.

33. I understand that "host unit" (claims 8, 15) has been identified as a term to be construed in pending litigation between the Patent Owner and Petitioner. In view of the prior art applied in my analysis, I do not expect that the meaning of "host unit" will be in dispute in this proceeding.

34. I understand that the '358 patent is the subject of a claim construction order in litigation between the Patent Owner and Corning Optical Communications in the Northern District of California. Ex. 1026 at 35-41. In that order, the court construed two terms: "distributing communications frequencies" (preamble of claim 7); and "geographic footprint" (claims 7, 9-10, 12, 15, 19). *Id.* First, the court found "distributing communications frequencies" (preamble of claim 7) to have its plain and ordinary meaning and is a limitation of claim 7. Ex. 1026 at 35. As to the plain and ordinary meaning of this term, the Court states "[t]he Court need not construe 'distributing communication frequencies,' with the understanding that 'distributing' essentially implicates a DAS." Ex. 1026 at 38. Second, the court found "geographic footprint" to mean "radio coverage area". Ex. 1026 at 39.

35. In view of the prior art applied in my analysis, I do not expect that the meaning of "distributing communications frequencies" and "geographic footprint" will be in dispute in this proceeding.

E. Anticipation and Obviousness Law

36. In this declaration I have been instructed by counsel on the law regarding anticipation and obviousness. I understand that a claim is invalid if it is anticipated or obvious. My opinions here relate to both anticipation and obviousness as detailed below.

1. Anticipation

37. I understand that anticipation of a claim requires that every element of a claim is expressly or inherently disclosed in a single prior art reference. I understand that an anticipating reference need not use the exact terms of the claims, but must describe the patented subject matter with sufficient clarity and detail to establish that the claimed subject matter existed in the prior art and that such existence would be recognized by persons of ordinary skill in the field of the purported invention. I also understand that an anticipating reference must enable one of ordinary skill in the art to reduce the purported invention to practice without undue experimentation.

2. Obviousness

38. I understand that a patent claim is also invalid if the claims would have been obvious to a POSA at the time of the invention. I understand that the obviousness inquiry should not be done in hindsight but rather from the perspective of a POSA as of the time of the invention.

39. I understand that to obtain a patent, the claims must have been, as of the time of the invention, nonobvious in view of the prior art. I understand that an obviousness analysis involves comparing a claim to the prior art to determine whether the claimed invention would have been obvious to a POSA at the time of the invention in view of the prior art and in light of the general knowledge in the art as a whole. I also understand that obviousness is ultimately a legal conclusion based on underlying facts of four general types, all of which must be considered:

(1) the scope and content of the prior art;

(2) the level of ordinary skill in the art;

(3) the differences between the claimed invention and the prior art; and

(4) any objective indicia of nonobviousness.

40. I understand that a claim is obvious when 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 to a POSA at the time of the invention.

41. I understand that certain objective indicia can be important evidence regarding whether a patent is obvious. Such indicia include: industry acceptance; commercial success of products covered by the patent claims; 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 as

compared to the closest prior art; praise of the invention by the infringer or others in the field; taking of licenses under the patent by others; expressions of surprise by experts and those skilled in the art at making the invention; and the patentee proceeded contrary to the accepted wisdom of the prior art. I understand that such evidence must have a nexus, or causal relationship to the elements of the claim. I am unaware of any such objective considerations having a nexus to the claims at issue in this proceeding.

42. I understand that obviousness can be established by combining multiple prior art references to meet each and every claim element, or by modifying a single prior art reference.

43. I understand that that a showing of obviousness requires that, as of the patent's effective filing date, (1) a POSA would have been motivated to combine prior art references to arrive at the claimed subject matter and (2) there would have been a reasonable expectation of success in achieving the claimed invention from such combination.

44. I also understand that to support a combination of multiple prior art references or a modification of a single reference, there must be a rationale explaining why a skilled artisan would combine or modify the references in the manner claimed and how the proposed combination or modification meets each and every claim element. But I also understand that a proposed combination or

modification of references can be susceptible to hindsight bias. When it appears hindsight bias is being used, I understand the modification or combination is not considered obvious.

45. I understand that exemplary rationales that may support a conclusion of obviousness include: combining or modifying prior art elements according to known methods to yield predictable results; simple substitutions of one known element for another to obtain predictable results; using a known technique to improve similar devices in the same way; applying a known technique to a known device ready for improvement to yield predicable results; choosing from a finite number of identified, predicable solutions, with a reasonable expectation of success; 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 are predicable to one of ordinary skill in the art; and 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 teachings to arrive at the claimed invention.

46. I understand that teaching away, e.g., discouragement from making the proposed modification, is strong evidence that the references are not combinable. I also understand that a disclosure of more than one alternative does not necessarily constitute a teaching away.

47. I understand that the combination does not need to result in the most desirable embodiment, but if the proposed combination does not have a reasonable expectation of success at the time of the invention, a POSA would not have had an adequate teaching, suggestion, or motivation to combine the references.

48. I understand that the test for obviousness is not whether the features of a secondary reference may be bodily incorporated or physically combined into the structure of the primary reference, but whether the claimed invention is rendered obvious by the teachings of the references as a whole.

VI. THE '358 PATENT

A. Technology Background

1. Distributed Antenna Systems

49. Distributed antenna systems are used, for example, to transport wireless communications signals to provide coverage to remote sites or difficult-to-reach coverage areas. Distributed antenna systems typically: (1) receive communication signals from a base station, (2) condition or manage those communication signals as appropriate (e.g., via circuity included in a DAS host unit to convert the signals from analog to digital, convert the signals from electrical to optical, or other conditioning to prepare the signals for transport), (3) transport those signals using coaxial cable, optical fiber, or a radio frequency (RF) link a plurality of antenna units in targeted coverage areas (although in the '358 patent,

the number of antenna units may be as small as one, in a configuration sometimes referred to as a remote antenna), and (4) rebroadcast the wireless signals into the targeted area to wireless units such as mobile phones. Distributed antenna systems also transport communication signals in the opposite direction. That is, the antenna units receives wireless communications from, for example, mobile phones within the targeted coverage areas and transport those signals back to a DAS hub or host unit for delivery to the base station. *See, e.g.*, Ex. 1014 at ¶ 0005, Fig. 3.

> …Distributed Antenna Systems are used to provide wireless communications coverage where it is ***impractical to install a conventional base station***. An example is in-building coverage where low cost radiating antennas are desired and base stations represent either too large or too expensive a solution. Distributed Antenna Systems allow a donor base station to be ***located outside the desired coverage area*** and its RF signals are distributed to multiple antennas using either electrical or optical means.

Id. at ¶ 0005.[1] *See also* Ex. 1014 at Fig. 3 showing an example of a DAS (reproduced below).

[1] All bold, italic or underline emphasis herein is added, unless otherwise indicated.

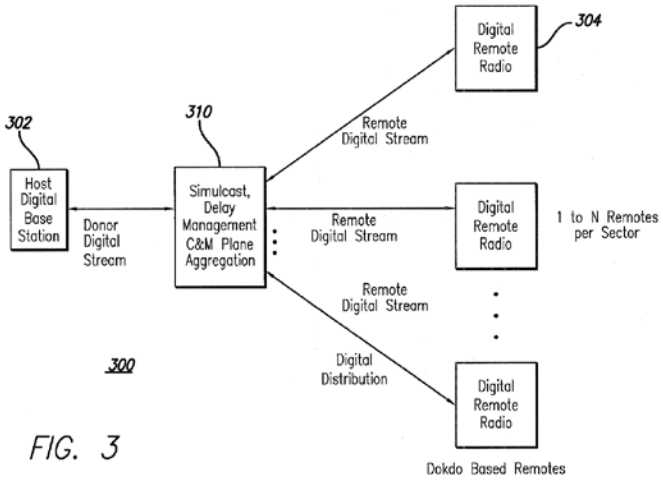


FIG. 3

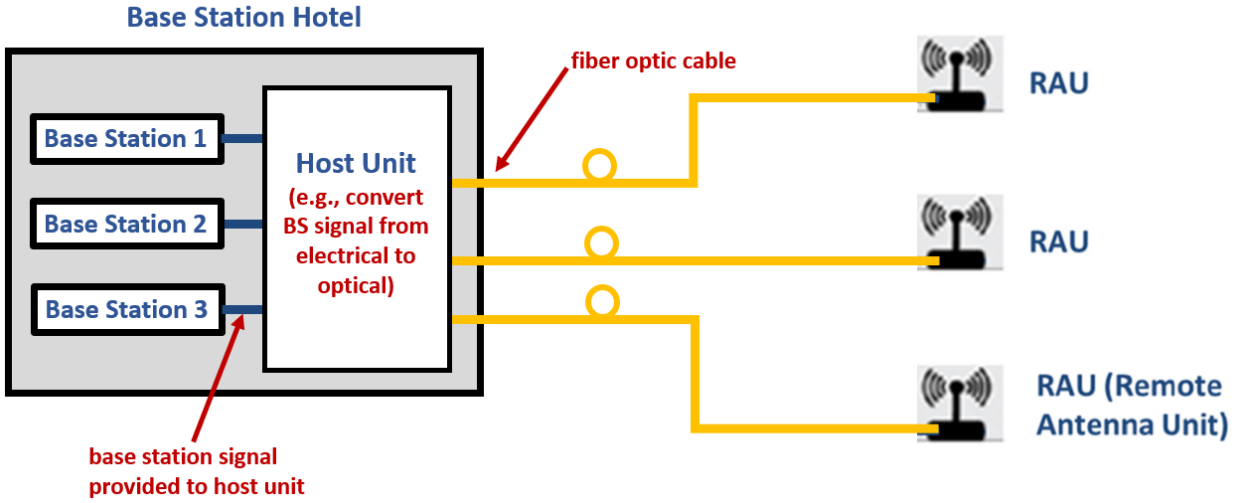
50. Distributed antenna systems (DAS) were known in the art and had been deployed for years prior to the filing of the '358 patent. "A DAS ***typically*** includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units." Ex. 1001 at 1:17-20.

> According to an embodiment of the present invention, a method for routing and switching ***operator RF signals*** is provided. The method includes providing ***one or more*** Digital Remote Units (DRUs), each configured to receive one or more downlink radio frequencies and to transmit one or more uplink radio frequencies, and providing at least one Digital Access Unit (DAU [an example of a host unit]) ***configured to communicate*** with at least one of the one or more DRUs.

Ex. 1001 at 1:50-57.

51. A DAS host unit, together with the DAS transport links "provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:21-24. "A radio base station is often

employed at the host unit location commonly known as a base station hotel … ." Ex. 1001 at 1:20-21. The DAS host unit (e.g., DAU) is "configured to communicate with at least one of the one or more DRUs." Ex. 1001 at 1:55-57. As noted, the transport links can be optical fiber and the host unit functionality may include, for example, converting the base station communication signals from electrical to optical for transport over a fiber optic link to the remote antenna units. These background concepts of employing a host unit at the base station(s) are illustrated in the drawing below.



52. While a DAS host unit functionality can be located at or even shown as included within the same box as the base station functionality, a DAS host unit is not a base station. A "host unit" is a unit that distributes communications frequencies between an operator network and one or more remote antenna units. A POSA, either before or after reading the '358 patent, would understand that a

DAS host unit is not a base station. The '358 patent distinguishes the base station from the host unit in that the DAS host unit "provides a means for distribution of the base stations downlink and uplink signals …" Ex. 1001 at 1:22-23. In the downlink, for example, after the base station functionality is complete, the base station signal can be provided to one or both of (a) a co-located base station antenna or (b) a DAS host unit. In both (a) and (b), the downlink base station functionality including the data modulation and scheduling functionality has been performed by the base station. But when the base station signals are provided to a host unit, the host unit will perform additional functionality to facilitate the transport of the signals over longer distances to the remote antenna units. Ex. 1001 at 1:55-57 ("providing at least one Digital Access Unit [host unit] … ***configured to communicate*** with at least one of the one or more DRUs.")

53. As indicated in the drawings, the main components of a distributed antenna system typically are the host or hub communicatively coupled to remote antenna units. In the downlink direction, the host unit, which is usually positioned in close proximity to a base station (or at a base station hotel as illustrated above), receives signals from the base station, converts the signals to an appropriate form for distribution to the remote antenna units and then transmits the resulting signals to the remote antenna units located within the desired coverage area, e.g., cell sites. The antenna units convert and condition the signal to an appropriate form for

wireless transmission and then radiate the signals wirelessly using antennas to wireless devices such as cell phones in the coverage area. In the reverse direction, the antenna units receive wireless signals transmitted by cell phones in their coverage areas, convert these into an appropriate form for transmission back to the host which then, for example, delivers a composite signal to the base station.

54. Well-known benefits to using a DAS to transport signals created by the base station to cell sites include: (1) in transporting signals, a DAS is agnostic to the air interface or wireless communication protocol used by the base station to modulate data onto the RF carriers, and (2) by using a DAS to transport radio resources to remote cell sites, the network operator can locate its base stations at a centralized site (known as a base station hotel) that is remote from the cell sites. A related benefit to item (2) is that it allows for the base station equipment to be more efficiently updated (i.e., as opposed to requiring a technician to travel to multiple remote sites to update the same equipment. Another related benefit to item (2) is that it gives the network operator more cost-effective options for storing the base station equipment. This benefit is particularly important for cellular network deployments in densely populated areas where purchasing or leasing property can be very expensive and thus cost prohibitive.

55. There were multiple approaches known in the art for a distributed antenna system. As explained, for example, in the Sabat prior art reference (Ex.

1014), both analog and digital DAS systems were known, and the communication link between the host units and the remote units could be either an analog interface or a digital interface. *See, e.g.*, Ex. 1014 at Figs. 1-2; ¶¶ 0008, 0013.

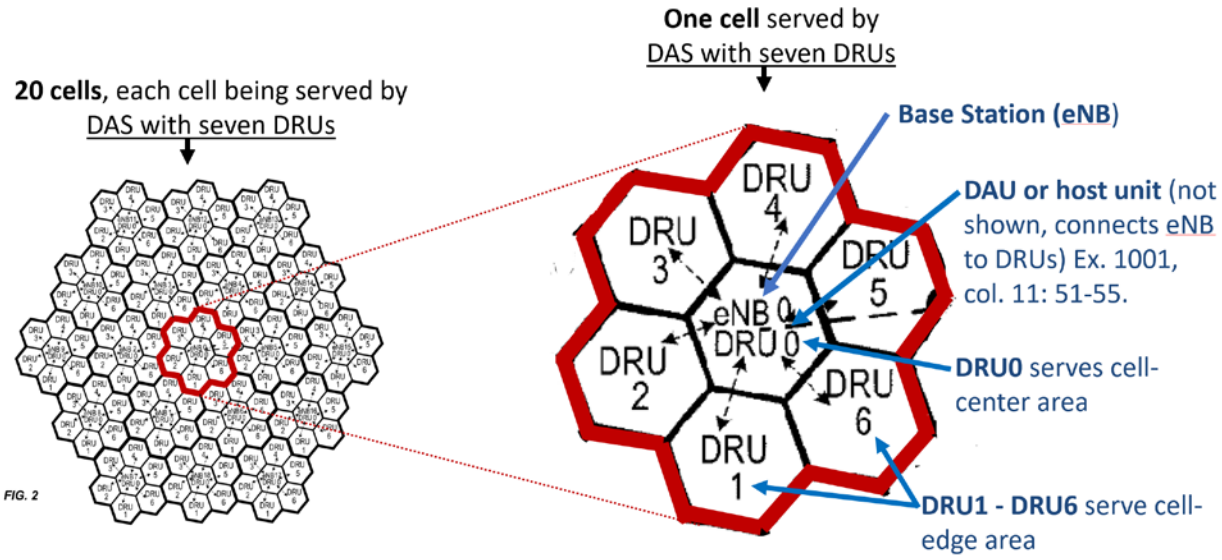
56. The coupling between the base station and the remote antenna units could be copper cabling (for shorter distances), optical fiber cable (for longer distances), or RF link (for line-of-sight applications). Ex. 1012 at ¶0004 ("Frequently, the RTUs [remote transceiver units] lack wireless line-of-sight to the base stations due to geography. Rather than RTUs and base stations interacting wirelessly, they communicate with each other by digitized data over a backhaul fiber optic link."); Ex. 1005 at 4439 ("[f]or practical application of DASs, the connection between the BS and RAs [remote antennas] may be a coaxial cable, optical fiber, or a radio frequency (RF) link."); Ex. 1001 at 6:59-61 ("dedicated wires, fiber optics, or via a radio frequency link"); Ex. 1011 at Fig. 3 and ¶0030 ("The remote hubs may also be interconnected, again using either cable links or wireless links, to provide additional resilience to the system.").

57. Typically, in a digital DAS, where the host receives analog radio frequency ("RF") signals from the base station, the host will include analog to digital converters to sample the RF signals to convert them to digital for transmission to the remote units which will then reconvert the signals from digital to analog before wireless transmission. Similar steps are taken for signals traveling

in the reverse direction from the cell phones. *See, e.g.*, Ex. 1014 at ¶ 0013 ("A digital distribution network, illustrated in FIG. 2, adds the extra steps of Analog-to-Digital and Digital-to-Analog conversions at both ends of the DAS network.").

58. DASs have been widely used as an effective way to provide wireless coverage to difficult-to-reach areas or to provide wireless communications coverage where it is impractical to install a conventional base station. Ex. 1014 at ¶0005; Ex. 1001 at 6:53-56. ("Distributed Antenna System (DAS) have been widely implemented in state-of-the art cellular communication systems to cover dead spots in wireless communications systems.").

59. The '358 patent illustrates how multiple distributed antenna systems can be deployed in a cellular communications system. Fig. 2 shows a cluster of cells with each cell being served by a separate DAS. Each cell includes a center Digital Remote Unit ("DRU" or "remote antenna") that serves the cell-center area and six distributed remotes to serve the cell-edge area. In each cell, a base station ("eNB") is shown to be co-located with the center remote. One cell from Fig. 2 is pulled out and enlarged below. Each cell in Figure 2 includes such a DRU at its center co-located with a base station (eNB) and six surrounding DRUs.



60. "These distributed antennas are connected to the eNodeB (eNB) LTE system by dedicated wires, fiber optics, or via a radio frequency link." Ex. 1001 at 6:57-61. The system can also include host unit (e.g., a digital access unit or DAU) that serves as the interface between the eNB and the antenna units.

> The first communications unit can include a central DRU and a plurality of peripheral DRUs disposed adjacent the central DRU. The system can also include a DAU communicatively coupled to the central DRU and the plurality of peripheral DRUs.

Ex. 1001 at 3:46-50.

61. In the downlink, the DAU converts the downlink RF signals to digitized RF signals and transmits the digitized RF signals over fiber to the digital remote units (DRUs).

62. The DRUs can comprise "remote radio units" (Ex. 1001 at 2:59). The host unit (DAU) may also be used as the interface to a plurality of base stations.

> The DRUs can comprise remote radio units. The method may also include communicating between a plurality of Base Transceiver Stations (BTS) coupled to the at least one DAU. One or more of the plurality of BTSs can be coupled to the DAU using a plurality of BTS sector RF connections. The method may further include transporting signals between one or more DRUs and the at least one DAU.

Ex. 1001 at 2:59-65; claim 3 ("method of claim 1 further comprising communicating between a plurality of Base Transceiver Stations (BTS) coupled to the at least one DAU."). The plurality of base stations may be co-located at a remote site, "commonly known as a base station hotel" (Ex. 1001 at 1:21), and the base station hotel may employ a DAS host unit as "a means to for distribution of the base station's downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24. The demonstrative below illustrates how this known concept of employing a host unit at a "base station hotel" to distribute the RF signals of the base stations to the cell sites of Fig. 1C of the '358 patent. *See also* Ex. 1009 at 1:60-65 ("The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. In these types of areas it is getting increasingly more difficult to deploy new cell sites due to a variety of factors including regulatory and space constraint issues.").

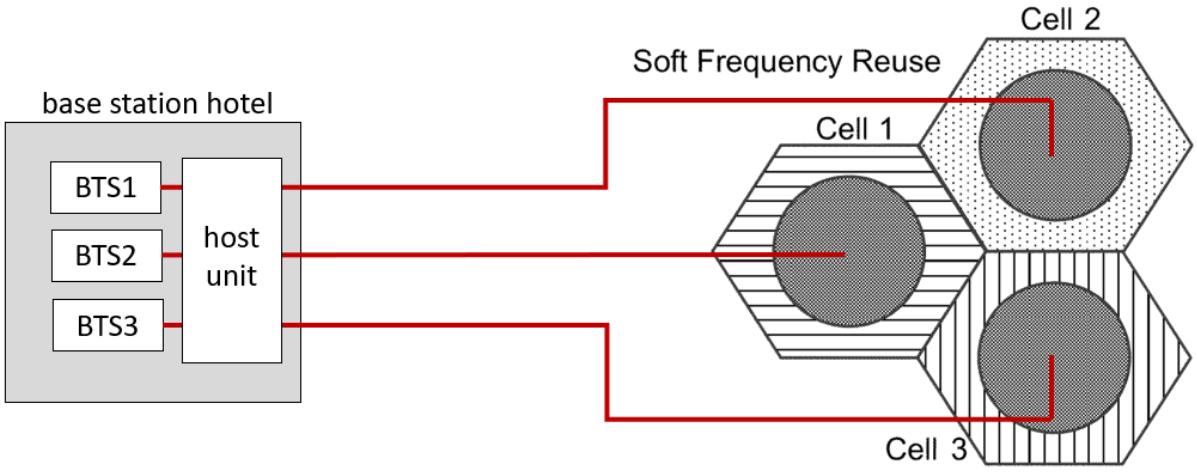
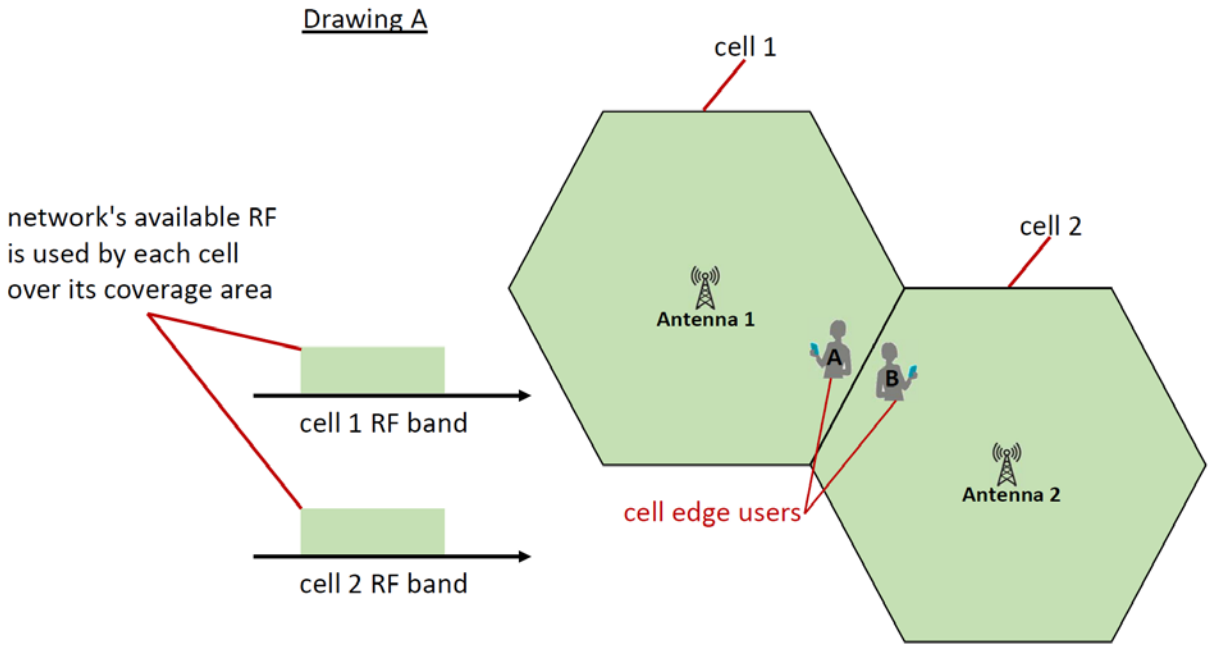


FIG. 1C

2. The Problem Addressed by the '358 Patent

63. The '358 patent purports to address the problem of inter-cell interference ("ICI") between neighboring cells of a cellular network. When the network's entire available radio frequencies are used by adjacent cells to transmit different communications over their respective coverage areas (as illustrated by demonstrative Drawing A), "[u]sers located at the cell edge largely suffer from co-channel interference ... or inter-cell interference from base stations (BS) of neighboring cells." Ex. 1001 at 6:25-28.



64. When "each cell serves users using the entire system bandwidth", the system has "a frequency reuse factor of one." Ex. 1001 at 6:28-29. Other references call this "unity frequency reuse" or "UFR". Ex. 1005 at 4439 (Section I). In Drawing A, when cell-edge users A and B each transmit or receive different data using the same frequencies, inter-cell interference often corrupts that data, reducing the data throughput. Ex. 1001 at 5:44-52 (for OFDMA-based systems "the downlink performance of cellular networks is ***known*** to be strongly limited by inter-cell interference").[2]

3. Known Techniques for Mitigating ICI

a. Distributed Antenna Systems

[2] All bold, italic or underlined emphasis herein is added, unless otherwise indicated.

65. As of the effective filing date for the challenged claims of the '358 patent, a POSA would have known that distributed antenna systems "were available" (Ex. 1001 at 1:16-17), had been "widely implemented in state-of-the art cellular communication systems" (Ex. 1001 at 6:53-55), and "typically" included "one or more host units" (Ex. 1001 at 1:17-18).

66. In addition to the known benefits discussed above under Section IV.A.1, it was also known that a DAS helps to mitigate inter-cell interference and improve data throughput. Ex. 1005 at 4439 ("a DAS improves the cell-edge throughput by placing the remote antennas (RAs) closer to the cell-edge terminals, hence naturally reducing the pathloss.").[3] The '358 patent also identifies this known DAS benefit of "alleviating interference" and enhancing "data throughput." Ex. 1001 at 6:44-48 (reducing the "overall transmit power by using" a DAS helps to "alleviate interference").

> Wireless communication systems employing Distributed Antenna Systems (DAS) are available. ...
>
> A DAS is advantageous from a signal strength and throughput perspective because its remote antenna units are physically close to wireless subscribers. The benefits of a DAS include ***reducing average downlink transmit power*** and ***reducing average uplink transmit power***, as

[3] Xu (Ex. 1005) was neither disclosed to nor considered by the Patent Office in the prosecution of the '358 patent.

well as ***enhancing quality of service and data throughput***."

Ex. 1001 at 1:16-32.

b. Frequency Reuse Techniques

67. Frequency reuse techniques were also known to be helpful in mitigating inter-cell interference.

68. The '358 patent introduces two examples of frequency reuse techniques: (1) Fractional Frequency Reuse (Figs. 1B and 1E) and (2) Soft Frequency Reuse (Figs. 1C and 1F) (these two techniques will be collectively referred to as "frequency reuse techniques").

69. Fractional Frequency Reuse. A known implementation of fractional frequency reuse is shown in the '358 patent in Figs. 1B and 1E (below).

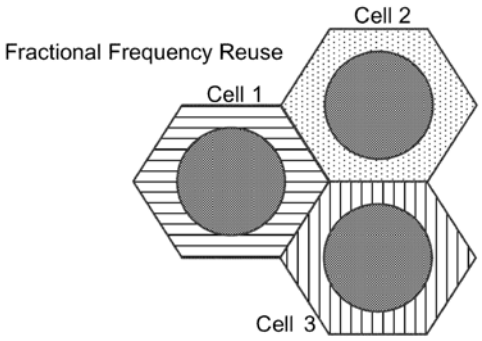


FIG. 1B

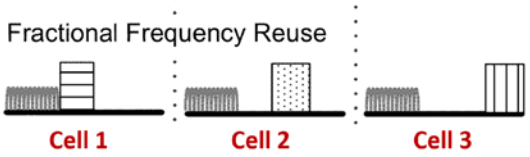


FIG. 1E

Below is a demonstrative I had prepared to assist in understanding the fractional frequency reuse of Fig. 1B and 1E.

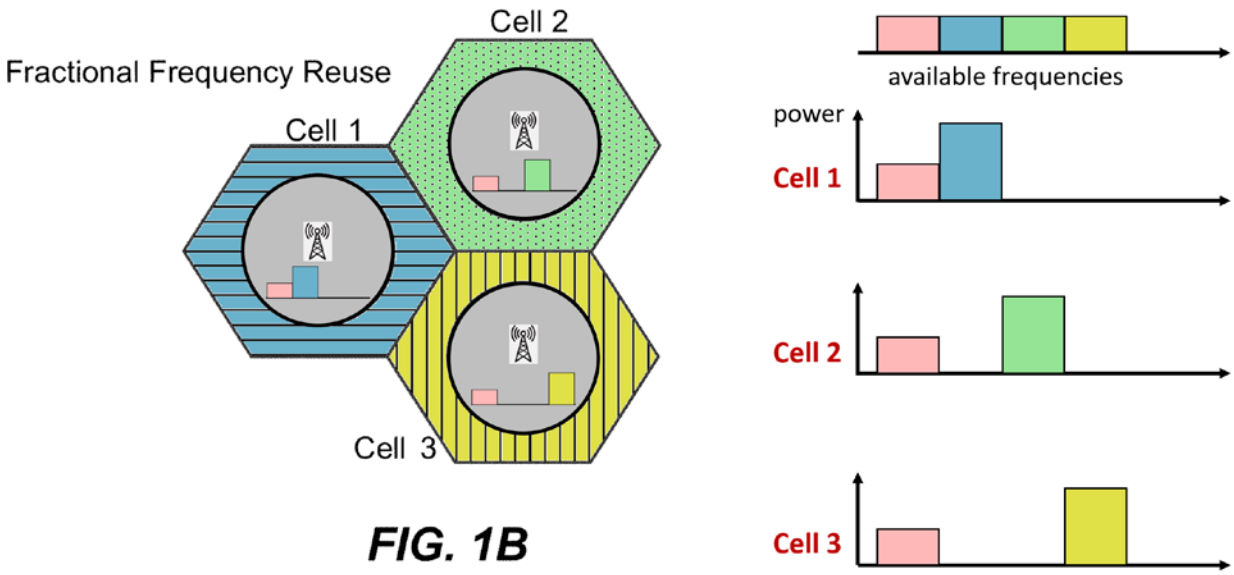


FIG. 1B

Each cell is served by one centrally located antenna unit (above). In each cell, the antenna unit transmits the red band at a lower power to define a cell-center radio coverage area for the red band (i.e., the red band is reused in the cell center of each of the cells). Each of the antenna units also transmits a different second band (cell 1= blue; cell 2= green; and cell 3 = yellow) at a higher power to define a cell-edge radio coverage area for the respective band. In this three-cell network, no frequencies are reused in the cell-edge area.

70. Soft Frequency Reuse. A known implementation of soft frequency reuse is shown in the '358 patent in Figs. 1C and 1F (below).

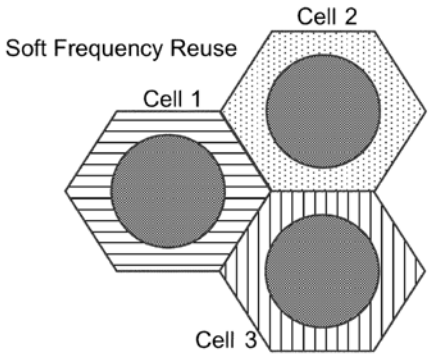


FIG. 1C

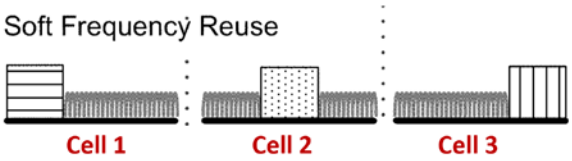
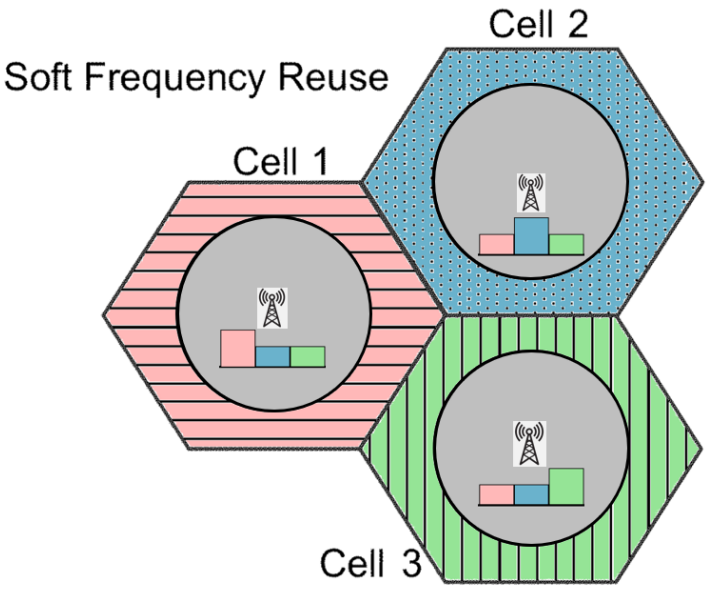


FIG. 1F

Below is a demonstrative I had prepared to assist in understanding the Fractional Frequency Reuse of Fig. 1C and 1F.



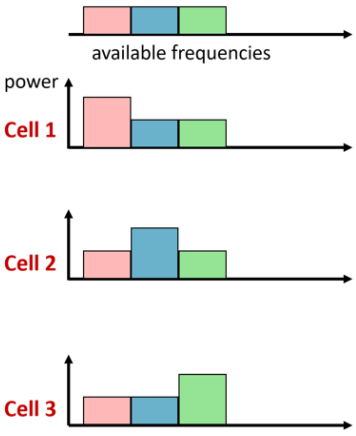


FIG. 1C

Each cell is served by one centrally located antenna unit. In each cell, the antenna unit transmits all three bands, but one of the three bands is sent at a higher power level. Cell 1 transmits the blue and green bands at a lower power to define a cell-

center radio coverage area using those bands, plus the red band at a higher power level to define an edge radio coverage area for cell 1 using the red band. Cell 2 sends the red and green bands at a lower power to define a cell-center coverage area using the red and green bands, plus the blue band at a higher power level to define an edge radio coverage area for cell 2 using the blue band. Cell 3 sends the red and blue bands at a lower power to define a cell-center coverage area using the red and blue bands, plus the green band at a higher power level to define an edge radio coverage area for cell 3 using the green band. Each of the antenna units transmits a different band (cell 1= red; cell 2= blue; and cell 3 = green) at a higher power to define a respective cell-edge radio coverage area using only the respective band. In this three-cell network, no frequencies are reused in the cell-edge areas, and yet all bands are used in all cells and are available in the cell-center coverage region of each cell. However, only one of the three distinct bands are available for use in each of the three cells edge coverage regions.

71. [Intentionally Blank]

.

72. I agree that before the effective dates for the challenged claims, the frequency reuse techniques shown in Figs. 1A & 1D; 1B & 1E and 1C & 1F of the '358 patent were known techniques used in cellular networks to mitigate inter-cell interference. E.g., Ex. 1001, 7:51-52 ("Soft Frequency Reuse ... is an inter-cell interference mitigation technique in OFDMA based wireless networks."). See also Ex. 1005 at 4439 (Abstract: "employing fractional frequency reuse techniques in conjunction with … distributed antenna systems (DASs)"), 4440 at Fig. 1 and Section II.A; Ex. 1007 at 2, Fig. 2; Ex. 1027 at 2-3 (Section III.A), Figs. 2-4.

73. In 2005, for example, Ericsson disclosed a frequency reuse technique for a multi-cell OFDM network that corresponds to Fig. 1C of the '358 patent (SFR), noting that Ericsson also refers to SFR as fractional reuse or fractional frequency reuse. *See* Figure 2 of Ericsson, below.[4]

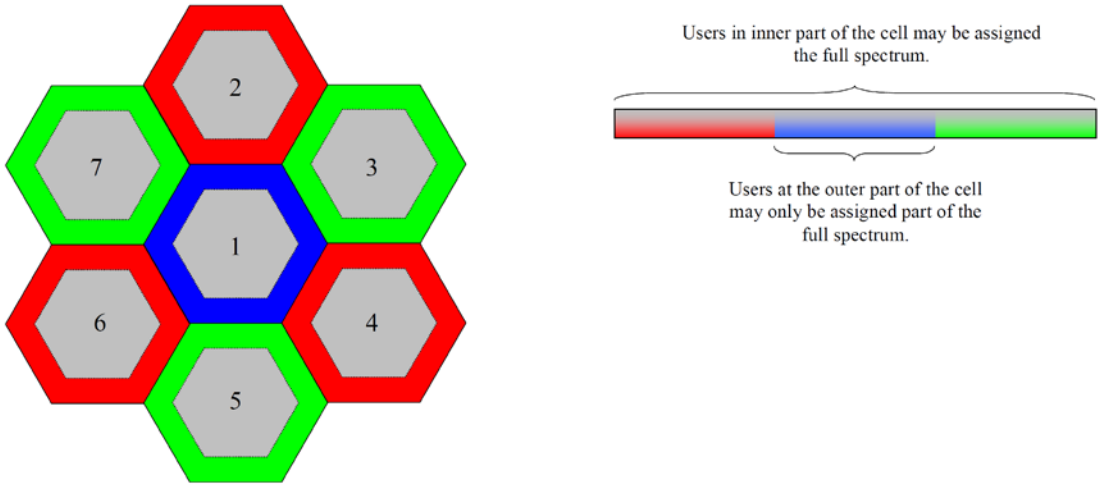


Figure 2: Example illustrating fractional reuse for cell-edge users (a continuous spectrum for the fractional reuse is assumed for illustrative purposes, distributed approaches could equally well be used).

Ex. 1007 at Fig. 2.

74. Ericsson at page 2 describes the frequency reuse technique implemented in Cells 1-7 of Fig. 2, stating:

> Fractional reuse, also known as ***soft frequency reuse*** …, has been proposed as a means to increase the performance for cell-edge users. With fractional reuse, only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users (at the cost of a reduced bandwidth). Typically, fractional reuse is implemented

[4] Ericcson was not cited or considered during prosecution of the '358 patent.

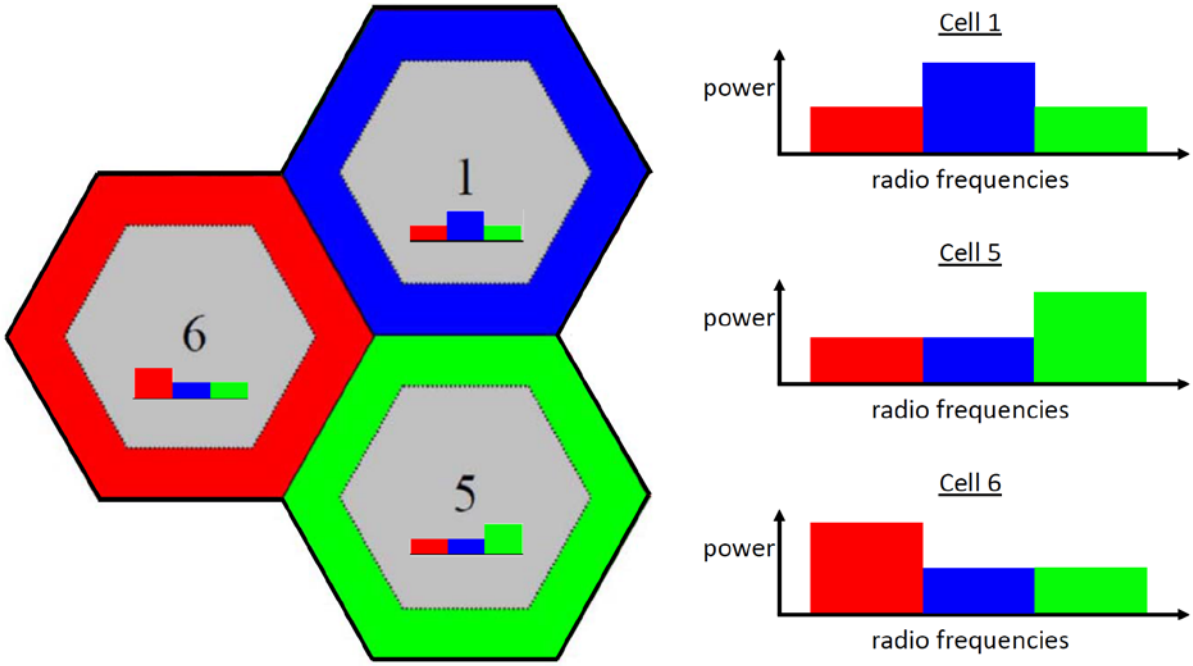
> as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, only cell 1 is allowed to transmit with ***full power*** using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a ***reduced power***. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2 (footnotes omitted).

75. The frequency reuse technique described in Ericsson is the same as the frequency reuse technique shown in Fig. 1C & 1F of the '358 patent, i.e., soft frequency reuse. Ex. 1007 at 2. To avoid any confusion, I note that Ericsson uses the terms "fractional reuse" and "soft frequency reuse" interchangeably to describe the scheme referred to as "soft frequency reuse" in the '358 patent (shown in Figures 1C and 1F). The term fractional frequency reuse as used in the '358 patent refers to an alternative frequency reuse scheme (as shown in Figures 1B and 1E of the '358 patent). Under Ericsson's soft frequency reuse technique, "only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users ... ." Ex. 1007 at 2.

76. To implement soft frequency reuse in a cell that includes one centrally located antenna, Ericsson explains that "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a reduced power. This will reduce the downlink interference seen by cell-edge users served by cell 1." Ex. 1007 at 2.

77. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse technique (specifically, SFR) for cells *having a single, centrally located antenna*. Each cell-center (gray area of Cells 1, 5 and 6) reuses the system's available RF bandwidth (red, blue, green). Each cell transmits a different band ***at a higher power*** to reach and serve its cell-edge users.



B. The alleged invention: combining DAS and frequency reuse techniques for mitigating inter-cell inference

78. While the techniques of DAS and frequency reuse, including fractional frequency reuse (FFR) and soft frequency reuse (SFR), for mitigating interference were known, the inventors of the '358 patent contend that they were the first to combine these DAS with SFR or FFR. Ex. 1001 at 8:57-59 ("On the other hand, there are no studies that combine DAS with SFR in order to reduce inter-cell interference."). The specification thus describes the invention as combining the DAS and frequency reuse techniques to mitigate inter-cell interference in cellular networks. Ex. 1001 at 1:42-43 ("present invention relates to a DAS utilizing Soft Frequency Reuse or Fractional Frequency Reuse techniques.") *See also* Ex. 1001 at 5:39-54, stating:

> Embodiments of the present invention provide a new cell architecture ***combining two inter-cell interference mitigation techniques, Distributed Antenna System and Soft Frequency Reuse***, to improve cell edge users throughput when the system has full spectral efficiency.
> ...
>
> In order to mitigate this interference, a number of techniques have recently been proposed, e.g. the Soft Frequency Reuse (SFR) scheme and Distributed Antenna System (DAS). According to embodiments of the present invention, ***these two techniques are combined in a unique cell architecture, which can be referred to as DAS-SFR***.

Ex. 1001 at 5:39-54.

C. The '358 Patent Specification

79. The '358 patent describes two embodiments for implementing frequency reuse techniques (FFR and SFR) in a multi-cell network.

80. The two embodiments are similar in the following regard: In both embodiments, each cell includes "a communications unit" that creates two different coverage areas including a cell-center (gray) and a cell-edge (red) as shown below (e.g., the SFR and FFR examples below). In the cell-center, at least some frequencies will be reused. For SFR, each cell center will reuse all of the system's available frequencies (below). For FFR, each cell center will reuse some common subset of the system's available frequencies (below). In the cell-edge of adjacent cells, frequencies are not reused. For adjacent cells in the network, each of the respective cell edge area will be served by a different subset of the available resources.

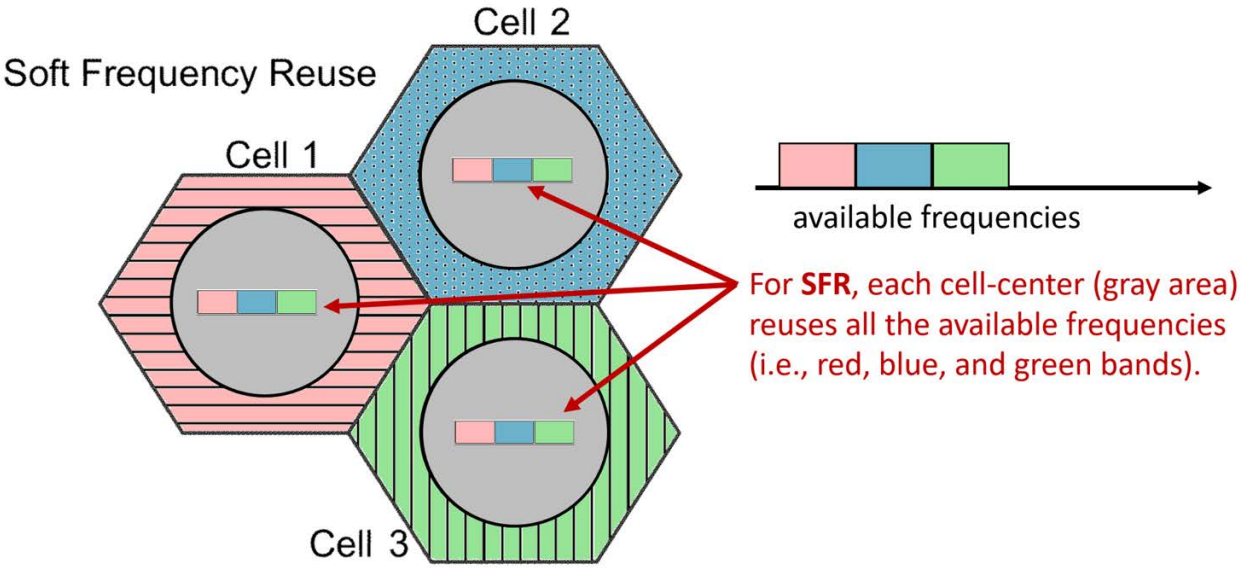

Soft Frequency Reuse
Cell 1
Cell 2
Cell 3
available frequencies
For SFR, each cell-center (gray area) reuses all the available frequencies (i.e., red, blue, and green bands).

FIG. 1C

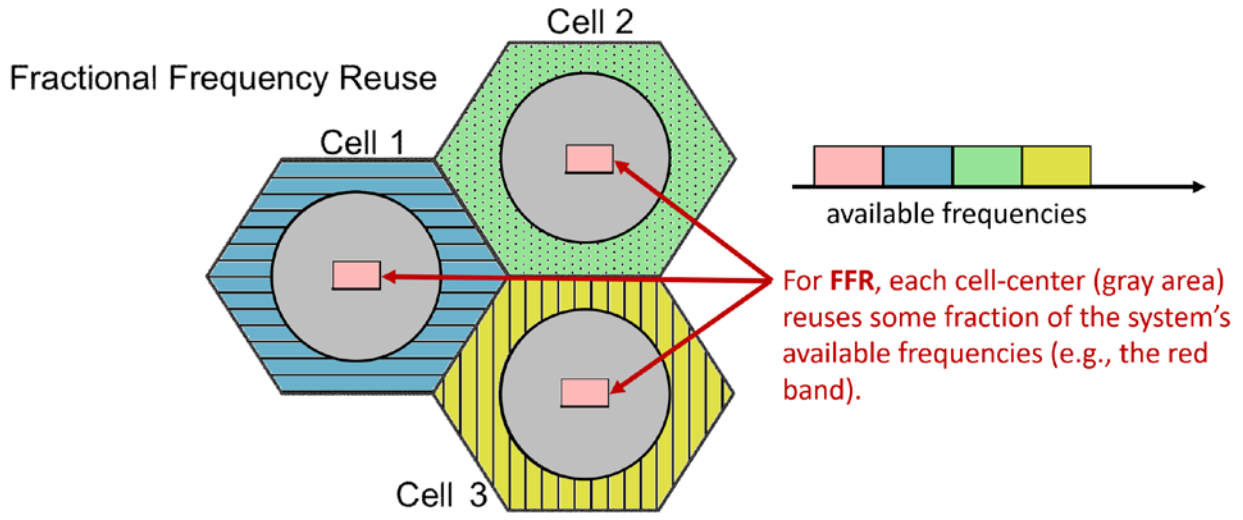
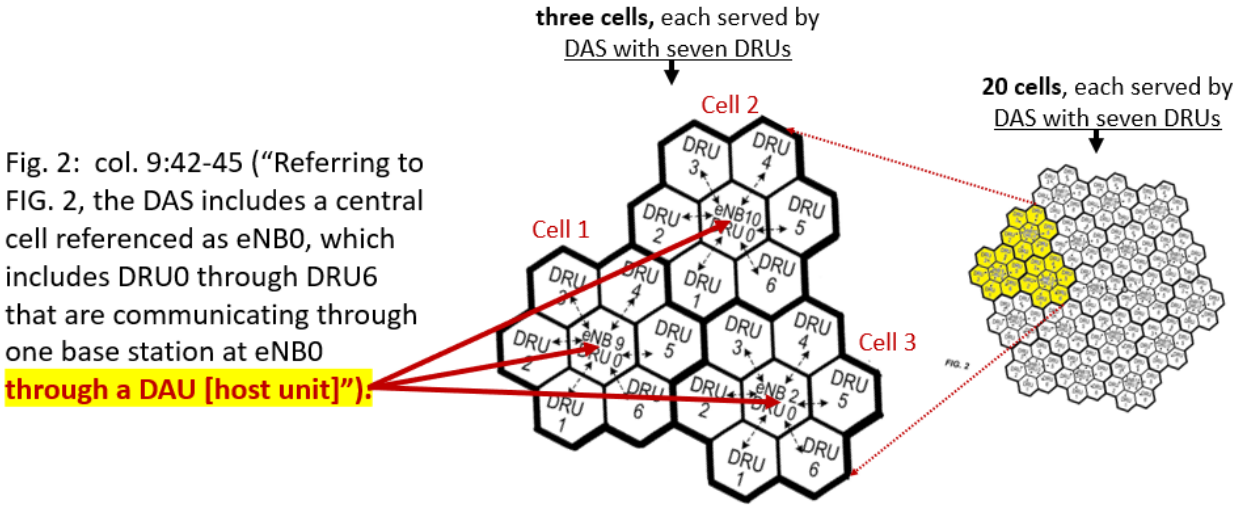

Fractional Frequency Reuse
Cell 1
Cell 2
Cell 3
available frequencies
For FFR, each cell-center (gray area) reuses some fraction of the system's available frequencies (e.g., the red band).

FIG. 1B

1. The first embodiment

81. Fig. 2 of the '358 patent (below) is directed to the first embodiment. Ex. 1001 at 11:16-32. It discloses a cluster of cells with each cell being served by seven antenna units. Three cells from Fig. 2 are pulled out and enlarged (below, left). Each cell's "communications unit" includes ***seven antenna units*** (including one centrally located antenna to serve the cell-center area and six periphery antenna units to serve the cell edge area). Ex. 1001 at Fig. 2, 9:42-45 ("Referring to FIG. 2, the DAS includes a central cell referenced as eNB0, which includes DRU0 through DRU6 that are communicating through one base station at eNB0 through a DAU."). *See also* Ex. 1001 at 11:16-32; 11:50-57 (indicating that DAUs may be interconnected to enable "virtualization of the eNB resources at the independent DRUs.").

first embodiment disclosed in the Provisional Application



82. The specification also indicates that the DAUs may be interconnected to enable "virtualization of the eNB resources at the independent DRUs. Ex. 1001 at 11:50-57.

> System Architecture (DAS-SFR)
> The general architecture of a Virtualized DAS in a multi-cell environment is shown in FIG. 2, where 7 Digital Remote Units (DRUs) are connected to an eNB via an optical fiber and a Digital Access Unit (DAU). The DAUs are interconnected and connected to multiple sectors. This capability enables the virtualization of the eNB resources at the independent DRUs.

Ex. 1001 at 11:50-57.

83. Below is a schematic I had prepared to illustrate the configuration used for the first embodiment implementing fractional frequency reuse.

Schematic illustrating the first embodiment implementing FFR

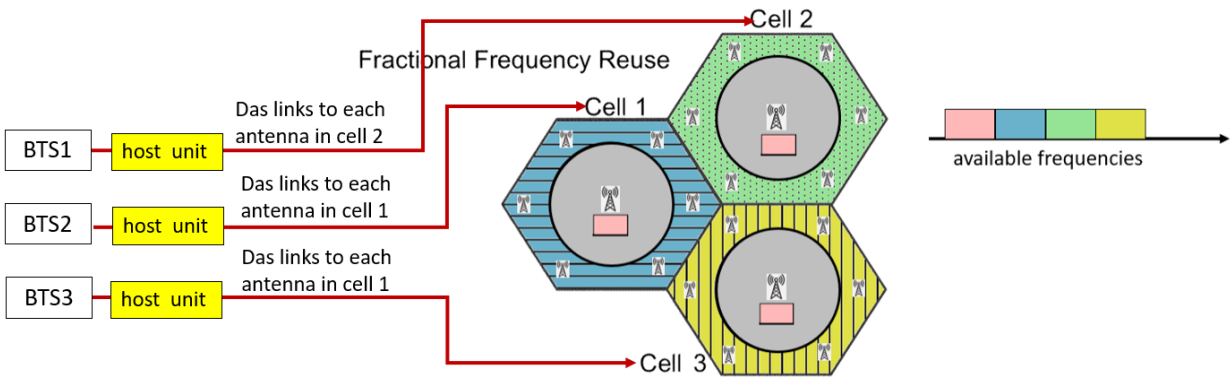
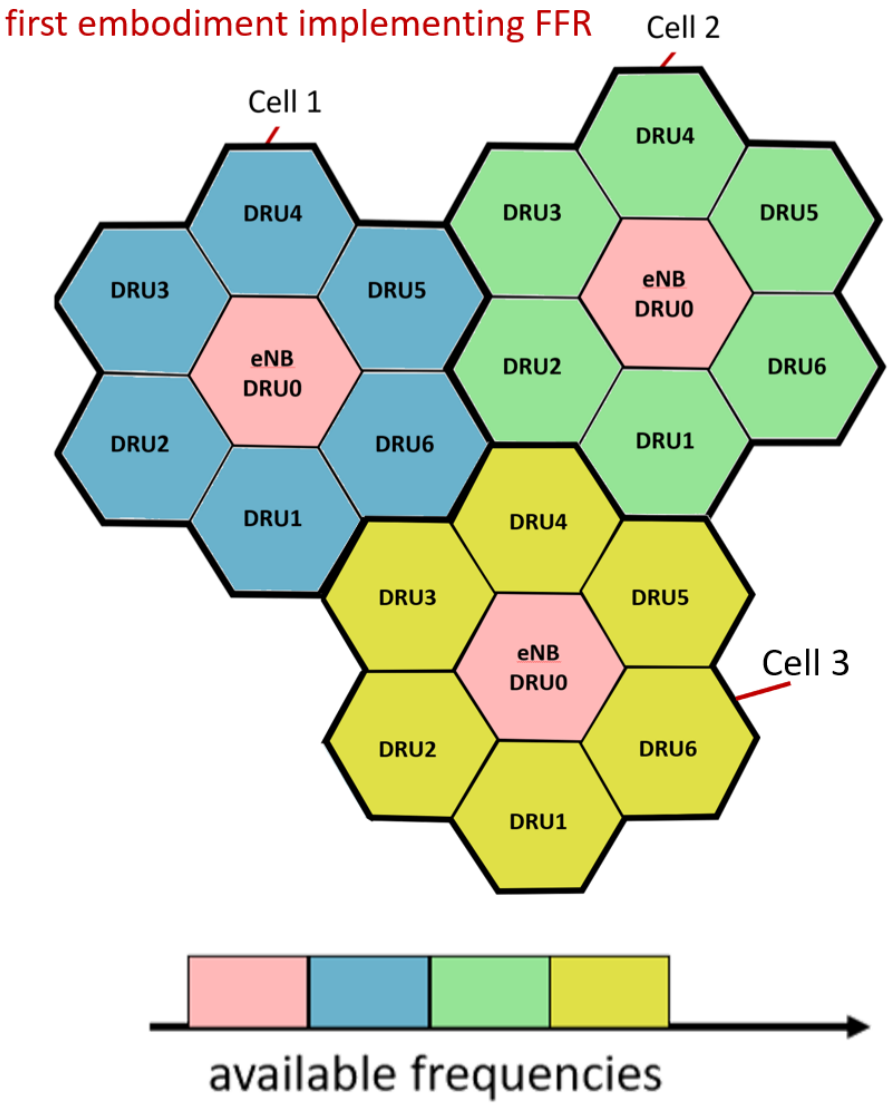


FIG. 1B

For each cell, a host unit (e.g., digital access unit or DAU) serves as an interface between a base station of the cell and distributed remote antenna units of the cell. I

note that for each cell in Figure 2, the base station and host unit are located within the cell. For illustrating the configuration in my schematic, for each cell, I have moved the base station and host unit to a location outside the cell. As discussed for example in Sections VIII.B.2 and VIII.F.1.a, for densely populated areas in which gaining access to property for storing base station equipment may be difficult or expensive, it was common to locate the base station equipment at a remote location commonly referred to as "a base station hotel"). Ex. 1001 at 1:21.

84. Below are three cells from Fig. 2, re-drawn in a cleaner form for the purpose of illustrating another example of a frequency reuse technique is implemented by the first embodiment in which each cell is served by seven distributed DRUs. *See also* Ex. 1001 at 11:16-32. As shown, in each cell, a central antenna provides service to and defines a cell-center coverage area in which the pink band is reused. The six "periphery" antennas of cell 1 transmit/receive the blue band to serve and define a cell-edge coverage area for cell 1. The six "periphery" antennas of cell 2 transmit/receive the green band to serve and define a cell-edge coverage area for cell 2. The six "periphery" antenna of cell 3 transmit/receive the yellow band to serve and define a cell-edge coverage area for cell 3.



85. In the first embodiment, all seven antenna units are disclosed to transmit at the ***same power***. Ex. 1001 at 15:53-55 ("The transmit power of each distributed antenna module is P whereas the transmit power of eNB in the conventional cellular system is 7P.").

86. The '358 patent at 10:25-30 also describes how the first embodiment implements FFR with reference to the three-cell network of Fig. 1B.

> In one embodiment, to implement the fractional frequency reuse technique illustrated in ***FIG. 1B*** using the architecture illustrated in FIG. 2, DRUs 1, 2, 3, 4, 5 and 6 of eNBO would transmit and receive data using frequencies in the horizontal stripe frequency band and DRUO of eNB0 would transmit and receive data using the grey frequencies.

Ex. 1001 at 10:25-30. Below I have incorporated seven antenna units (i.e., per Fig. 2) into each of the cells of Fig. 1B as described in the specification above to illustrate how the first embodiment of the '358 patent implements Fractional Frequency Reuse (FFR).

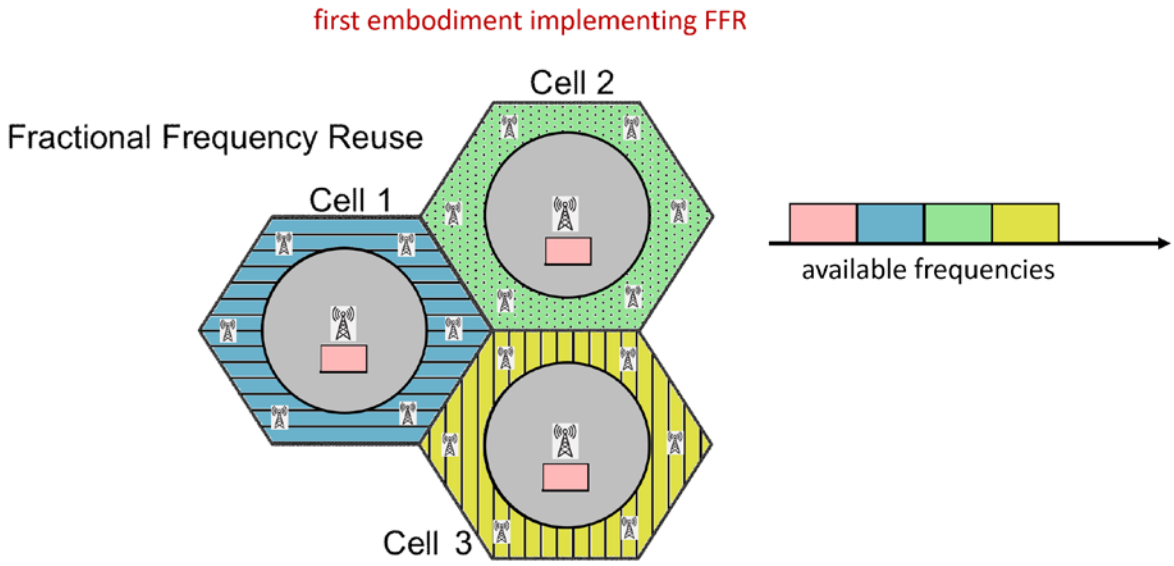


FIG. 1B

87. The '358 patent at10:40-49 describes how the first embodiment implements SFR.

> Referring to FIG. 1C, an architecture implementing Soft Frequency Reuse is illustrated and the matching spectrum

> in FIG. 1F illustrates the full use the spectrum by each of the adjacent cells. In an embodiment in which multiple DRUs are utilized per cell, the horizontal stripe geographical area in Cell 1 is associated with the outer DRUs in the communications unit illustrated as eNB0 in FIG. 2 (i.e., DRUs 1-6) and the grey geographical area in Cell 1 is associated with the central DRU in the communications unit illustrated as eNB0 in FIG.2 (i.e., DRUO).

Ex. 1001 at 10:40-49. Below I have incorporated seven antenna units (i.e., per Fig. 2) into each of the cells of Fig. 1C as described in the specification above to illustrate how the first embodiment of the '358 patent implements Soft Frequency Reuse (SFR).

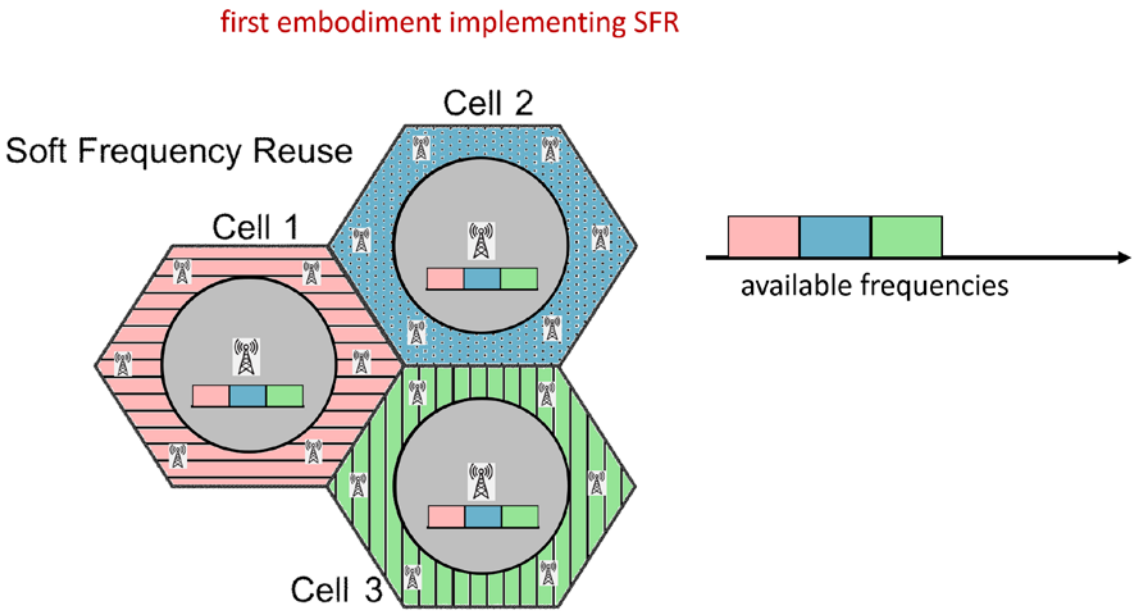


FIG. 1C

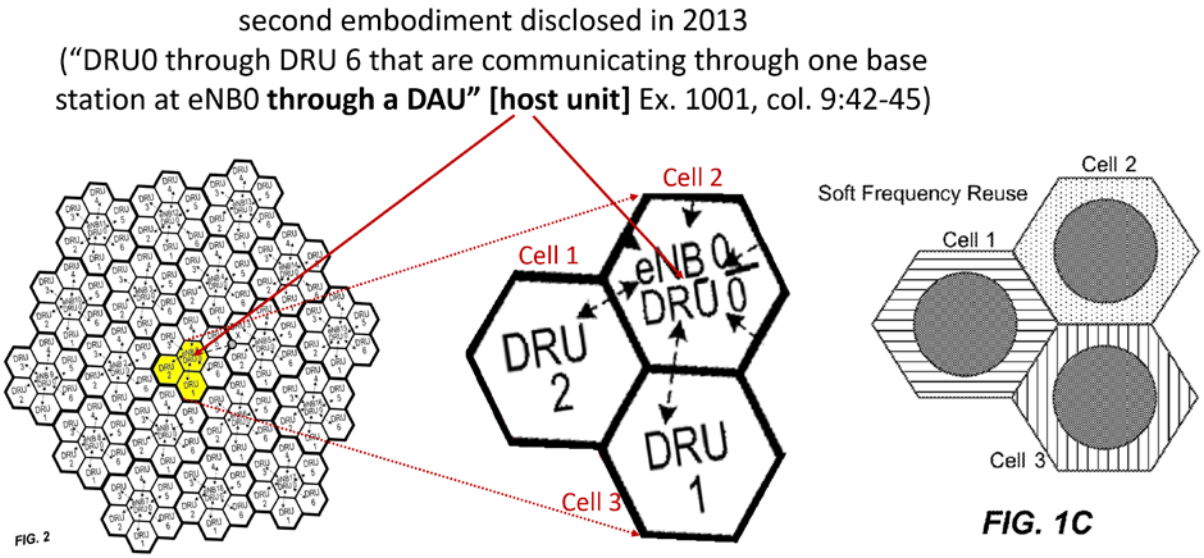
2. The second embodiment

88. In the second embodiment (illustrated below), each cell is served by a ***single, centrally located antenna unit***, instead of seven antenna units. Instead of all seven DRUs (DRU0-DRU7) of Fig. 2 serving one cell, the ***coverage area of an individual DRU is equated*** to a cell of Figs 1A-1C. Ex. 1001 at 9:45-47 ("DRU0 can be considered to be Cell 1 in FIGS. 1A-1C, DRU1 can be considered to be Cell 2 in FIGS. 1A-1C, and DRU2 can be considered to be Cell 3 in FIGS 1A-1C.").

89. Pursuant to Figure 2, the second embodiment would include one host unit that is coupled to each of DRU0, DRU1 and DRU2 (i.e., each antenna unit of cell 1, cell 2, and cell 3 share a host unit). As noted, for this embodiment, the host unit would be shared by the three antenna units. This is consistent with claim 15 which requires "a host unit" and states that each of the first and second communications units are "coupled to the host unit." The Summary of the Invention section of the '358 patent also indicates that the DAU or host unit may be the interface between "a plurality of Base Transceiver Stations (BTS)". Ex. 1001 at 2:59-65.

> The DRUs can comprise remote radio units. The method may also include communicating between a plurality of Base Transceiver Stations (BTS) coupled to the at least one DAU. One or more of the plurality of BTSs can be coupled to the DAU using a plurality of BTS sector RF connections. The method may further include transporting signals between one or more DRUs and the at least one DAU.

Ex. 1001 at 2:59-65. *See also* Ex. 1001 at 9:42-45 (while the DAU is not shown in Fig. 2, the specification states: "Referring to FIG. 2, the DAS includes a central cell referenced as eNB0, which includes DRU0 through DRU6 that are communicating through one base station at eNB0 through a DAU" [host unit]).



90. Below is a schematic I had prepared to illustrate the configuration used for the second embodiment implementing soft frequency reuse (SFR).

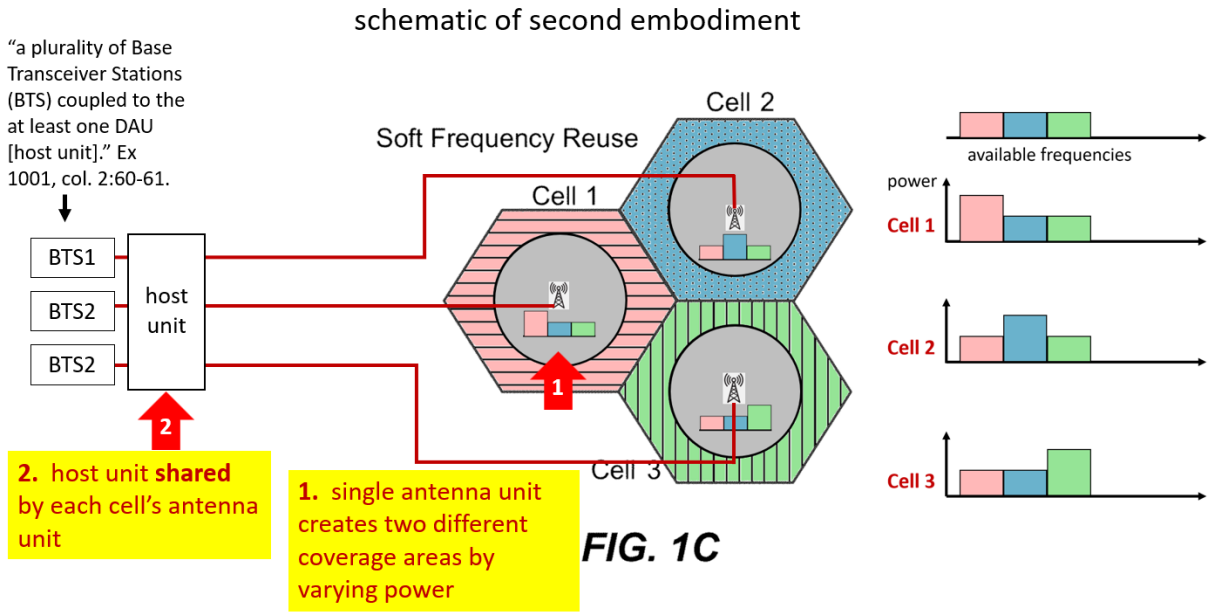


FIG. 1C

As illustrated, second embodiment is different from the first embodiment in two ways. First, each cell is served by a single, centrally located DRU (antenna unit) that implements a frequency reuse technique by transmitting different frequency bands at different power levels. Second, each the first and second communications units (i.e., each of the antenna units for cell 1, cell 2 and cell 3) is coupled to one host unit, i.e., they share a host unit. For illustrating the configuration in my schematic, for each cell, I have moved the **shared** host unit and base stations to a location outside the cell. As discussed in Sections VIIIB.1 and VIII.F.1.a, for densely populated areas in which getting access to property for storing base station equipment is difficult or expensive, it was common to locate the base station

equipment at a remote location commonly referred to as "a base station hotel") Ex. 1001 at 1:21.

91. In the final specification of the '358 patent (as issued), at col.10:33-39, the specification describes how the second embodiment implements the FFR technique with reference to Fig. 1B, stating:

> In another embodiment, each DRU in eNB0 transmits and receives data at a first power level using frequencies in the grey frequency bands and at a second, higher power level, using frequencies in the horizontal stripe/ shaded/vertical stripe/etc. frequency bands. In this embodiment, three of the seven DRUs illustrated in an eNB are illustrated by Cells 1-3 [of Fig. 1B].

Ex. 1001, 10:33-39.

92. In the final specification of the '358 patent (as issued), the specification describes how the second embodiment implements SFR (Ex. 1001 at 10:56-61) ("In other embodiments, a single DRU in Cell 1 broadcasts at low power over the grey band and at a higher power over the horizontal stripe spectrum.").

93. The second embodiment also includes "a host unit" (e.g., a DAU) and each cell's single antenna unit is coupled to a host unit (e.g., digital access unit or DAU).

> According to an embodiment of the present invention, a method for routing and switching operator RF signals is provided. The method includes providing one or more Digital Remote Units (DRUs), each configured to receive one or more downlink radio frequencies and to transmit one or more uplink radio frequencies, and providing at

> least ***one Digital Access Unit (DAU)*** configured to communicate with at least one of the one or more DRUs. ***A first DRU*** in a first cell is operable to communicate using a first set of frequencies characterized by a first frequency band over a first geographic footprint and a second set of frequencies characterized by a second frequency band different from the first frequency band over a second geographic footprint including and surrounding the first geographic footprint. ***A second DRU*** in a second cell is operable to communicate using the first set of frequencies over a third geographical footprint and a third set of frequencies characterized by a third frequency band different from the first frequency band and the second frequency band over a fourth geographic footprint including and surrounding the third geographic footprint

Ex. 1001 at 1:50-2:2. *See also* claim 1 (reciting a "DAU" [host unit] that communicates with "a first DRU" [a first antenna unit] and "a second DRU" [a second antenna unit]); claim 15 (requiring the first and second communications units to be "coupled" to "a host unit").

94. The demonstratives below illustrate the second embodiment of the '358 patent implementing the FFR and SFR techniques.

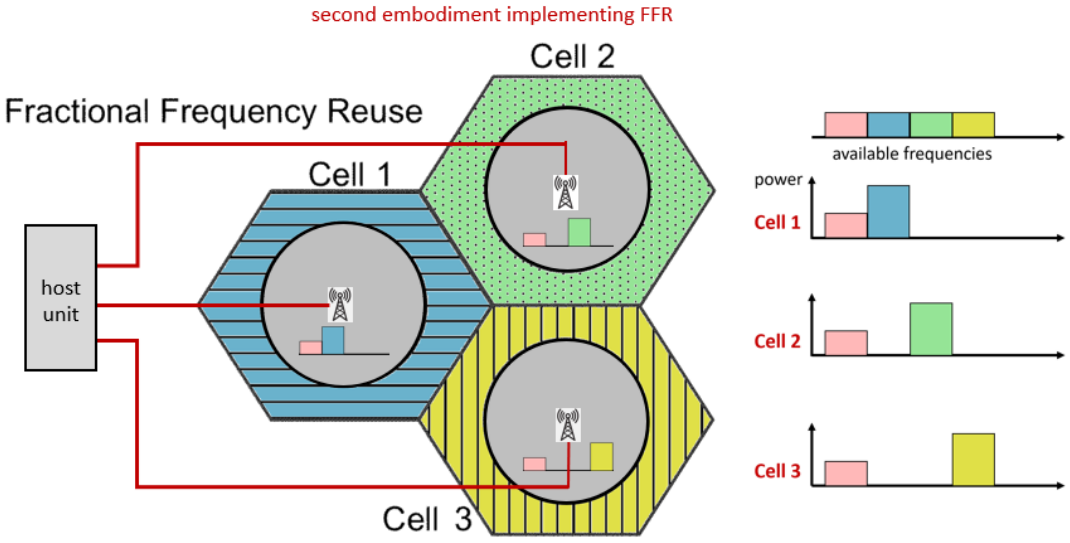


FIG. 1B

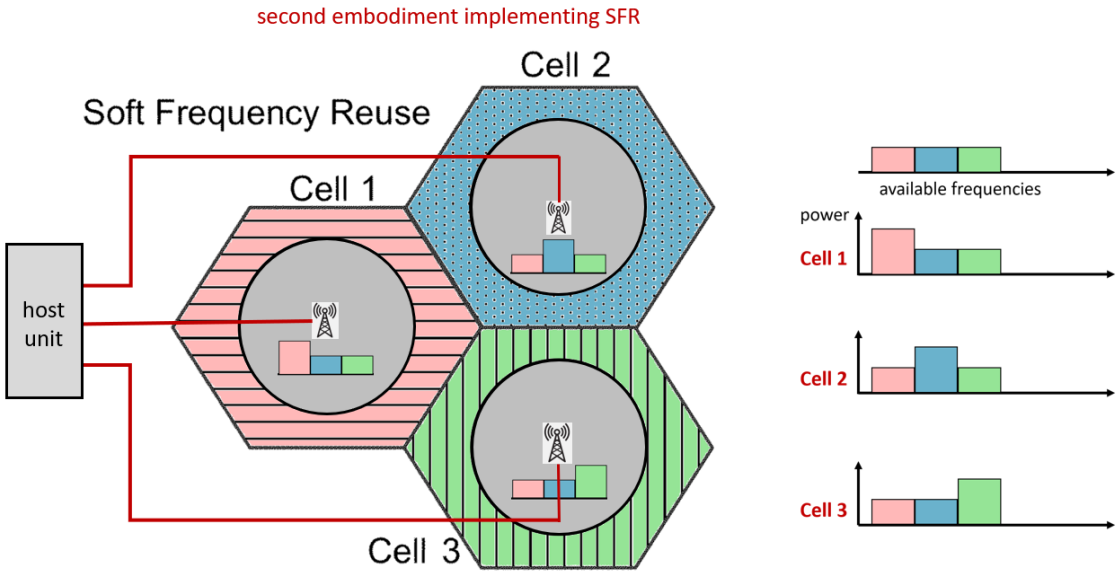


FIG. 1C

95. As discussed above, the plurality of base stations may be co-located at a remote site, "commonly known as a base station hotel" (Ex. 1001 at 1:21), and the base station hotel may employ a DAS host unit as "a means to for distribution

of the base station's downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24; 1:20-24; 2:59-65; claim 3 ("method of claim 1 further comprising communicating between a plurality of Base Transceiver Stations (BTS) coupled to the at least one DAU.").

96. The demonstratives below illustrate the second embodiment of the '358 patent combined with the base station hotel concept discussed in the background of the '358 patent. Ex. 1001 at 1:20-24. In the first drawing, the antenna units are implementing the FFR technique. In the second drawing, the antenna units are implementing the SFR technique. As discussed below in for example sections VIII.B.1 and VIII.F.1.a, a POSA would understand that for densely populated areas where getting access to property inside every cell may be difficult or expensive, the concept of hoteling or housing the base station equipment at a location remote from the cell sites was very common and well known. *E.g.*, Stratford at 1:26-65, stating:

> This traditional approach of deploying all the cell site equipment locally at each remote site has several drawbacks that contribute to the expense of the infrastructure, and upgrades to the infrastructure. At each remote site, a BTS room or cabinet to host the large base station equipment is require, as well as additional electric power supplies for the base station. <u>This increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment</u>. The remote cell site equipment must be designed for future coverage and capacity growth, and

upgrades to the equipment require physical access to the remote site.

To mitigate these problems, some cellular systems have been designed with a different architecture, as shown in FIG. 2. The base stations **240** for multiple remote sites **200** are centralized in a base station hotel **210,** while the antenna towers and antennas remain located at various remote sites at a distance from the base station hotel. Separating the base stations **240** from the antennas, however, makes it necessary to transport RF signals between the base station hotel and the various cell sites that it serves, typically using signal converters **250,** network interface equipment **260,** and a broadband communication network **220.** When broadband fiber optic cables are used, RF signals from the base stations are converted to optical format and communicated over the fiber optic cable and then converted back to analog RF signals at the remote sites. After the optical/RF conversion, the signal is sent to one of several sector transmitters **230** and radiated over the air via the antenna to provide cellular coverage. The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. In these types of areas it is getting increasingly more difficult to deploy new cell sites due to a variety of factors including regulatory and space constraint issues.

Ex. 1009 at 1:26-65. *See also* Ex. 1008 at 1:34-40, Fig. 2; Ex. 1014, ¶0005, Fig. 6.

second embodiment with "base station hotel" concept (col. 1:20-24) -- implementing FFR

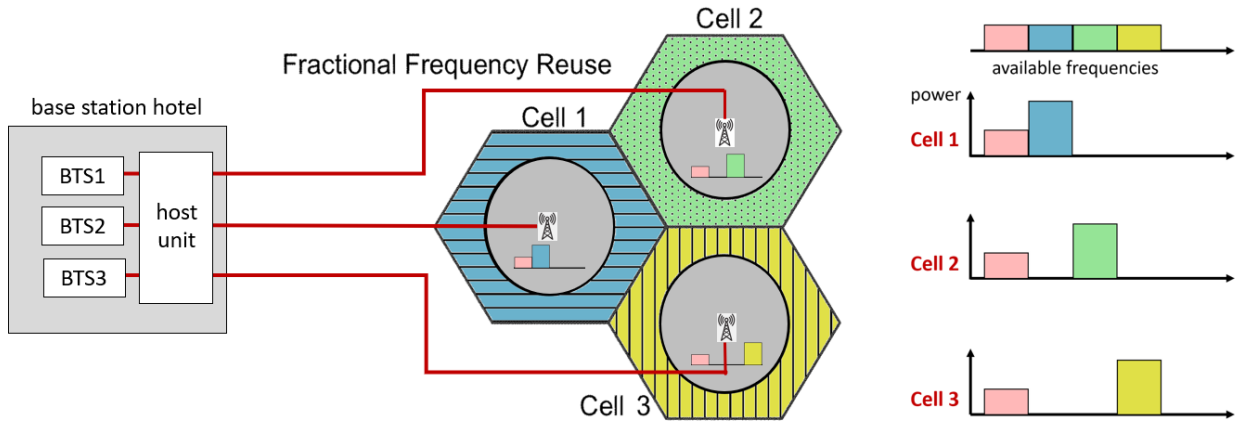


FIG. 1B

second embodiment with "base station hotel" concept (col. 1:20-24) -- implementing SFR

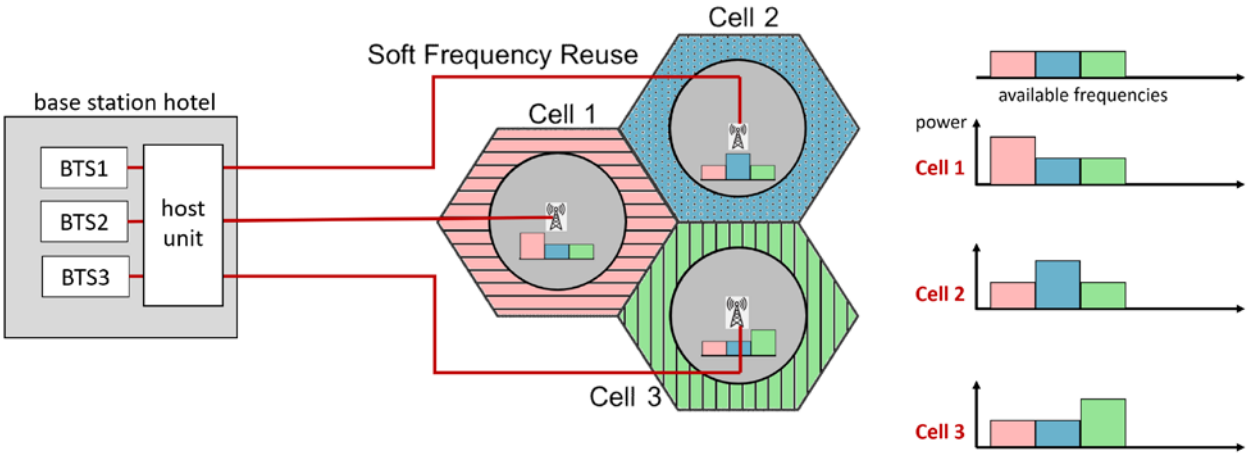


FIG. 1C

D. The Challenged Claims of the '358 Patent

97. The challenged claims include claims 7-9, 11, 15, 17-18, 20-21. These claims include two independent claims (7 and 15) and seven dependent claims (dependent claims 8, 9, and 11 depend from claim 7, and dependent claims 17, 18, 20, and 21 depend from claim 15).

98. Challenged claims 7, 8, 9, 11 and 15, 20, 21 are agnostic on whether "the first communications unit" (e.g., serving cell 1) or "second communications unit" (e.g., serving cell 2) comprise multiple antennas (e.g., seven as in first embodiment) or one centrally located antenna (the second embodiment). Notably, the specification states that a "communications unit" can include a plurality of DRUs. Ex. 1001 at 4:29-30 ("The first communications unit can include a plurality of DRUs ..."); 3:46-48 ("The first communications unit can include a central DRU and a plurality of peripheral DRUs disposed adjacent the central DRU.").

99. Claims 7 and 15 require frequency reuse in the first and third "geographic footprints," but are agnostic on whether that frequency reuse technique is FFR or SFR.

100. The challenged claims are also agnostic as to whether system is analog or digital. None of the challenged claims, for example, recite the terms "digital access unit," "digital remote unit," "digital" or "digitized signals."

Second, the challenged claims are also agnostic as to the type of connection for transmitting signals to/from the claimed remotes or communication units, e.g., coaxial cable, optical fiber, or wireless link.

101. The text of independent claim 7 is as follows. The element designation numbers have been added for reference.

	Claim 7
Element 7A	7. A method of distributing communications frequencies, the method providing:
Element 7B	providing a set of communications units;
Element 7C	transmitting and receiving, from a first communications unit of the set of communications units: a first set of frequencies characterized by a first frequency band and a first geographic footprint; and a second set of frequencies characterized by a second frequency band different from the first frequency band and a second geographic footprint larger than and at least partially surrounding the first geographic footprint; and
Element 7D	transmitting, and receiving, from a second communications unit of the set of communications units: a third set of frequencies including one or more frequencies in the first frequency band and a third geographical footprint; and a fourth set of frequencies including one or more frequencies in a third frequency band and a fourth geographical footprint larger than and at least partially surrounding the third geographical footprint.

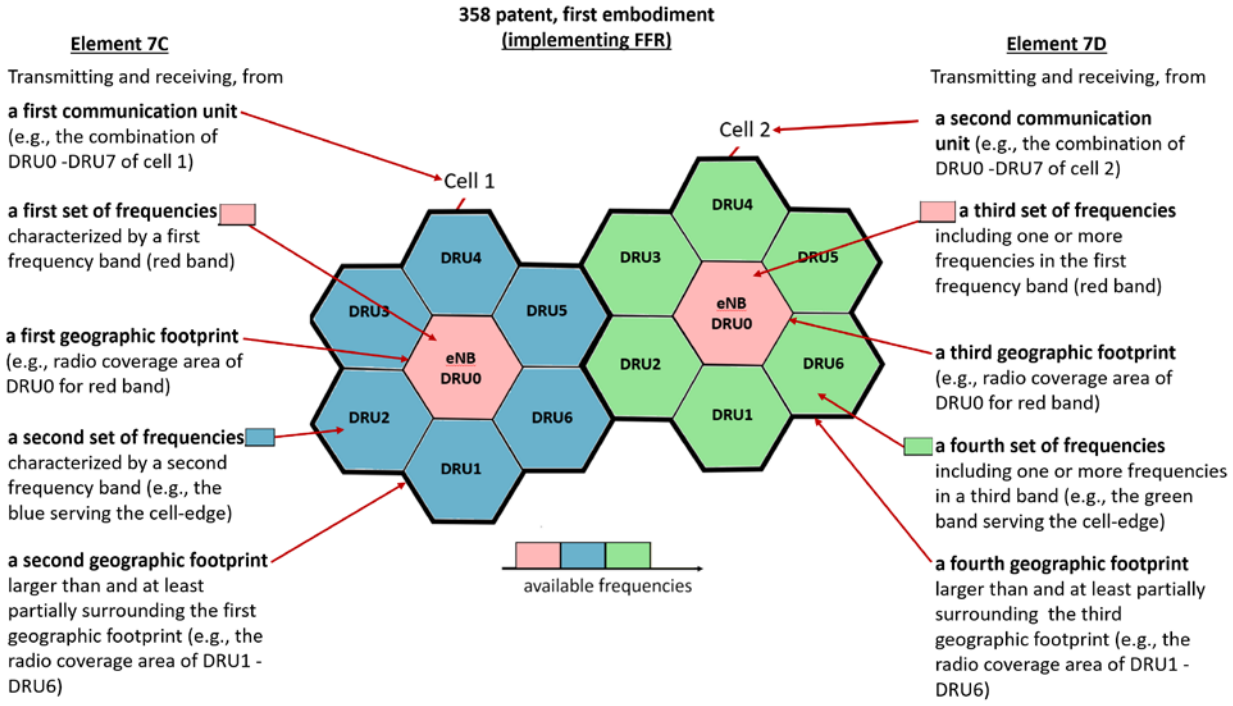
102. Independent claims 7 and 15 are reproduced below for comparison.

Claim 7	Claim 15
7. A method of distributing communications frequencies, the method providing:	15. A communications system comprising:
	a host unit;
providing a set of communications units;	a first communications unit coupled to the host unit and operable to
transmitting and receiving, from a first communications unit of the set of communications units:	transmit and receive communications using
a first set of frequencies characterized by a first frequency band and a first geographic footprint; and	a first set of frequencies in a first frequency range and associated with a first geographical footprint and
a second set of frequencies characterized by a second frequency band different from the first frequency band and a second geographic footprint larger than and at least partially surrounding the first geographic footprint; and	a second set of frequencies in a second frequency range and associated with a second geographical footprint larger than the first geographical footprint; and
transmitting, and receiving, from a second communications unit of the set of communications units:	a second communications unit coupled to the host unit and operable to transmit and receive communications using
a third set of frequencies including one or more frequencies in the first frequency band and a third geographical footprint; and	one or more of the first set of frequencies in a region associated with a third geographical footprint and
	a third set of frequencies in a third frequency range and associated with a

a fourth set of frequencies including one or more frequencies in a third frequency band and a fourth geographical footprint larger than and at least partially surrounding the third geographical footprint.	fourth geographical footprint larger than the third geographical footprint.

103. Claim 7 is the broadest claim. The following figure shows how claim 7 can be read on both the first and second embodiments disclosed in the specification. Both embodiments disclose "a method of distributing communication frequencies" (Element 7A) which provides "a set of communications units" (Element 7B) – the first and second communications units.

104. Mapping Elements 7C and 7D to the first embodiment. The limitations associated with the "first communications unit" (Element 7C) and "second communications unit" (Element 7D) read on the first embodiment of the '358 patent as shown below. I should note that while, while the example below illustrates the first embodiment implementing FFR, claim 7 is agnostic on whether that frequency reuse technique is FFR or SFR.



105. It should also be noted that while the '358 patent illustrates the first embodiment via Fig. 2, the written specification of the '358 patent also describes the first embodiment with respect to Figs 1B & 1E (FFR) and Figs. 1C & 1F (SFR). See discussion at section VI.C.1. *See also* Ex.1001 at 10:25-30 ("the fractional frequency reuse technique illustrated in ***FIG. 1B*** using the architecture illustrated in FIG. 2, DRUs 1, 2, 3, 4, 5 and 6 of eNB0"); Ex. 1001 at 10:40-49 (describing the first embodiment implementing SFR). See demonstratives below, which could also be used to illustrate how Elements 7C and 7D map to the first embodiment.

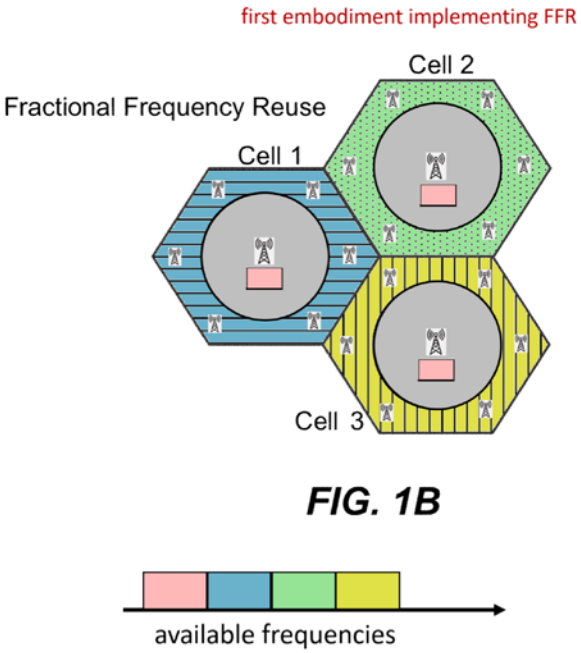


FIG. 1B

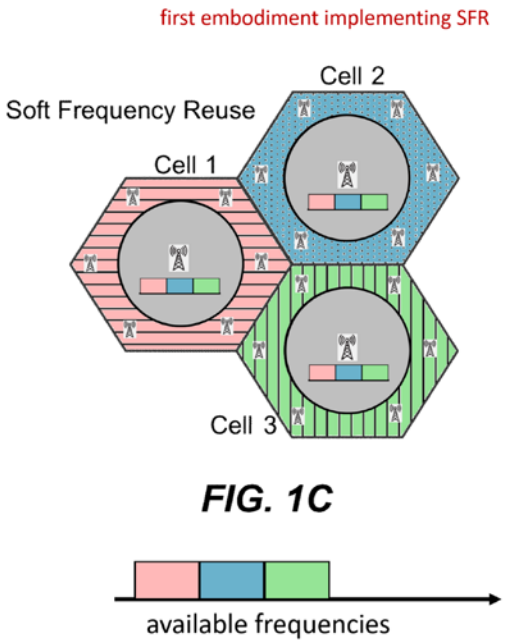
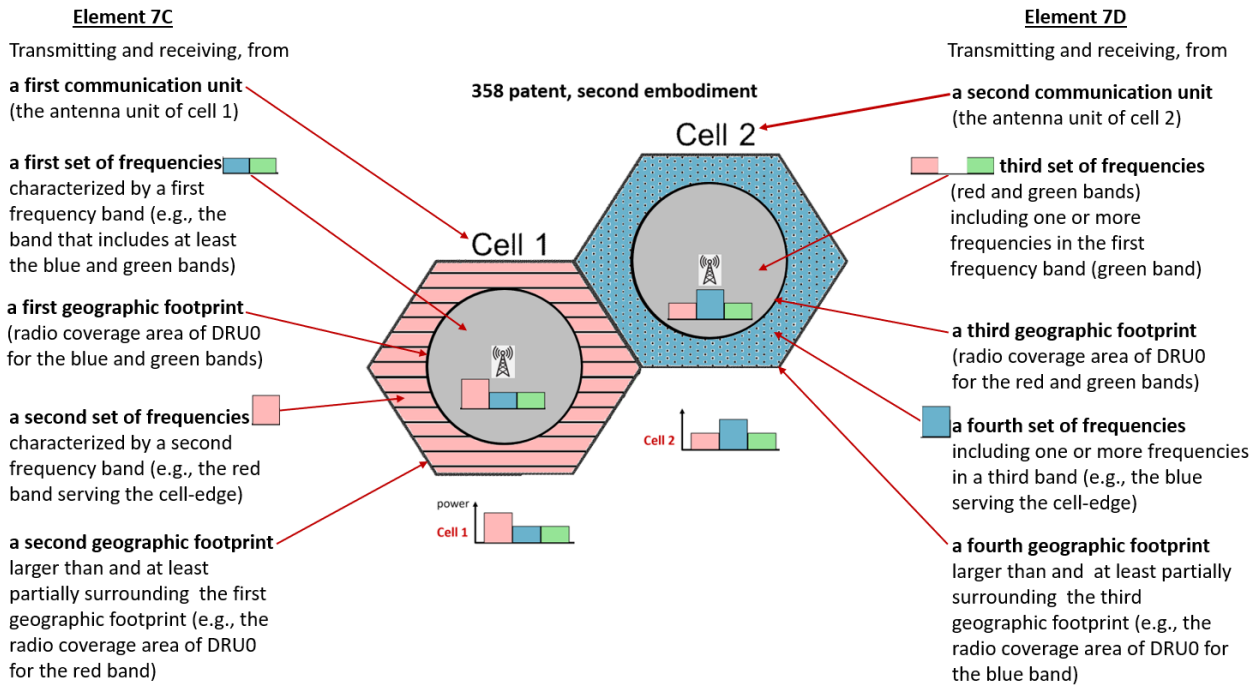


FIG. 1C

106. Mapping Elements 7C and 7D to the second embodiment. The limitations associated with the "first communications unit" (Element 7C) and "second communications unit" (Element 7D) read on the second embodiment of the '358 patent as shown below.



G. Prosecution History

107. The utility application that became the '358 Patent was filed on May 14, 2013. It claims priority to Provisional Application No. 61/649,143, filed on May 18, 2012.

108. I had the Provisional Application compared to the Utility Application to create a redline comparing how the Provisional Application was changed when the Utility Application was filed. Those changes are shown in Ex. 1018 (red-line comparing the Provisional Application to the Utility Application). That comparison shows that the Provisional Application only disclosed the first embodiment (i.e, in which each cell is served by seven antenna units) and that the

Utility Application added the second embodiment (i.e., in which each cell is served by a single, centrally located antenna unit and each cell's antenna unit is connected to a shared host unit).

109. The Provisional Application discloses the first embodiment. It does not disclose the second embodiment. None of the claims of the Provisional Application mention power. There is no disclosure in the "Claims" or "Detail Description of Specific Embodiments" of a second embodiment that: (a) describes a multi-cell network, (b) in which each cell uses one centrally located antenna unit to implement a frequency reuse technique, and (c) each cell's antenna unit is coupled to the same host unit.

110. Instead, the Provisional Application only discloses the first embodiment in which each cell is served by seven antenna units that are connected to the cell's eNodeB through a DAU. Fig. 2. The transmit power for all the distributed antennas is set at "P", i.e., a constant value. Ex. 1001 at 15:53-55 ("The transmit power of each distributed antenna module is P whereas the transmit power of eNB in the conventional cellular system is 7P.").

111. Below are examples of how the Provisional Application was changed when the Utility Application was filed May 14, 2013. In Ex. 1018, added text is indicated by blue and underlining and deleted text is indicated by blue and strike-through.

[0002] Wireless communication systems employing Distributed Antenna Systems (DAS) are available. A DAS typically includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units. A radio base station is often employed at the host unit location commonly known as a base station hotel, and the DAS provides a means for distribution of the base station's downlink and uplink signals among multiple remote antenna units. The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable.

[0006] According to an embodiment of the present invention, a method for routing and switching operator RF signals is provided. The method includes providing one or more Digital Remote Units (DRUs), each configured to receive one or more downlink radio frequencies and to transmit one or more uplink radio frequencies, and providing at least one Digital Access Unit (DAU) configured to communicate with at least one of the one or more DRUs. A first DRU in a first cell is operable to communicate using a first set of frequencies characterized by a first frequency band over a first geographic footprint and a second set of frequencies characterized by a second frequency band different from the first frequency band over a second geographic footprint including and surrounding the first geographic footprint. A second DRU in a second cell is operable to communicate using the first set of frequencies over a third geographical footprint and a third set of frequencies characterized by a third frequency band different from the first frequency band and the second frequency band over a fourth geographic footprint including and surrounding the third geographic footprint.

[0008] According to a specific embodiment of the present invention, a communications system is provided. The communications system includes a host unit and a first communications unit coupled to the host unit and operable to transmit and receive communications using a first set of frequencies in a first frequency range and associated with a first geographical footprint and a second set of frequencies in a second frequency range and associated with a second geographical footprint larger than the first geographical footprint. The communications system also includes a second communications unit coupled to the host unit and operable to transmit and receive communications using one or more of the first set of frequencies in a region associated with a third geographical footprint and a third set of frequencies in a third frequency range and associated with a fourth geographical footprint larger than the third geographical footprint.

[0009] According to an embodiment of the present invention, a method for routing and switching operator RF signals is provided. The method includes providing one or more Digital Remote Units (DRUs), each configured to receive one or more downlink radio frequencies and to transmit one or more uplink radio frequencies and providing at least one Digital Access Unit (DAU) configured to communicate with at least one of the one or more DRUs. A first DRU of a first cell is operable to communicate using a first set of frequencies characterized by a first frequency band over a first geographic footprint and a plurality of additional DRUs of the first cell are operable to communicate using a second set of frequencies characterized by a second frequency band different from the first frequency band over a second geographic footprint surrounding the first geographic footprint. A first DRU of a second cell is operable to communicate using the first set of frequencies over a third geographical footprint and a plurality of additional DRUs of the second cell are operable to communication using a third set of frequencies characterized by a third frequency band different from the first frequency band over a fourth geographic range surrounding the third geographic range.

[0010] The DRUs can comprise remote radio units. The method may also include communicating between a plurality of Base Transceiver Stations (BTS) coupled to the at least one DAU. One or more of the plurality of BTSs can be coupled to the DAU using a plurality of BTS sector RF connections. The method may further include transporting signals between one or more DRUs and the at least one DAU.

[0011] According to another embodiment of the present invention, a method of distributing communications frequencies is provided. The method includes providing a set of communications units in an array configuration and transmitting and receiving, from a first communications unit of the set of communications units, a first set of frequencies characterized by a first frequency band and a first geographic footprint and a second set of frequencies characterized by a second frequency band different from the first frequency band and a second geographic range surrounding the first geographic footprint. The method also includes transmitting, and receiving, from a second communications unit of the set of communications units, a third set of frequencies including one or more frequencies in the first frequency band and a third geographical footprint and a fourth set of frequencies including one or more frequencies in a third frequency band and a fourth geographical footprint surrounding the third geographical footprint.

[0043] Referring to FIGS. 1C and 1D, frequencies in the grey frequency band (~ upper 2/3 of the available frequencies) are transmitted/received by a DRU at a first power level in Cell 1, providing coverage for the central portion of Cell 1. Frequencies in the horizontal stripes band are transmitted/received by the DRU at a second power level higher than the first power level, providing coverage over both the central portion of Cell 1 as well as the peripheral portions of Cell 1 since the higher power level results in a larger coverage area. In this example, each cell utilizes a single DRU, although other embodiments can utilize multiple DRUs per cell as described more fully herein. DRUs in the other cells also transmit/receive at both high power for a subset of the frequencies and low power for remaining frequencies as shown in FIG. 1D, producing the coverage maps illustrated in FIG. 1C, with low power frequencies providing centralized coverage and higher power frequencies providing a large coverage area extending to the peripheral regions of the cells. Although all three cells are transmitting/receiving using overlapping (or the same) frequencies at low power, the corresponding propagation distances for these frequencies are smaller, preventing geographic overlap between the central grey regions.

[0044] In order to reduce interference in areas where cells are adjacent, the frequencies associated with higher power are grouped into sub bands, with little or no overlap between the subbands. Referring to FIG. 1D, in the SFR implementation, Cell 1 uses high power for the horizontal stripes band in approximately the first third of the frequency bandwidth, Cell 2 uses high power for the dotted band in approximately the second third of the frequency bandwidth, and Cell 3 uses high power for the vertical stripes band in approximately the last third of the frequency bandwidth. Thus, at the intersections between cells, since different portions of the available frequency band are being utilized, interference is reduced. Thus, in some embodiments, different frequency bands are utilized in adjacent cells, which is illustrated by the high power frequency bands for SFR in FIG. 1D: the first frequency band in Cell 1, the second frequency band different from the first frequency band in Cell 2, and the third frequency band different from the first frequency band and the second frequency band in Cell 3. For an additional number of cells, the subdivision of the available bandwidth can be increased as appropriate to the particular number of adjacent cells in the implementation. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

[~~0030~~0049] Referring to FIG. 2, the DAS includes a central cell referenced as eNB0, which includes DRU0 through DRU6~~, which can be considered to be cell 1 in~~ that are communicating through one base station at eNB0~~FIG. 1A. eBN1,~~ through a DAU. DRU0 can be considered to be Cell 1 in FIGS. 1A - 1C, DRU1 can be considered to be Cell 2 in FIGS. 1A - 1C, and DRU2 can be considered to be Cell 3 in FIGS. 1A- 1C.

[~~0033~~0052] ~~To~~In one embodiment, to implement the fractional frequency reuse technique illustrated in FIG. 1~~A~~B using the architecture illustrated in FIG. 2, ~~DRU~~DRUs 1, 2, 3, 4, 5 and 6 of eNB0 would transmit and receive data using ~~the blue~~ frequencies in the horizontal stripe frequency band and DRU0 of eNB0 would transmit and receive data using the grey frequencies. In an embodiment, the size of the area covered by DRU0 can be increased by increasing the transmit power associated with the central DRU (i.e., DRU0). In another embodiment, each DRU in eNB0 transmits and receives data at a first power level using frequencies in the grey frequency bands and at a second, higher power level, using frequencies in the horizontal stripe / shaded / vertical stripe / etc. frequency bands. In this embodiment, three of the seven DRUs illustrated in an eNB are illustrated by Cells 1-3.

[~~0034~~0053] Referring to FIG. 1~~B~~C, an architecture implementing Soft Frequency Reuse is illustrated and the matching spectrum in FIG. 1D illustrates the full use the spectrum by each of the adjacent cells. ~~The~~In an embodiment in which multiple DRUs are utilized per cell, the horizontal ~~blue~~stripe geographical area in Cell 1 is associated with the outer DRUs in the communications unit illustrated as eNB0 in FIG. 2 (i.e., DRUs 1-6) and the grey geographical area in Cell 1 is associated with the central DRU in the communications unit illustrated as eNB0 in FIG. 2 (i.e., DRU0). As discussed above, the size of the grey circle can be increased/decreased by increasing/decreasing the power of utilized in conjunction with DRU0. As shown in the SFR spectrum for Cell 1, data is transmitted and received over the entire allocated spectrum, including portions of the spectrum that were unused for Cell 1 in the HFR example. The increase in spectrum provides increased data rate, increased capacity, combinations thereof, or the like. In other embodiments, a single DRU in Cell 1 broadcasts at low power over the grey band and at a higher power over the horizontal stripe spectrum. Other cells demonstrate similar behavior. One of ordinary skill in the art would recognize many variations, modifications, and alternatives.

1. A method for routing and switching operator RF signals, the method comprising:

providing one or more Digital Remote Units (DRUs), each configured to receive one or more downlink radio frequencies and to transmit one or more uplink radio frequencies;

providing at least one Digital Access Unit (DAU) configured to communicate with at least one of the one or more DRUs;

wherein a first DRU ~~of~~in a first cell is operable to communicate using:

a first set of frequencies characterized by a first frequency band over a first geographic footprint; and ~~wherein a plurality of additional DRUs of the first cell are operable to communicate using~~ a second set of frequencies characterized by a second frequency band different from the first frequency band over a second geographic footprint including and surrounding the first geographic footprint;

wherein a ~~first~~second DRU ~~of~~in a second cell is operable to communicate using ~~the first~~:

the first set of frequencies over a third geographical footprint; and

~~wherein a plurality of additional DRUs of the second cell are operable to communication using~~ a third set of frequencies characterized by a third frequency band different from the first frequency band and the second frequency band over a fourth geographic ~~range~~footprint including and surrounding the third geographic footprint.~~range.~~

6. The method of claim 1 wherein a power level associated with the first set of frequencies is less than power levels associated with the second set of frequencies and the third set of frequencies.

~~14~~15. A communications system comprising:

a host unit;

a first communications unit coupled to the host unit and operable to transmit and receive communications using a first set of frequencies in a first frequency range and associated with a first geographical footprint and a second set of frequencies in a second frequency range and associated with a second geographical footprint larger than the first geographical footprint; and

a second communications unit coupled to the host unit and operable to transmit and receive communications using one or more of the first set of frequencies in a region associated with a third geographical footprint and ~~one or more of the second~~a third set of frequencies in a ~~region associated with a fourth~~third frequency range and associated with a fourth geographical footprint.

16.~~15.~~ The communications system of claim 15~~14~~ wherein the host unit comprises a DAU, the first communications unit comprises a first~~central~~ DRU, and ~~a plurality of peripheral DRUs disposed adjacent the central DRU~~ the second communications unit comprises a second DRU.

17. The communications system of claim 15 wherein the communications using the first set of frequencies in the first frequency range are associated with a first power level and the communications using the second set of frequencies in the second frequency range are associated with a second power level greater than the first power level.

18. The communications system of claim 15 wherein the communications using one or more of the first set of frequencies in the region associated with a third geographical footprint are associated with a first power level and the communications using the third set of frequencies in the third frequency range are associated with a second power level greater than the first power level.

112. During prosecution, the Examiner rejected all claims as being anticipated by U.S. Patent Publication No. 2005/0239403 ("Karabinis"). Ex-1002, 237. Applicant traversed the rejection, and a Notice of Allowance issued on July 17, 2015. *Id.* at 262-66.

H. Prior IPR proceedings on the '358 patent

113. In February of 2021, Corning filed a request for IPR on the '358 patent, Case IPR2021-00492 ("Corning's IPR request"). That request for IPR was denied. See Ex. 1023 (IPR Petition); Ex. 1024 (Patent Owner's Preliminary Response); Ex. 1025 (Decision denying institution) (collectively, "the prior IPR proceedings").

114. In the prior IPR proceedings, neither Xu nor Ericsson, nor Stratford was relied on for any grounds asserted in that IPR request. Instead, all the grounds relied on Fujii. Ex. 1023 at 6, 20-70; Ex. 1019.

115. The prior IPR proceedings seemed to focus on the second embodiment of the '358 patent that relies on, for each cell, a single antenna unit that transmits set of frequencies at first power level and a second set of frequencies at a second power level that is greater than the first power level. The IPR request seemed to have ignored the first embodiment of the '358 patent and that the first and second "communications units" of the claims could each comprise a plurality of antenna units such as disclosed in the first embodiment of the '358 patent. Ex 1023 at 38, 43, 46, 48, 53, 57, 59; Ex. 1024 at 1-3, 7 24-44; Ex. 1025 at 3-5, 20-23.

VII. The Prior Art

A. Public availability of printed publications including Xu and Ericsson

116. I have reviewed the Declaration of Sylvia Hall-Ellis, Ph.D (Ex. 1022) regarding the public availability of various printed publications applied in my analysis. Based on my review of Dr. Hall-Ellis's declaration, it is my understanding that each of Xu (Ex. 1005), Ericsson (Ex. 1007), and Huawei (Ex. 1006) qualify as prior art to the '358 patent because each reference was publicly available prior to May 18, 2012, the date of the U.S. Provisional Application No. 61/649,143 to which the '358 Patent claims priority. *See* Ex. 1022 at ¶57 (finding

that Xu was publicly available on or shortly after November 30, 2011); ¶65 (finding that Ericsson was publicly accessible no later than August 25, 2005); ¶69 (finding that Huawei was publicly accessible no later than August 25, 2005).

B. Primary References

1. Xu

117. Xu (Ex. 1005) is a publication entitled "Imperfect Digital-Fiber-Optic-Link-Based Cooperative Distributed Antennas With Fractional Frequency Reuse in Multicell Multiuser Network" authored by Xinyi Xu, Rong Zhang, Salman Ghafoor, and Lajos Hanzo which was published in the IEEE Transactions on Vehicular Technology, Vol. 60, No. 9 dated November 2011.

118. Xu addresses the same problem (inter-cell interference) and discloses the same solution -- combining the techniques of DAS and fractional reuse to improve cell-edge throughput.

119. Xu explains inter-cell interference: "unity frequency reuse (UFR)" (i.e., when each cell reuses all the system's available frequencies over its respective coverage area) increases "the co-channel interference (CCI) level; hence, the UFR typically exhibits low throughput at the cell edge." Ex. 1005 at 4439. Xu discloses that fractional frequency reuse or FFR reduces inter-cell interference. "As a result, FFR has also been adopted" for LTE and WiMAX. Ex. 1005 at 4439. Xu also recognizes that "a DAS improves the cell-edge throughput

by placing the remote antennas (RAs) closer to the cell-edge terminals, hence naturally reducing the pathloss." *Id.* at 4439. Xu therefore discloses a multi-cell system in Fig. 1 (below) that **combines DAS with fractional frequency reuse**. Xu's study shows the benefits of combining the techniques of DAS and FFR in improving cell-edge throughput for both a noncooperative DAS aided FFR system (Figs. 3 and 4) and a cooperative DAS aided FFR system (Fig. 6).

120. To assist in understanding Xu's system of Fig. 1, a map for the abbreviations and annotations has been added (below, left side). Each cell is served by central base station (BS) and seven antenna units, including a central antenna co-located with the base station that serves the cell-center area and six remote antennas (RAs) distributed around cell periphery to serve the cell-edge area. Ex. 1005 at Fig. 1 ("N_r = 6 RAs are employed"); 4440, Section II.A at ¶1 ("…B_0 is assumed to be at the origin [in Fig. 1]. We assume cell *symmetry*, where every cell has the same configuration"); 4444 ("…the transmit power of the BS should be sufficiently high to ensure that the average throughput maintained at a distance of r remains exactly as high as that of the classic UFR technique, whereas the rest of the power is evenly allocated to the RAs."); 4442 ("Focusing our attention on the cell B_0 of Fig. 1, when non-cooperative DASs are employed, the ***transmit power P_B of the BS*** and the ***transmit power P_R of each RA*** should obey the total transmit power constraint of $P_B + N_r P_R = P$, where P is the full power at

the BS of the traditional UFR and FFR scheme."); 4440 Section II.A at ¶2 ("A total of N_r RAs are employed in each cell").

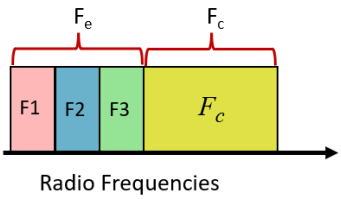
121. For **each** of the adjacent cells (e.g., labeled Cell 1, Cell 2, and Cell 3), (1) a centrally located antenna at the base station provides service to a cell-center area using the F_c band (yellow), and (2) six distributed remote antennas provide service to a cell-edge coverage area using a different sub-band from the F_e band (Cell-edge 1 = red, Cell-edge 2 = blue, and Cell-edge 3 = green). Xu explains how the FFR scheme partitions the available frequencies at page 4440, Section II.A.

> The frequency partitioning strategy of the total available bandwidth F is characterized by $Fc \cap Fe = Ø$, where Fc and Fe represent the cell center's frequency band and the cell edge's frequency band, respectively. Fe is divided into three orthogonal frequency bands Fi, $i \in [1, 3]$, which were exclusively used at the cell edge of one of the three adjacent cells.

Ex. 1005 at 4440, Section II.A. While Fig. 1 does not show the six remote antennas at the periphery of Cell 1 and Cell 2, Xu at Section II.A., ¶1 states that "every cell has the same configuration." Ex. 1005 at 4440.

map for abbreviations used in Xu, Fig. 1

B = Base station (e.g., B_0, B_1, B_2 ...)
RAs = remote antennas (each cell includes 6 RAs to cover cell edge area)
N_r = number of RAs = 6 RAs in each cell. Xu, p 4440, Section A at ¶1 ("every cell has the same system configuration"), ¶2 ("A total of N_r RAs are employed in each cell")
F_c = cell center's frequency
F_e = "cell edge's frequency which is divided into three orthogonal bands" (**F1 F2 F3**).



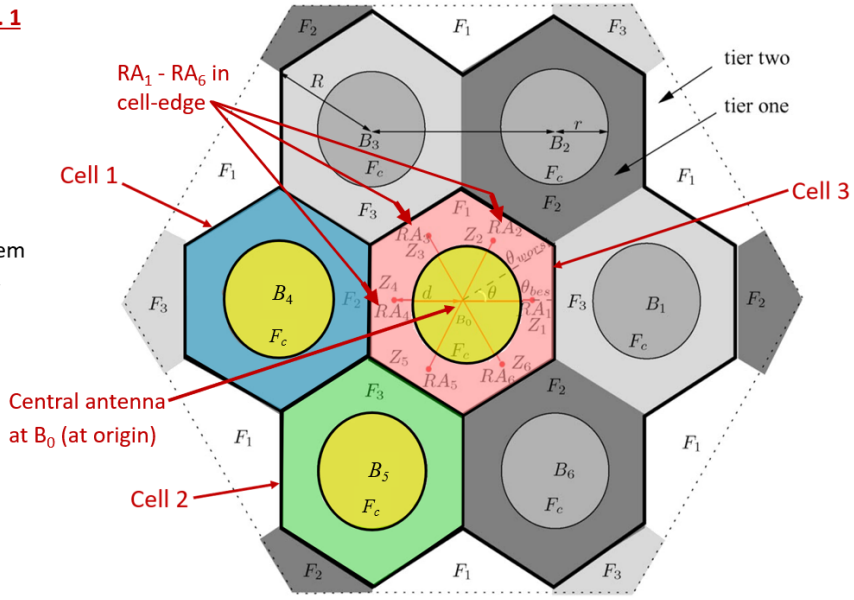


Fig. 1. Topology of two tiers of 19 cells relying on an FFR and DAS arrangement, where $N_r = 6$ RAs are employed. The structure of the cells in tier two is the same as that in tier one.

122. DAS links to RAs: Xu also explains that "[f]or practical application of DASs, the ***connection between the BS and RAs*** may be a coaxial cable, optical fiber, or a radio frequency (RF) link." Ex. 1005 at 4439. "In this study" Xu "opted for the DFO link." Ex. 1005 at 4439 ("digital fiber optic (DFO)-link-based transmission technique … for the BS to RA links"). In Fig. 2 (below, annotated) Xu shows an example of a DFO link to one of the six RAs. A separate DFO link would be employed for each of the RAs in the Xu system. Within the box labeled "BS," Xu's system includes DAS host unit functionality, i.e., the base station signal is received by the circuitry I have labeled "host unit" which converts the base station signal from an electrical signal to an optical signal for transport over fiber optic link. Ex. 1005 at Fig. 2. Using this circuitry, the BS of Xu defines an

interface between (a) the base station (where payload data is encoded into modulation of phase/amplitude/frequencies using the modulation scheme of the applicable air interface) of the operator's network and (b) the remote antenna units of the distributed antenna system and allows Xu's BS to manage communications between the remote antennas and the operator's network.

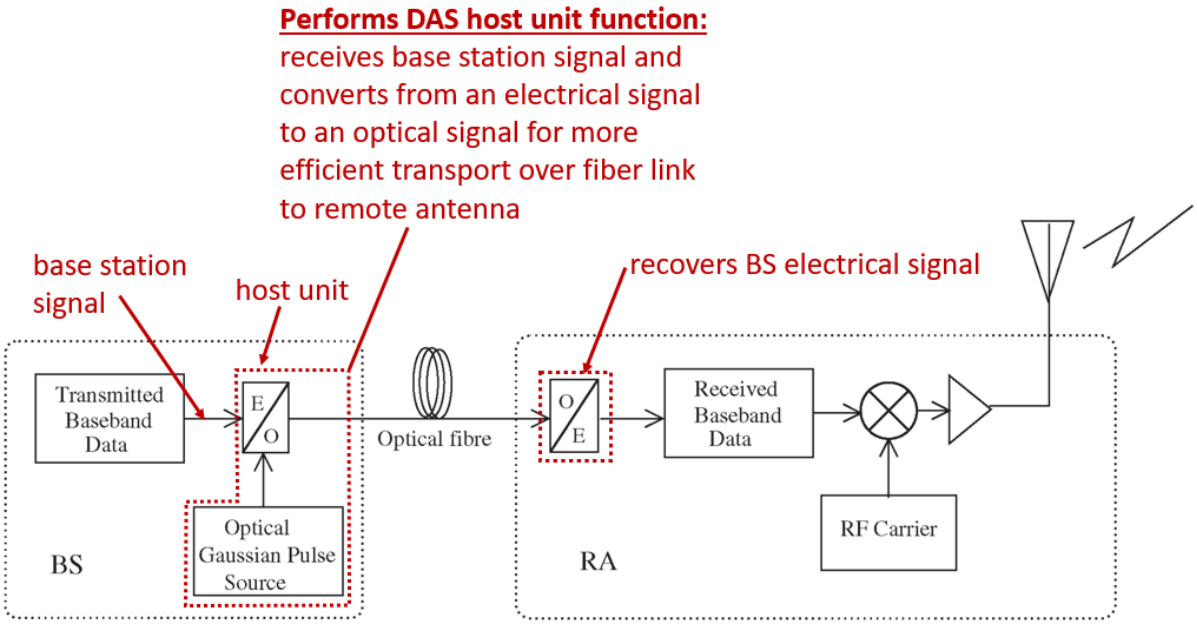
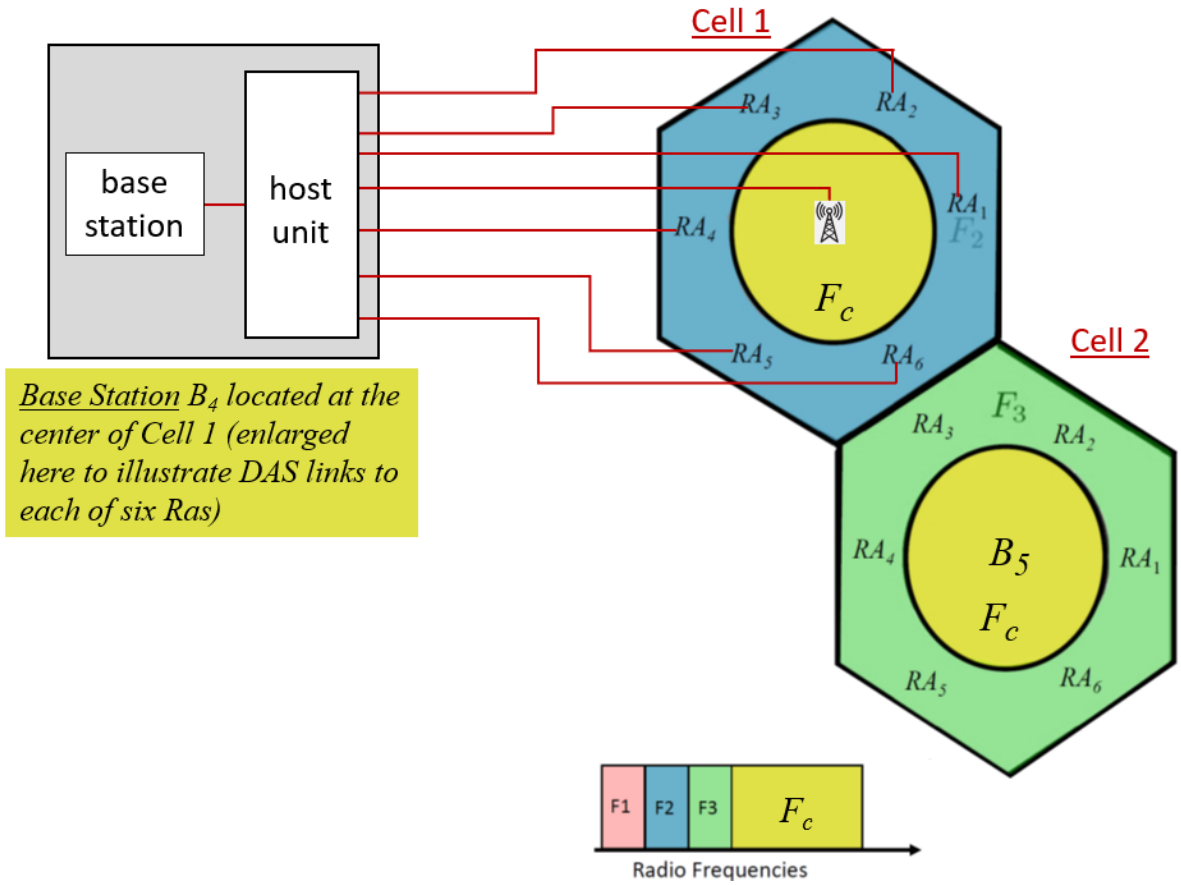


Fig. 2. System architecture of the DFO link, showing a single optical fiber link spanning from the BS to the RA. The transmitted baseband data are used to modulate a stream of optical Gaussian pulses, where an ideal optical modulator is assumed; therefore, it does not impose any chirp on the optical pulse. Then, the Gaussian optical signaling pulses are transmitted through the optical fiber, which imposes both linear and nonlinear distortions. At the RA, after an ideal photodetector, the optical signaling pulses are converted back to the corresponding baseband electronic signals.

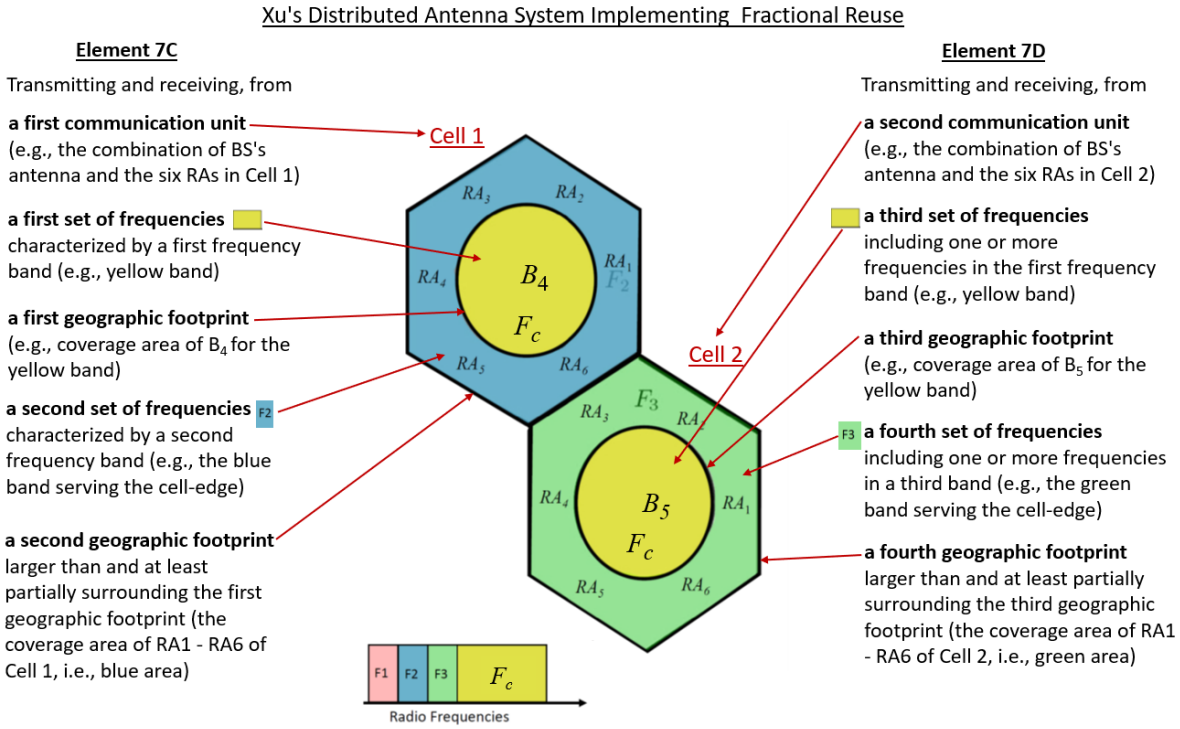
Ex. 1005 at 4441, Fig. 2.

123. In the demonstrative below, to illustrate the DAS link to each RA in cell 1 of Xu's system, I moved base station B_4 outside of cell 1.



124. As will be explained in more detail in the analysis presented later in this report, claim 7 can be read onto Xu's system. Xu discloses "a method of distributing communication frequencies" (Element 7A) by combining the techniques of DAS and Fractional Reuse to mitigation inter-cell interference in a multi-cell communications network. Just as in the '358 patent's first embodiment, Xu provides "a set of communications units" (Element 7B) that includes a "first

communications unit" (e.g., in cell 1, the combination of the central antenna and the six remote antennas together constitute the first communications unit) and a "second communications unit" (e.g., in cell 2, the combination of its central antenna and its six remote antennas). As illustrated below, the limitations associated the "first communications unit" (Element 7C) and "second communications unit" (Element 7D) also read on Xu's system.

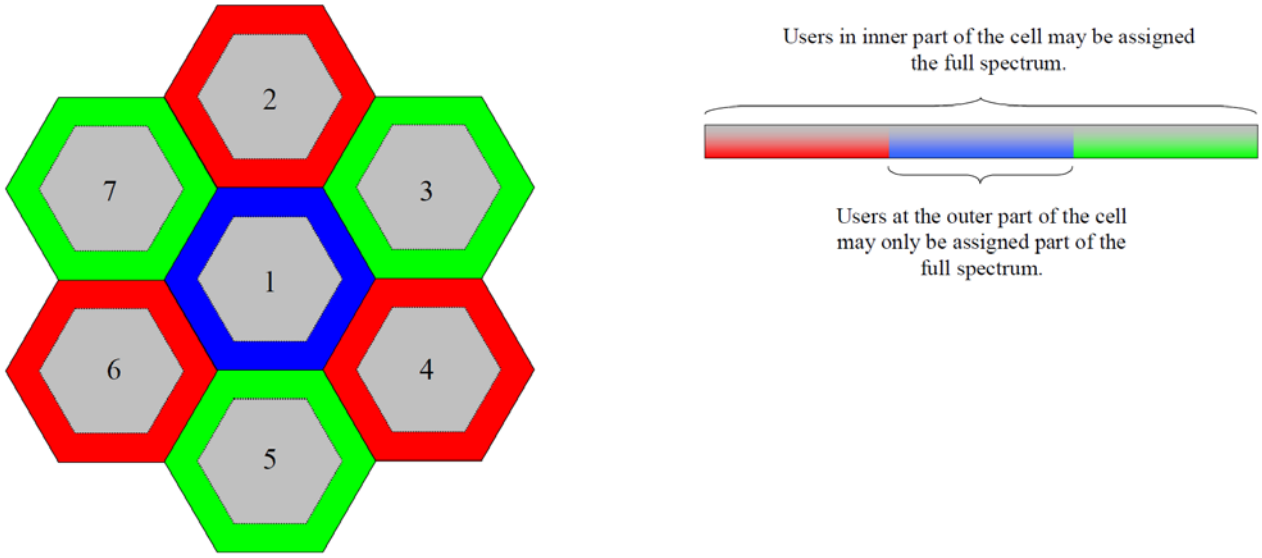


2. Ericsson

125. Ericsson (Ex. 1007) is a publication entitled "Inter-cell Interference Handling for E-UTRA" authored by Ericsson in the 3GPP TSG-RAN Working

Group in connection with Meeting #42 held in London, UK during the week of August 29-September 2, 2005, document number R1-050764.

126. Ericsson addresses the problem of inter-cell inference in OFDM networks. In Section 3, Ericsson discloses a frequency reuse technique in which "only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users ... ." Ex. 1007 at 2. (Fig. 2, below).



Ex. 1007 at Fig. 2.

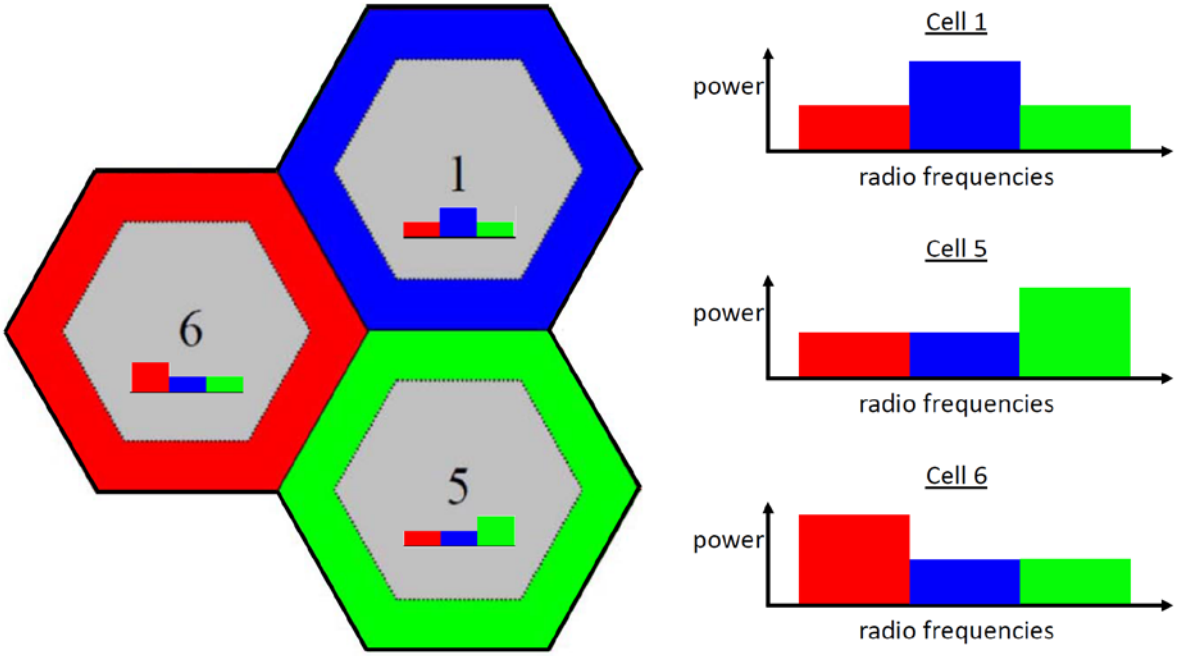
127. Ericsson at page 2 describes the frequency reuse technique implemented in Cells 1-7 of Fig. 2, stating:

> Fractional reuse, also known as ***soft frequency reuse*** …, has been proposed as a means to increase the performance for cell-edge users. With fractional reuse, only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference

> experienced by these users (at the cost of a reduced bandwidth). Typically, fractional reuse is implemented as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, only cell 1 is allowed to transmit with ***full power*** using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a ***reduced power***. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2 (footnotes omitted)

128. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ex. 1007 at 2 (e.g., "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").



3. Stratford

129. Stratford (Ex. 1009) is U.S. Patent 6,785,558 which issued August 31, 2004, which was more than one year prior to any effective filing date for the '358 patent. Therefore, Stratford is prior art to the '358 patent.

130. Stratford discloses a distributed antenna system for distributing wireless cellular communication signals between a base station hotel and remote cell sites with digitized RF carrier signals. Ex. 1009 at Abstract, Fig. 3, 2:37-44, 3:9-20, 6:29-51. As shown, for example, in Figure 3, the system operates to distribute RF signals digitally from base stations located in a base station "hotel" to multiple remote cell sites. Ex. 1009 at Fig. 3, 1:26-65; 3:9-20. Figure 3 is reproduced below.

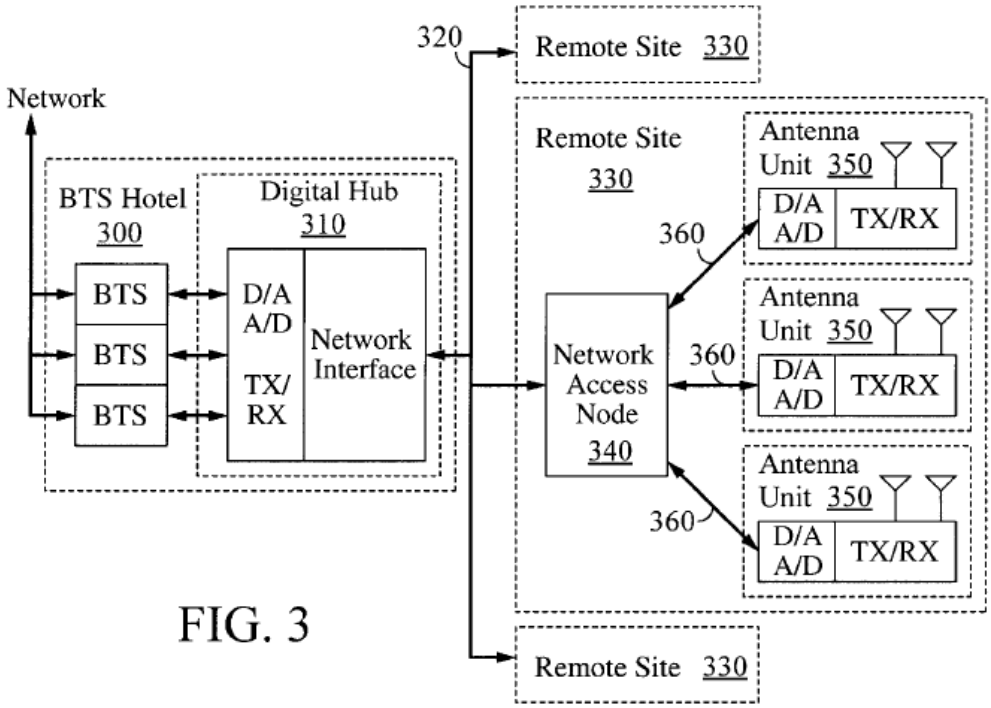


FIG. 3

Ex. 1009 at Fig. 3. The system includes a digital hub 310 that distributes RF signals from multiple base stations over digital fiber links to remote cell sites where antenna units convert the digital signals back into analog RF signals for wireless transmission into each cell's coverage area. *See* Ex. 1009 at Fig. 3, 3:9-47.

131. Stratford notes the cost and inefficiency problems associated with the traditional cellular system in which a "base station ... is normally located in each remote site ... ." Stratford explains that this traditional approach "increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment. Ex. 1009 at 1:26-43.

132. To mitigate these problems, Stratford notes that it was known to locate multiple base stations at a site (called a "base station hotel") that is remote

from the various cell sites within the system. Ex. 1009 at 1:44-65; Fig. 3; 6:29-51. The base stations at the base station hotel are connected to the digital hub that is co-located with the base stations at the base station hotel. The digital hub is connected via a digital optical fiber network to remote cell sites. The digital hub receives base station signals, digitizes and formats those signals for transport over digital optical communication links, and distributes the signals to antenna units at various remote cell sites. The remote cell sites include one or more antenna units that receive the base station signals via the hub and network access nodes, convert the signals back to analog and broadcast them to wireless subscribers within their coverage areas. The same units perform reciprocal functions in the upstream direction as well.

C. Secondary references and other background DAS prior art

133. Base station hotel (centralizing base station resources). As discussed below, there are many prior art references discussing the benefits of centralizing base station resources in a "base station hotel" and using a distributed antenna system (DAS), including a DAS host unit and DAS links to distribute the radio resources to antenna units located at the remote cell sites. Ex. 1009 at 1:26-65; Ex. 1008 at 1:34-40, Fig. 2; Ex. 1014 at ¶0005, Fig. 6; Ex. 1010 at Fig. 1. A POSA, viewing Ericsson's system, would have also known that to deploy Ericsson's system in densely populated areas it may not have been practical, or even possible

when there was lack of access to sufficient space, to install the base station equipment at the cell site. See e.g., Stratford explaining the problem:

> This traditional approach of deploying all the cell site equipment locally at each remote site has several drawbacks that contribute to the expense of the infrastructure, and upgrades to the infrastructure. At each remote site, a BTS room or cabinet to host the large base station equipment is require, as well as additional electric power supplies for the base station. This increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment. …
>
> … To mitigate these problems, some cellular systems have been designed with a different architecture, as shown in FIG. 2. The base stations **240** for multiple remote sites **200** are centralized in a base station hotel **210,** while the antenna towers and antennas remain located at various remote sites at a distance from the base station hotel. Separating the base stations **240** from the antennas, however, makes it necessary to transport RF signals between the base station hotel and the various cell sites that it serves, typically using signal converters **250,** network interface equipment **260,** and a broadband communication network **220.** When broadband fiber optic cables are used, RF signals from the base stations are converted to optical format and communicated over the fiber optic cable and then converted back to analog RF signals at the remote sites. After the optical/RF conversion, the signal is sent to one of several sector transmitters **230** and radiated over the air via the antenna to provide cellular coverage.

Ex. 1009 at 1:26-65. *See also* Ex. 1008 at 1:34-40, Fig. 2.

134. Further, as noted in prior art discussed below, there are efficiency benefits to centralizing base station recourses (such as ease of upgrading all the

base stations when the equipment is centralized versus when that equipment is dispersed throughout a large metropolitan area) that would have also motivated a POSA to modify Ericsson's system by moving the base station equipment to a centralized location, such as a base station hotel, that is remote from the cell sites. E.g., Stratford stating:

> The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. In these types of areas it is getting increasingly more difficult to deploy new cell sites due to a variety of factors including regulatory and space constraint issues.

Ex. 1009, col. 1:60-65.

135. DAS for distributing radio resources from the base station hotel to the remote cell sites. The DAS art was well developed by the time the '358 patent was filed. Exs. 1008, 1009, 1010, 1012, and 1014. A POSA would have known that it was common to employ a DAS, including a DAS host unit and DAS links, to distribute radio resources from a base station hotel to remote cell sites. *Id.* One well-known benefit motivating the use of a DAS is that such systems are agnostic to the communication protocols used by the base stations. Ex. 1009 at 4:64-67 ("The techniques of the invention are independent of the specific wireless protocol … and the protocol used over the telecommunications network."); Ex. 1008 at 7:17-20 ("means for routing traffic channel resources (such as CDMA), is placed at a centralized location"); Ex. 1010 at ¶0010 ("can serve multiple operators, multi-

mode radios (modulation independent)"); Ex. 1012 at ¶0030 ("Distribution system 100 can support technologies or protocols including GSM, EDGE, CDMA, TDMA, FDMA, WCDMA, WiMAX, or other wireless technologies."). Thus, a DAS host unit could receive base station signals from multiple base stations, prepare those signals as appropriate for transport over the DAS links, and then distribute those signals to the remote cell sites.

136. The background section of the '358 patent notes that the concept of "base station hotel" is "commonly known" and that a DAS, including a DAS host unit, would be used as the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units. That teaching can be found in each of the prior art references discussed below. *E.g.*, Ex. 1008 at Fig. 2, 3:25-26 ("centralized base-station site and the remote cells"); Ex. 1009 at Fig. 2 ("BTS Hotel"); Ex. 1010 at Fig. 1, ¶0007 ("providing a distributed antenna system responsive to one or more base stations and having at least one but in some embodiments a plurality of Digital Access Units").

a. Schwartz

137. Schwartz (Ex. 1008) is U.S. Patent 6,353,600 which issued March 5, 2002.

138. Schwartz addresses the cost and inefficiency problems associated with conventional cellular networks that "employ an architecture which divides a

geographical area into coverage areas called cells" and "a base-station is placed at the center of each cell to serve the cellular traffic." Ex. 1008 at 1:16-20. In such a network, each cell's available radio resources is fixed and limited. Ex. 1008 at 1:20-24. Cellular traffic within the network, however, is non-uniform and dynamic, "resulting in capacity shortages in some of the cells while" others experience "capacity excesses." Ex. 1008 at 1:29-33. Thus, it is difficult to operate such networks efficiently. Ex. 1008 at 1:37-40. Schwartz also explains, that because the base station equipment is distributed throughout the network within each cell, such conventional networks are more costly to upgrade. Ex. 1008 at 1:33-40.

139. To address these problems Schwartz discloses a cellular network as illustrated in Fig. 2 (below) that includes a central base station site that is remote from the cells. The base station site includes "one or more base stations" and a "router" (i.e., host unit) that serves as an interface between the base station(s) and the antennas in the cells. Schwartz's router is an example of the '358 patent's host unit which also performs a routing function. Ex. 1001 at Abstract ("method of routing"); 1:24-26 ("The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable."); 1:50-52 ("According to an embodiment of the present invention, a method for routing and Switching operator RF signals is provided.").

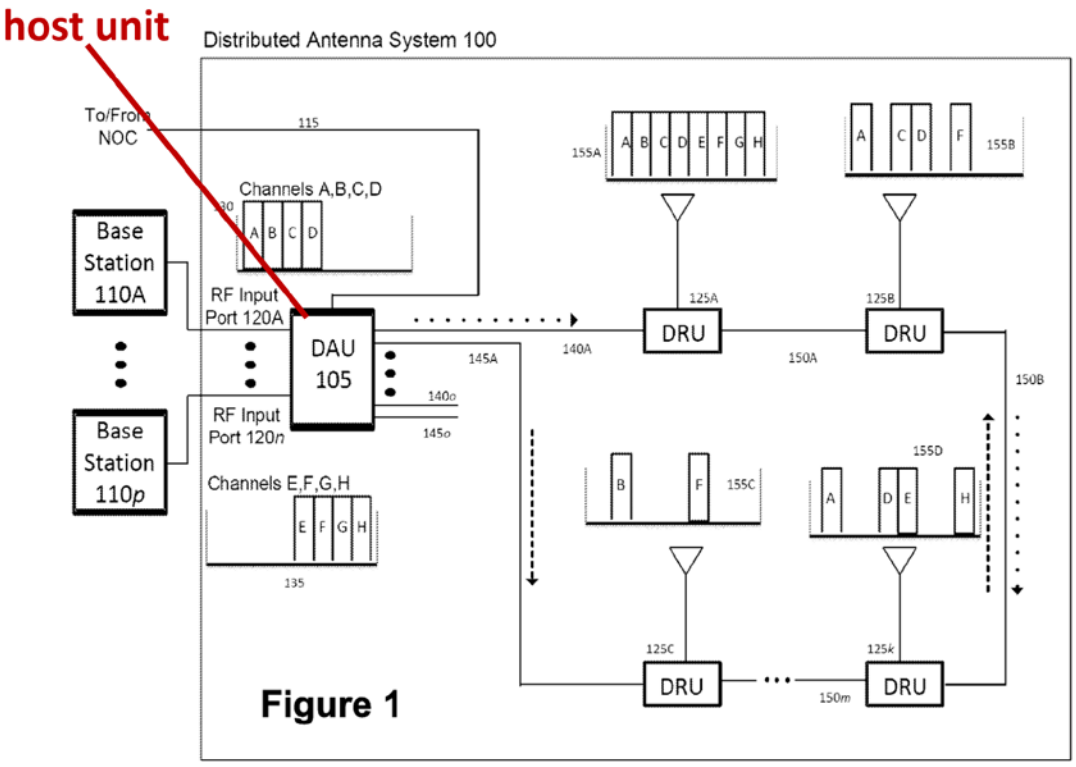
140. Schwartz Fig. 2 (below) teaches a system that includes a base station site that includes multiple base station units (such sites are sometimes referred to as "base station hotels"), a router at the base station site coupled to the base station units, which is also coupled to multiple remote cell sites having RF antennas. The centrally located router at the base station site (which does not need to be within any of the cell sites (Ex. 1008 at 3:30-32; 5:1-17)) allows centralized channel resources to be dynamically allocated to remote cells according to demand. Ex. 1008 at 2:55-58; 3:30-48, 6:24-41; Fig 2.

b. Stapleton

141. Stapleton (Ex. 1010) is U.S. Patent Application Publication No. 2012/0039254 which published on February 16, 2012, i.e., before the effective date of the '358 patent and therefore Stapleton is prior art.

142. Stapleton also increased the efficiency and traffic capacity of cellular networks by providing a distributed antenna system that supports the transport of radio resources from multiple base stations. Fig. 1 (below) of Stapleton discloses a distributed antenna system 100. "The system employs a Digital Access Unit ... 105" (DAU or host unit). Ex. 1010 at ¶ 0028. "The DAU ... **serves as an interface between associated base stations** (BTS) 110A-B and a plurality of digital remote units (DRU) ... ." *Id.* The DAU prepares the downlink signals from the base stations for transport over an optical fiber cable to the remote units. Ex. 1010 at ¶0029.

Stapleton (US 2012/0039254)



c. Sabat

143. Sabat (Ex. 1014) is U.S. Patent Application Pub. No. 2009/0180426 which published on July 16, 2009, which was more than one year prior to any effective filing date for the '358 patent. Therefore, Sabat is prior art to the '358 patent.

144. Sabat explain that "Distributed Antenna Systems are used to provide wireless communications coverage where it is impractical to install a conventional base station." Ex. 1014 at ¶ 0005. Sabat Fig. 3 (below) shows an example a DAS.

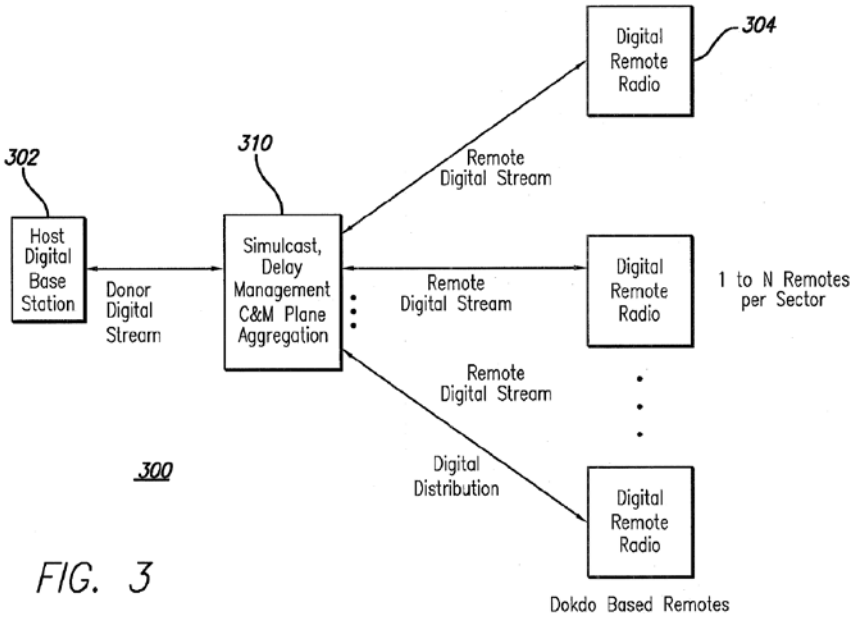


FIG. 3

d. Huawei

145. Huawei (Ex. 1006) is a prior art publication entitled "Further Analysis of Soft Frequency Reuse" authored by Huawei for the 3GPP TSG RAN Working Group 1#42 in 2005. Based on Ex. 1022 (Declaration of Sylvia Hall-Ellis, Ph.D) Huawei was publicly accessible to persons interested in and ordinarily skilled in the art exercising reasonable diligence no later than August 25, 2005, which is more than one year prior to any effective filing date for the '358 patent. Therefore, Huawei is prior art to the '358 patent.

146. Huawei teaches utilizing soft frequency reuse schemes to mitigate inter-cell interference.

> In the proposed soft frequency reuse scheme, sub-carriers are divided into two groups in every cell. One group is called major sub-carriers group, and the other one is called minor sub-carriers group. For each group of sub-carriers, one maximum allowed transmission power is set for them. Normally, the maximum allowed transmission power for major sub-carriers is higher than minor sub-carriers. The transmission power on each sub-carrier shall not exceed this limitation. The major sub-carrier can be used to cover the whole cell area, while the minor sub-carrier is used only in the inner part of the cell, as is showed in figure 1(the blue represents the inner zones and the other colors represent the cell edges). Major subcarriers in neighboring cell are orthogonal (i.e. no overlap). The so called "Power Ratio" is the ratio between transmit power limitation of minor sub-carriers and major subcarriers. Power Ratio adjusted gradually from 0 to 1, the effective reuse factor changes from 3 to 1 smoothly. So, the SFR is the compromise of reuse 1 and reuse 3.

Ex. 1006 at 1. Huawei illustrates soft frequency reuse as shown in Figure 1.

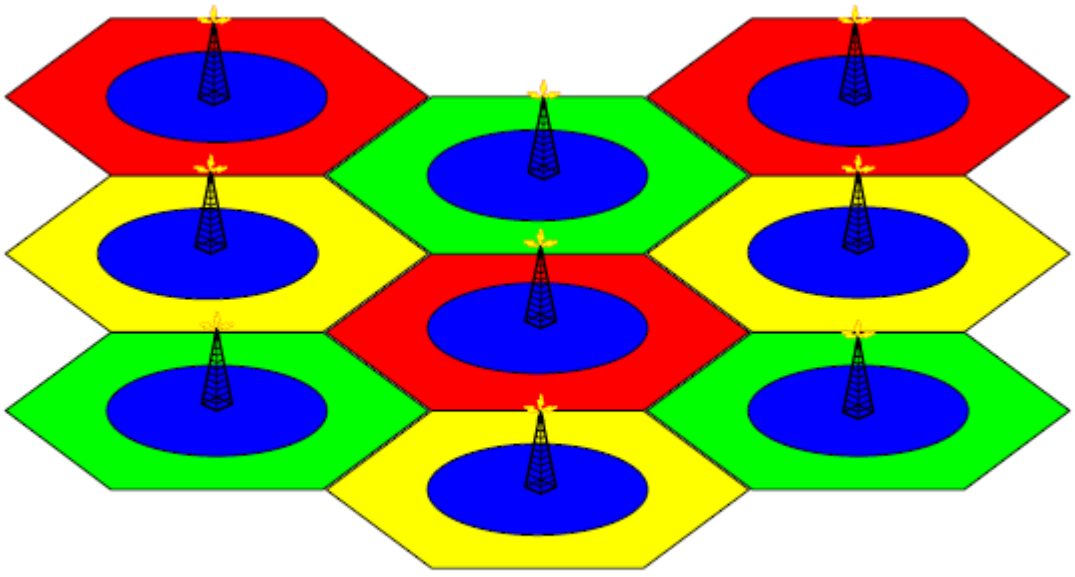


Figure 1, Cell deployment

Ex. 1006 at Fig. 1.

VIII. GROUNDS

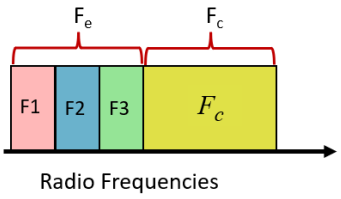
A. Ground 1: Xu anticipates claims 7, 8, 9 and 11

1. Claim 7

147. Xu anticipates claim 7. Fig. 1 from Xu is reproduced below (annotated). A map for the abbreviations and annotations has been added (below, left side) to assist in understanding Xu's system of Fig. 1.

map for abbreviations used in Xu, Fig. 1

B = Base station (e.g., B_0, B_1, B_2 ...)
RAs = remote antennas (each cell includes 6 RAs to cover cell edge area)
N_r = number of RAs = 6 RAs in each cell. Xu, p 4440, Section A at ¶1 ("every cell has the same system configuration"), ¶2 ("A total of N_r RAs are employed in each cell")
F_c = cell center's frequency
F_e = "cell edge's frequency which is divided into three orthogonal bands" (**F1 F2 F3**).



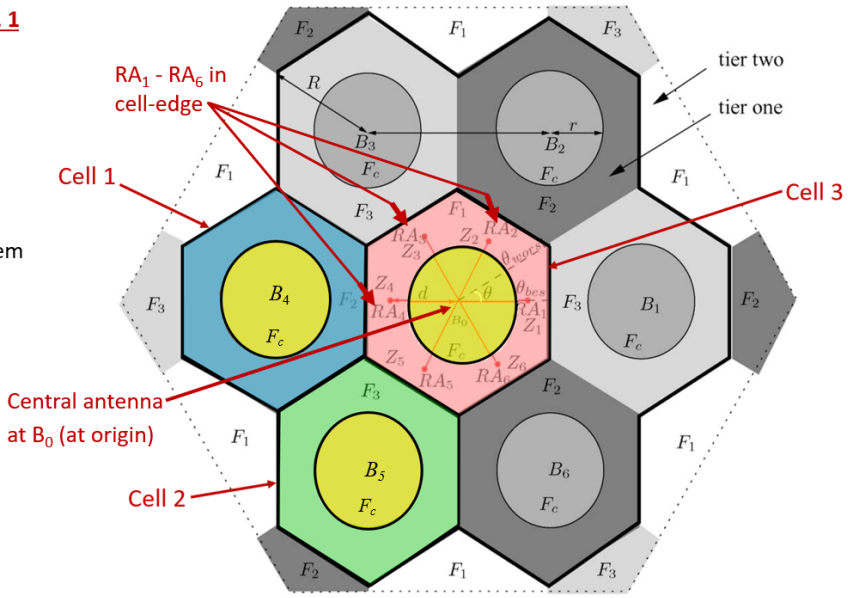


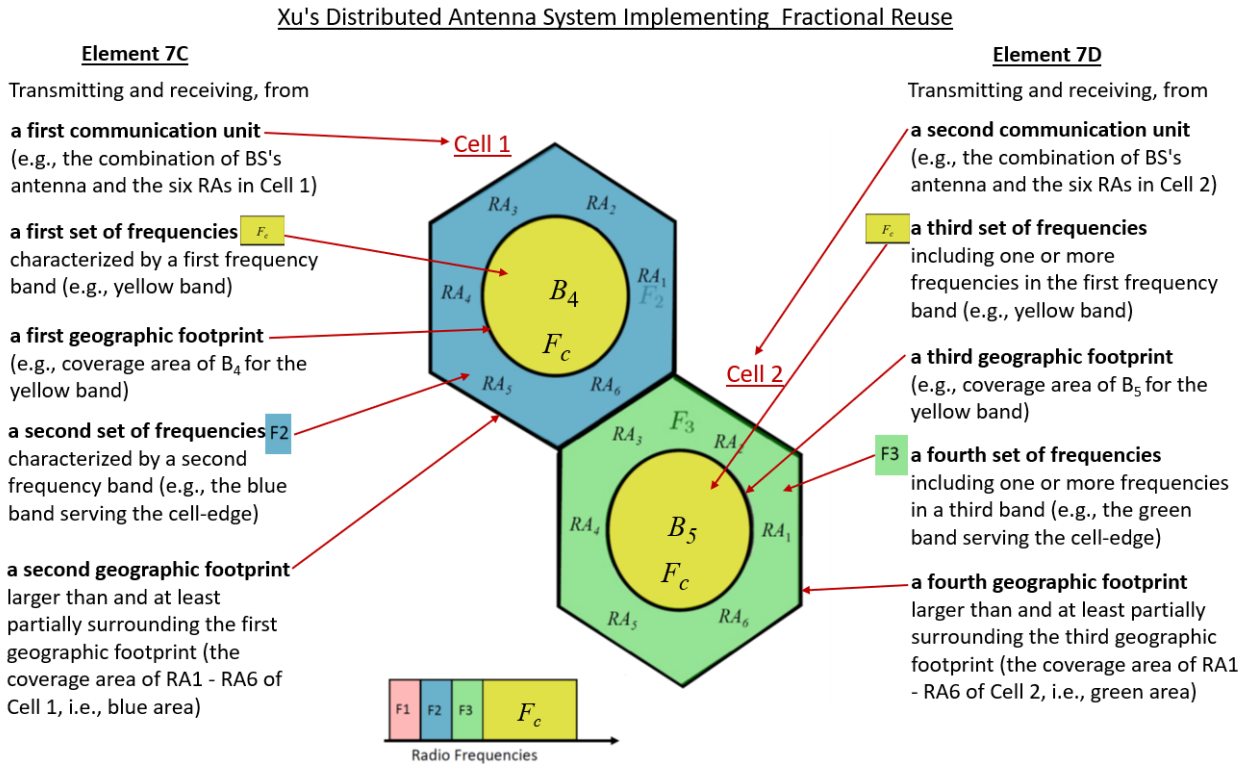
Fig. 1. Topology of two tiers of 19 cells relying on an FFR and DAS arrangement, where $N_r = 6$ RAs are employed. The structure of the cells in tier two is the same as that in tier one.

148. For the purposes of analyzing the claim, cell 1 and cell 2 of Fig. 1 are isolated below and annotated to show the six periphery antenna units of Xu's model DAS for each cell. The Xu System implements fractional frequency reuse

(FFR) in each cell by using DAS that includes seven distributed antenna units – the same as the first embodiment of the '358 patent. For the same reasons that claim 7 reads on the first embodiment of the '358 patent, it also reads on the Xu system.

149. Reading claim 7 on Xu's system. As discussed in more detail below, Xu discloses "a method of distributing communication frequencies" (Element 7A) by combining the techniques of DAS and fractional frequency reuse to mitigate inter-cell interference in a multi-cell communications network. Ex. 1005 at 4440, Fig. 1, Section II.A (describing "Multicell Multuser System Topology"). Just as in the '358 patent's first embodiment, Xu provides "a set of communications units" (Element 7B) that includes a "first communications unit" (e.g., in cell 1, the combination of the central antenna at base station B_4 and the six surrounding remote antennas RA_1-RA_6 in cell 1) and a "second communications unit" (e.g., in cell 2, the combination the central antenna at base station B_5 and the six surrounding remote antennas RA_1-RA_6 in cell 2). Ex. 1005 at Fig. 1 (above, annotated). As illustrated below, the limitations associated the "first communications unit" (Element 7C) and "second communications unit" (Element

7D) also read on Xu's system.



a. Element 7A

"distributing communications frequencies"

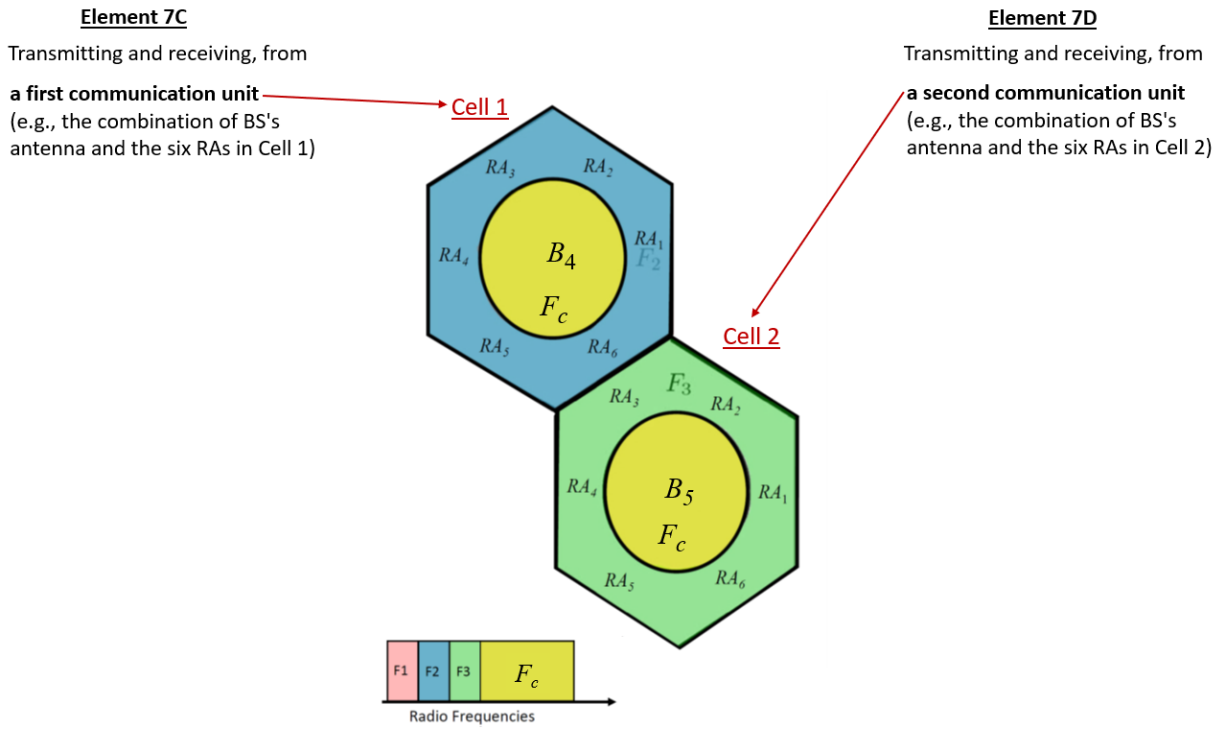
150. Xu teaches this element because it discloses a multi-cell wireless communication system for transporting wireless communications. Ex. 1005 at 4439 ("Distributed Antennas With Fractional Frequency Reuse in Multicell Multiuser Networks"); Fig. 1; 4440, Section II.A (describing the "Multicell Multiuser System Topology" for transporting wireless communications); 4442, Section III.A (describing "Noncooperative DAS with FFR Systems" using FFR and DAS arrangement of Fig. 1). Within each cell, the system transports wireless

communications from a base station via a distributed antenna system (DAS) that implements a frequency reuse technique (e.g., FFR).

b. Element 7B

"providing a set of communications units;" that includes "a first communications unit" (from element 7C) and "a second communications unit" (from element 7D)

151. In Xu, the set of antennas serving cell 1 is a "first communications unit" (below, left), and the set of antennas serving cell 2 is a "second communications unit" (below, right). Xu's first and second communications units satisfy "a set of communications units" of Element 1B.



152. The cell configuration of Xu's FFR communication system is virtually the same as the first embodiment of the '358 patent. Each cell is served by central base station (BS) and seven antenna units, including a central antenna co-located with the base station that serves the cell-center area and six remote antennas (RAs) distributed around cell periphery to serve the cell-edge area. Ex. 1005 at Fig. 1 ("N_r = 6 RAs are employed"); Ex. 1005 at 4440, Section A at ¶1 ("…B_0 is assumed to be at the origin [in Fig. 1]. We assume cell *symmetry*, where every cell has the same configuration"); Ex. 1005 at 4444 ("…the transmit power of the BS should be sufficiently high to ensure that the average throughput maintained at a distance of r remains exactly as high as that of the classic UFR technique, whereas the rest of the power is evenly allocated to the RAs."); Ex. 1005 at 4442 ("Focusing our attention on the cell B_0 of Fig. 1, when non-cooperative DASs are employed, the ***transmit power P_B of the BS*** and the ***transmit power P_R of each RA*** should obey the total transmit power constraint of $P_B + N_r P_R = P$, where P is the full power at the BS of the traditional UFR and FFR scheme."); Ex. 1005 at 4440 Section II.A. at ¶2 ("A total of N_r RAs are employed in each cell").

153. Under the same logic and reason that "a set of communications units" that includes "a first communications unit" and "a second communications unit" reads on the first embodiment of the '358 patent (see Section VI.D), those limitations also read on Xu's system. Just as in the first embodiment of the '358

patent, Xu's set of seven antennas serving cell 1 is "a communications unit" (i.e., "a first communications unit"). Likewise, Xu's set of seven antennas serving cell 2 is also "a communications unit" (i.e., "a second communications unit"). Collectively, Xu's first communications unit and second communications unit is a "set of communications units." Ex. 1001 at 4:29-30 ("The first communications unit can include a plurality of DRUs ..."); 3:46-48 (referring to the first embodiment, the 358 patent states that the "first communications unit can include a central DRU and a plurality of peripheral DRUs disposed adjacent the central DRU.").

c. Element 7C

154. Below I have illustrated how Element 7C reads on Xu's system.

Xu's System

Element 7C

Transmitting and receiving, from

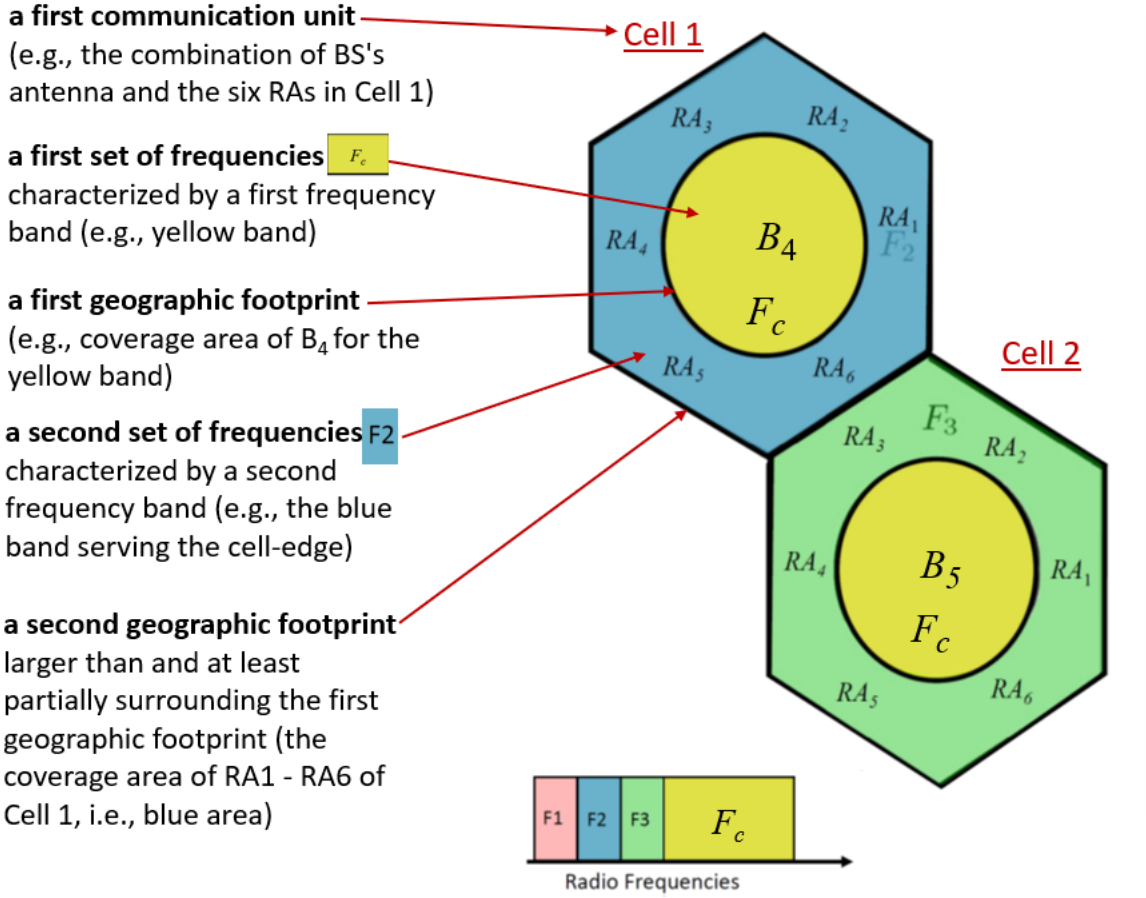
a first communication unit (e.g., the combination of BS's antenna and the six RAs in Cell 1)

a first set of frequencies F_c characterized by a first frequency band (e.g., yellow band)

a first geographic footprint (e.g., coverage area of B_4 for the yellow band)

a second set of frequencies F2 characterized by a second frequency band (e.g., the blue band serving the cell-edge)

a second geographic footprint larger than and at least partially surrounding the first geographic footprint (the coverage area of RA1 - RA6 of Cell 1, i.e., blue area)



155. That Xu discloses Element 7C is consistent with the same logic and reason under which Element 7C reads on the first embodiment of the '358 patent. See mapping to of claim 7 to the first embodiment of the '358 patent at Section VI.D of my declaration.

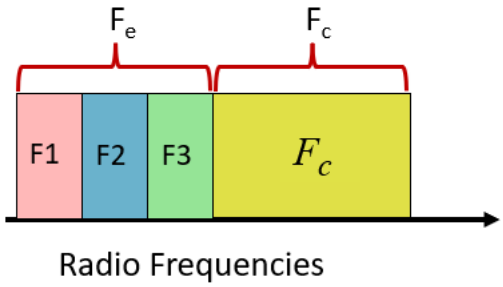
156. The first communications unit: In Xu's cell 1 (above), the combination of the base station's antenna B_4 (i.e., the centrally located antenna) and the six remote antennas is "a first communications unit".

157. Transmitting and receiving ... a first set of frequencies characterized by a first frequency band: In Xu's system, the central antenna (i.e., base station antenna B_4 of cell 1, above) of the first communications unit transmits a first set of frequencies characterized by a first frequency band (F_c), i.e., the yellow band. *See* Xu (Ex. 1005) at 4440, Section II.A and Fig. 1 where Xu explains how the fractional reuse scheme of Xu Fig. 1 partitions the available frequencies. Xu explains:

> The frequency partitioning strategy of the total available bandwidth F is characterized by $F_c \cap F_e = Ø$, where F_c and F_e represent the cell center's frequency band and the cell edge's frequency band, respectively. Fe is divided into three orthogonal frequency bands F_i, $i \in [1, 3]$, which were exclusively used at the cell edge of one of the three adjacent cells.

Ex. 1005 at 4440. Below I have illustrated how Xu's system partitions the available frequencies.

F_c = cell center's frequency
F_e = "cell edge's frequency which is divided into three orthogonal bands" (**F1 F2 F3**).



Ex. 1005 at 4440, Section II.A, Fig. 1. In Xu's system the yellow band will, therefore, be transmitted from the central antenna unit of Cell 1 to user devices and will be received from the central antenna unit by the user devices (in the downlink) and by the base station (in the uplink).

158. Transmitting and receiving ... a first set of frequencies characterized by ... a first geographic footprint: In Xu's cell 1, the radio coverage area of the central antenna (i.e., the base station antenna B_4) for the yellow band (F_c) is "a first geographic footprint". Ex. 1005 at 4440, Section II.A and Fig. 1. The central circle shown in Fig. 1 of Xu corresponds to the first geographic footprint. The size of the footprint Xu teaches is dependent on the power level of the central antenna at the base station of each cell. Ex. 1005 at 4444 ("…the transmit power of the BS should be sufficiently high to ensure that the average throughput maintained at a

distance of r remains exactly as high as that of the classic UFR technique, whereas the rest of the power is evenly allocated to the RAs.").

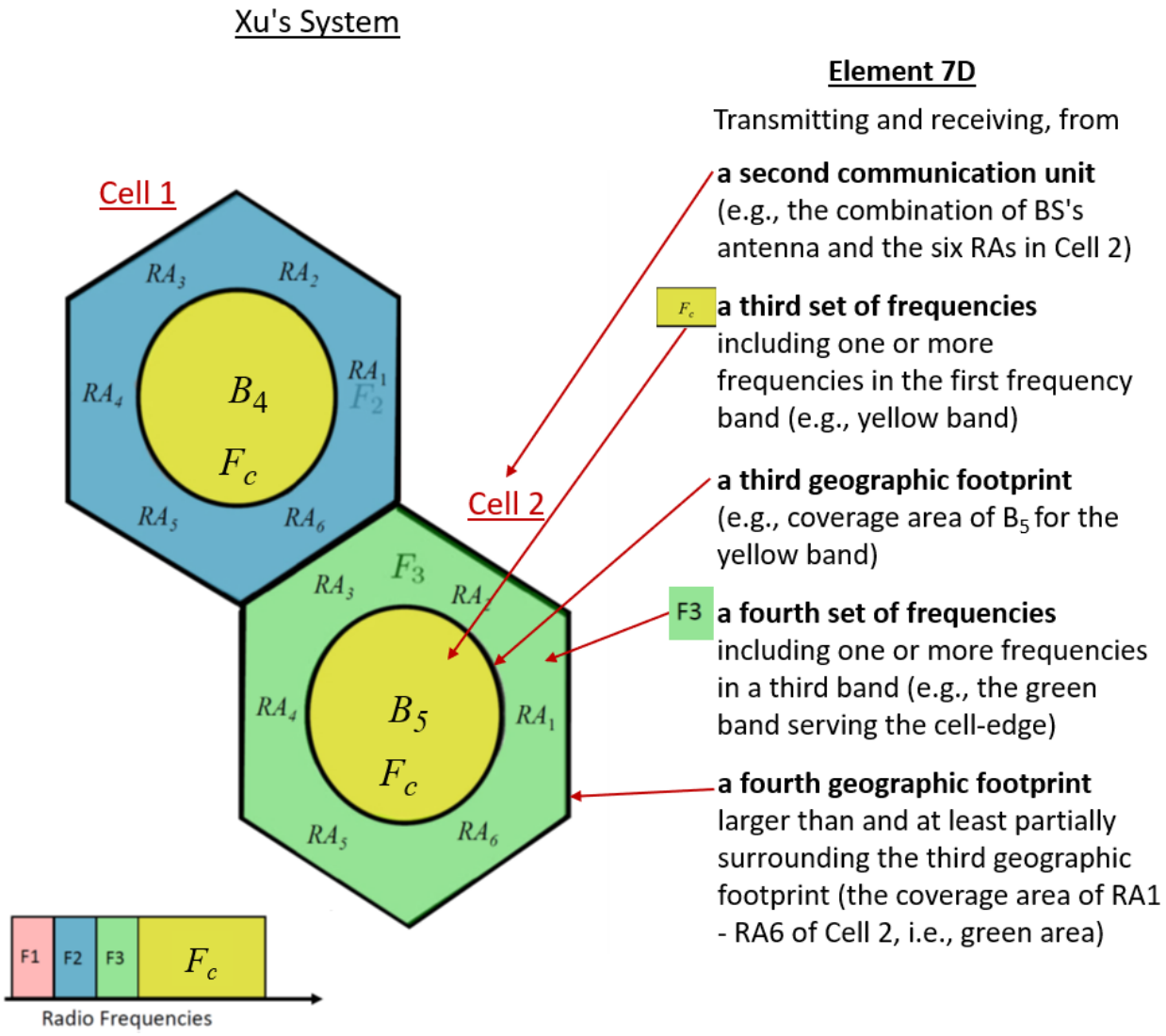
159. Transmitting and receiving... a second set of frequencies characterized by a second frequency band: In cell 1 of Xu's system, six periphery antennas (RA_1 – RA_6) of the first communications unit transmits a second set of frequencies characterized by a second frequency band (band F2 of the cell-edge frequencies F_e), i.e., the blue band in my illustration above. Ex. 1005 at 4440, Fig. 1. Therefore, in Xu's system the blue band will be transmitted from the periphery antenna units of Cell 1 to user devices and will be received from the periphery antenna units by the user devices (in the downlink) and by the base station (in the uplink).

160. Transmitting and receiving... a second set of frequencies characterized by ... a second geographic footprint larger than and at least partially surrounding the first geographic footprint: In Xu's cell 1, the radio coverage area of six periphery antennas (RA1 – RA6) for the blue band is "a second geographic footprint". A visual inspection of Xu's first and second geographic footprints shows that the second geographic footprint is larger than and at least partially surrounds the first geographic footprint. Furthermore, at page 4444, right column, and with reference to Figure 1, Xu sets the distance d between the base station and an RA at 0.7R, where R is the radius of the circle surrounding one cell. Some

straightforward geometry then produces a distance between an RA and a vertex of the hexagon equal to 0.527 x R. Assuming that the cell center covers a radius of 0.527 x R (so that the footprint of all seven antennas have the same radius), the area of the center equals $(0.527)^2 \times \pi = 0.872 \times R^2$. The hexagonal cell consists of six equilateral triangles, each having a side of length R. Accordingly, each has an area equal to $(\sqrt{3})/4 \times R^2 = 0.433R^2$, yielding a total hexagonal cell area of $6 \times (.433) \times R^2 = 2.598 \times R^2$. Subtracting the area of the cell core then yields a remaining area of $1.726 \times R^2$, which larger than the area of the cell core (which has an area of $0.872 \times R^2$). Accordingly, the geographical footprint of the second footprint is larger than and completely encompasses the geographical area of the first geographic footprint.

d. Element 7D

161. Below I have illustrated how Element 7D reads on Xu's system.

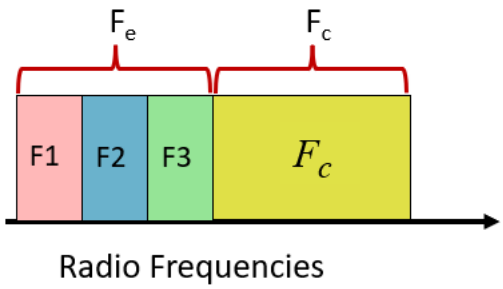


162. That Xu discloses Element 7D is consistent with the same logic and reason under which Element 7D reads on the first embodiment of the '358 patent. See mapping to of claim 7 to the first embodiment of the '358 patent at Section IV.D my declaration.

163. The second communications unit: In Xu's cell 2 (above), the combination of the base station's antenna at B_5 (i.e., the centrally located antenna) and the six remote antennas surrounding B_5 is "a second communications unit".

164. Transmitting and receiving ... a third set of frequencies including one or more frequencies in the first frequency band: In Xu's system, the central antenna (i.e., base station antenna B_4 of cell 2, above) of the second communications unit transmits a third set of frequencies that include one or more frequencies in the first frequency band, the yellow band (F_c). As explained by Xu (Ex. 1005) at 4440, Section II.A, the F_c band (yellow band in my illustration) is reused in the cell-center area of cell 1 and cell 2.

F_c = cell center's frequency
F_e = "cell edge's frequency which is divided into three orthogonal bands" (**F1 F2 F3**).



165. Therefore, in Xu's system the yellow band will be transmitted from the central antenna unit of Cell 2 to user devices and will be received from the central antenna unit by the user devices (in the downlink) and by the base station (in the uplink).

166. Transmitting and receiving ... a third set of frequencies ... in ... a third geographic footprint: In Xu's cell 2, the radio coverage area of the central antenna (i.e., the base station antenna B_5) for the yellow band (F_c) is "a third geographic footprint". Ex. 1005 at 4440, Fig. 1. The central circle of cell 2 shown in Fig. 1 of Xu corresponds to the third geographic footprint.

167. Transmitting and receiving ... a fourth set of frequencies including one or more frequencies in a third band: In cell 2 of Xu's system (above), six periphery antennas (RA1 – RA6) of the second communications unit transmits a fourth set of frequencies including one or more frequencies in a third band (band F2 of the cell-edge frequencies Fe), i.e., the green band in my illustration above. Ex. 1005 at 4440, Fig. 1. Therefore, in Xu's system the green band will be transmitted from the periphery antenna units of Cell 2 to user devices and will be received from the periphery antenna units by the user devices (in the downlink) and by the base station (in the uplink).

168. Transmitting and receiving ... a fourth set of frequencies ... in ... a fourth geographic footprint larger than and at least partially surrounding the third geographic footprint: In Xu's cell 2, the radio coverage area of six periphery antennas (RA1 – RA6) for the green band is "a fourth geographic footprint". A visual inspection of Xu's third and fourth geographic footprints shows that the fourth geographic footprint is larger than and at least partially surrounds the third

geographic footprint. Furthermore, at page 4444, right column, and with reference to Figure 1, Xu sets the distance d between the base station and an RA at 0.7R, where R is the radius of the circle surrounding one cell. Some straightforward geometry then produces a distance between an RA and a vertex of the hexagon equal to 0.527 x R. Assuming that the cell center covers a radius of 0.527 x R (so that the footprint of all seven antennas have the same radius), the area of the center equals $(0.527)^2 \times \pi = 0.872 \times R^2$. The hexagonal cell consists of six equilateral triangles, each having a side of length R. Accordingly, each has an area equal to $(\sqrt{3})/4 \times R^2 = 0.433R^2$, yielding a total hexagonal cell area of $6 \times (.433) \times R^2 = 2.598 \times R^2$. Subtracting the area of the cell core then yields a remaining area of $1.726 \times R^2$, which larger than the area of the cell core (which has an area of $0.872 \times R^2$). Accordingly, the geographical footprint of the fourth footprint is larger than and completely encompasses the geographical area of the third geographic footprint.

169. Transmitting and receiving ... a fourth set of frequencies ... in ... a fourth geographic footprint larger than and at least partially surrounding the third geographic footprint: In Xu's cell 2, the radio coverage area of six periphery antennas (RA1 – RA6) for the green band is "a fourth geographic footprint". A visual inspection of Xu's third and fourth geographic footprints shows that the fourth geographic footprint is larger than and at least partially surrounds the third

geographic footprint. Furthermore, at page 4444, right column, and with reference to Figure 1, Xu sets the distance d between the base station and an RA at 0.7R, where R is the radius of the circle surrounding one cell. Assuming that the cell center covers a radius of 0.5 R (a liberal assumption, given that this would extend the cell center coverage more than half-way to the location of an RA), the area of the center equals $(0.5)^2 \times \pi = 0.785 \times R^2$. The hexagonal cell consists of six equilateral triangles, each side of which is of length R. Accordingly, each has an area equal to $(\sqrt{3})/4 \times R^2 = 0.433R^2$, yielding a total hexagonal cell area of $6 \times (.433) \times R^2 = 2.6 \times R^2$. Subtracting the area of the cell core then yields a remaining area of $1.815 \times R^2$, which larger than the area of the cell core. Accordingly, the geographical footprint of the fourth footprint is larger than and completely encompasses the geographical area of the third geographic footprint.

2. Claim 8

The method of claim 7 wherein the set of communications units includes a plurality of remote units in communication with a host unit.

170. Xu discloses this limitation in Fig. 2 and the system architecture that supports the transport of the base station signals over the DAS links to the remote antenna units. Ex. 1005 at 4440-41, Fig. 2. Xu Fig. 2 shows an example of the DFO links leading to each RA.

171. Xu's Fig. 2 (below, annotated) discloses circuitry that constitutes a DAS host unit. Within the box labeled "BS" of Fig. 2, Xu's system includes DAS host unit functionality, i.e., the base station signal is received by the circuitry I have labeled "host unit" which converts the base station signal from an electrical signal to an optical signal for transport over fiber optic link. Ex. 1005 at Fig. 2. Using this circuitry, the BS of Xu distributes communications frequencies between the base station and the remote antenna units and defines an interface between (a) the base station of the operator's network and (b) the remote antenna units of the distributed antenna system. This host unit functionality allows Xu's BS to manage communications between the remote antennas and the operator's network.

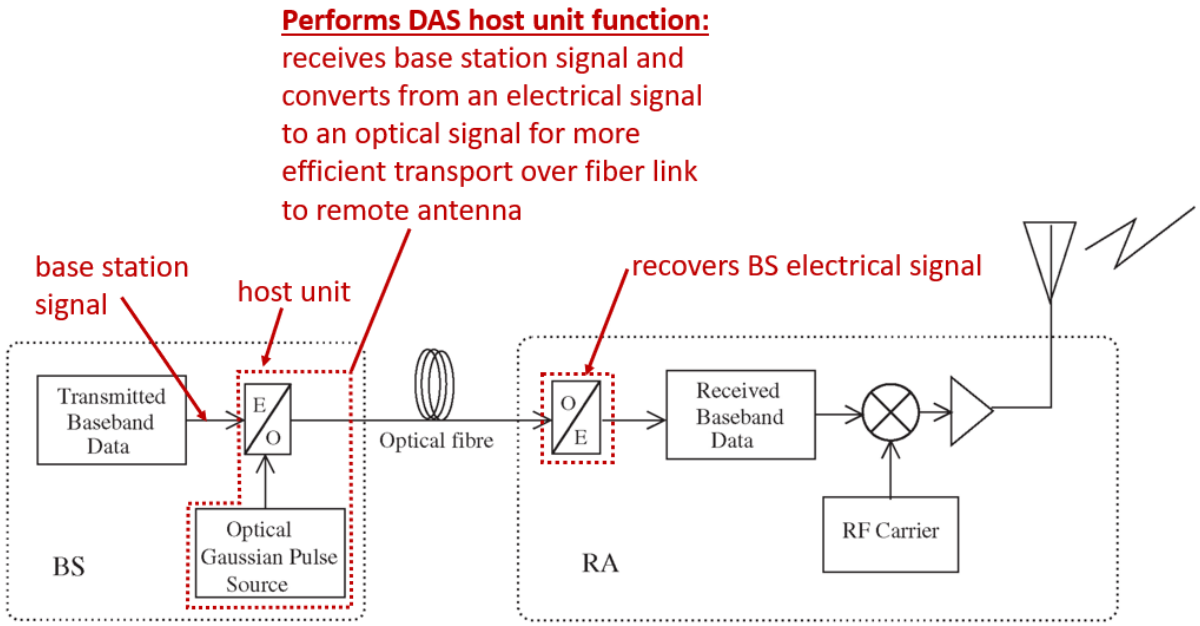
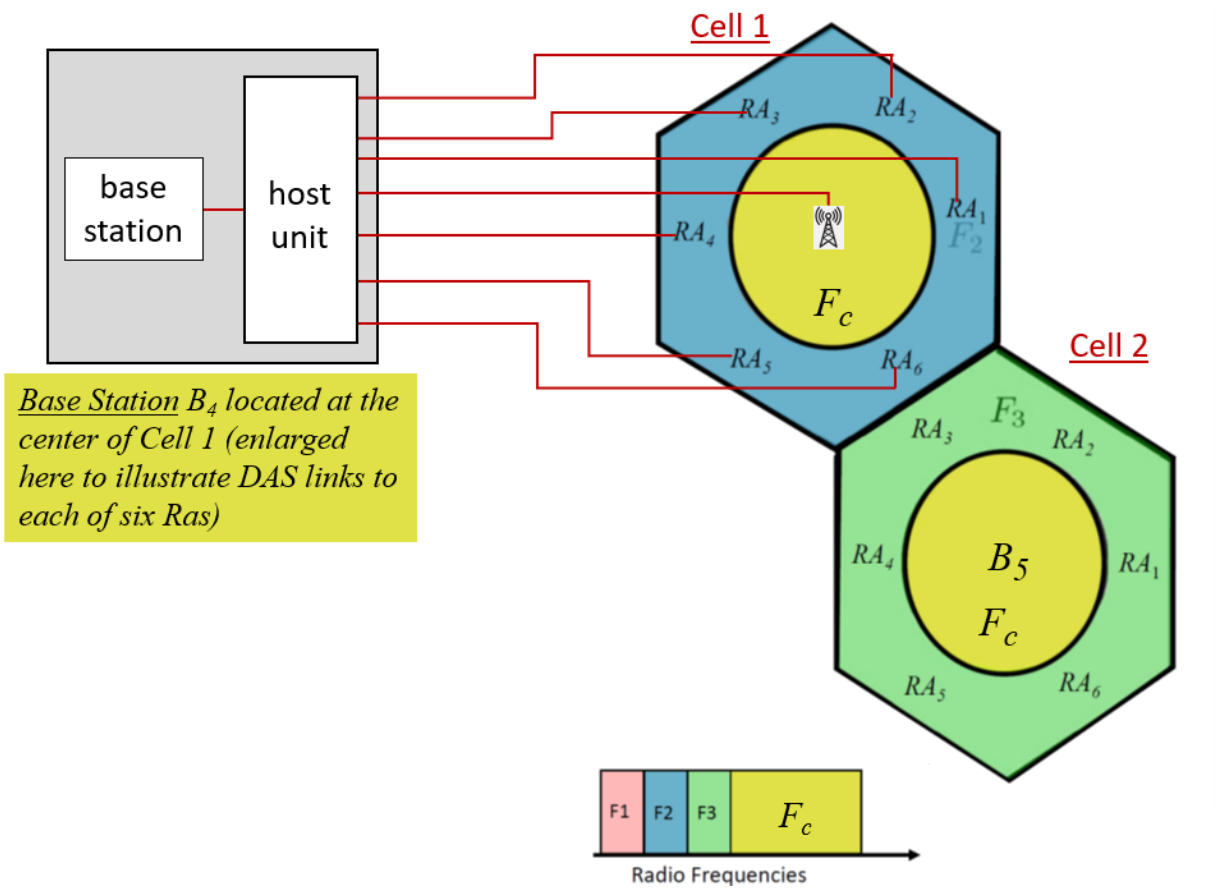


Fig. 2. System architecture of the DFO link, showing a single optical fiber link spanning from the BS to the RA. The transmitted baseband data are used to modulate a stream of optical Gaussian pulses, where an ideal optical modulator is assumed; therefore, it does not impose any chirp on the optical pulse. Then, the Gaussian optical signaling pulses are transmitted through the optical fiber, which imposes both linear and nonlinear distortions. At the RA, after an ideal photodetector, the optical signaling pulses are converted back to the corresponding baseband electronic signals.

172. A DAS DFO (digital fiber optic) link is used to connect each of Xu's RAs to the base station. Ex. 1005 at 4439 ("For practical application of DASs, the ***connection between the BS and RAs*** may be a coaxial cable, optical fiber, or a radio frequency (RF) link. The radio over fiber (RoF) and digital fiber optic (DFO)-link-based transmission technique may also be used for the BS to RA links, which is more reliable than a wireless backhaul … . In this study, we ***opted for the DFO link***.").

173. DAS links to RAs: Xu explains that "[f]or practical application of DASs, the ***connection between the BS and RAs*** may be a coaxial cable, optical fiber, or a radio frequency (RF) link." Ex. 1005 at 4439. "In this study" Xu "opted for the DFO link." Ex. 1005 at 4439 ("digital fiber optic (DFO)-link-based transmission technique … for the BS to RA links").

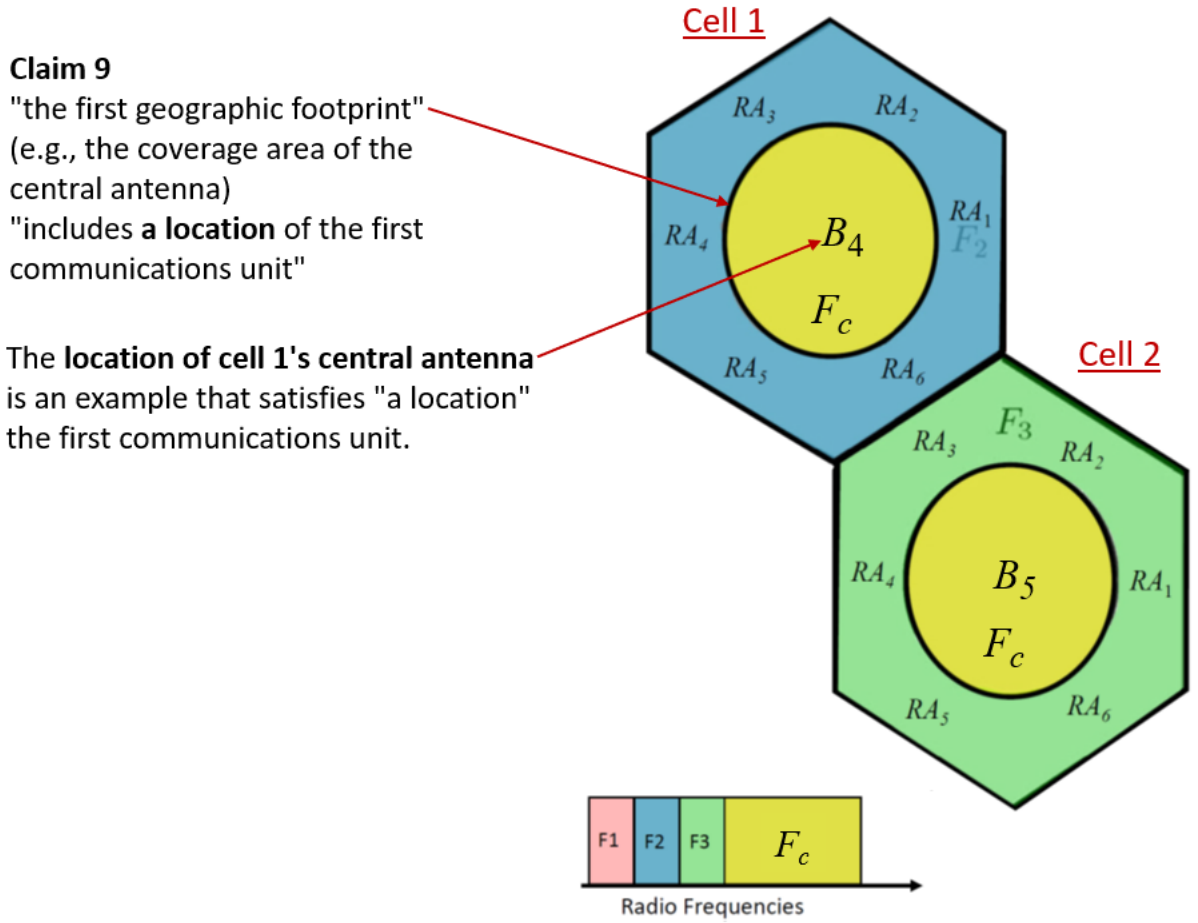
174. In the demonstrative below, to illustrate the DAS link to each RA in cell 1 of Xu's system, I moved base station B_4 outside of cell 1.



3. Claim 9

"the first geographic footprint includes a location of the first communications unit"

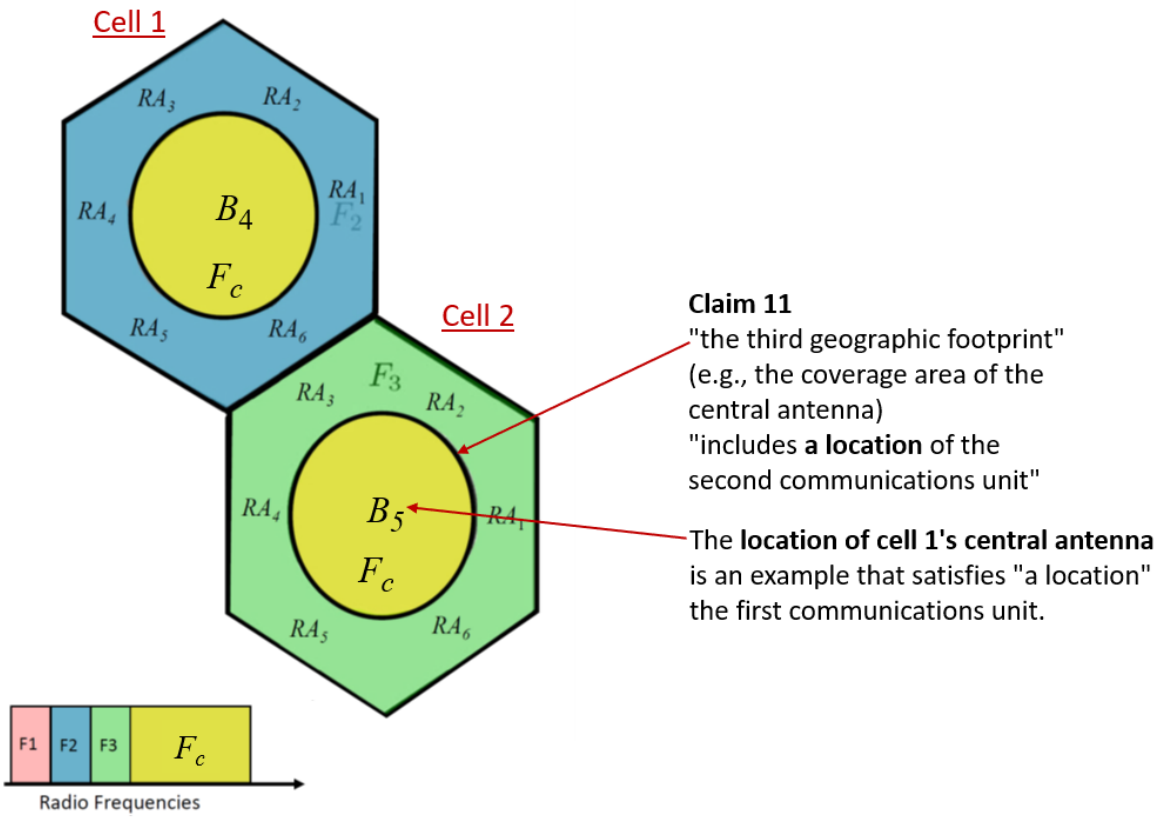
175. Since the first geographic footprint of Xu's cell 1 includes the antenna unit co-located with based station B4, the limitation added by claim 9 is satisfied. The location of any one of the seven antennas would satisfy "a location" of the first communications unit.



4. Claim 11

"the third geographical footprint includes a location of the second communications unit"

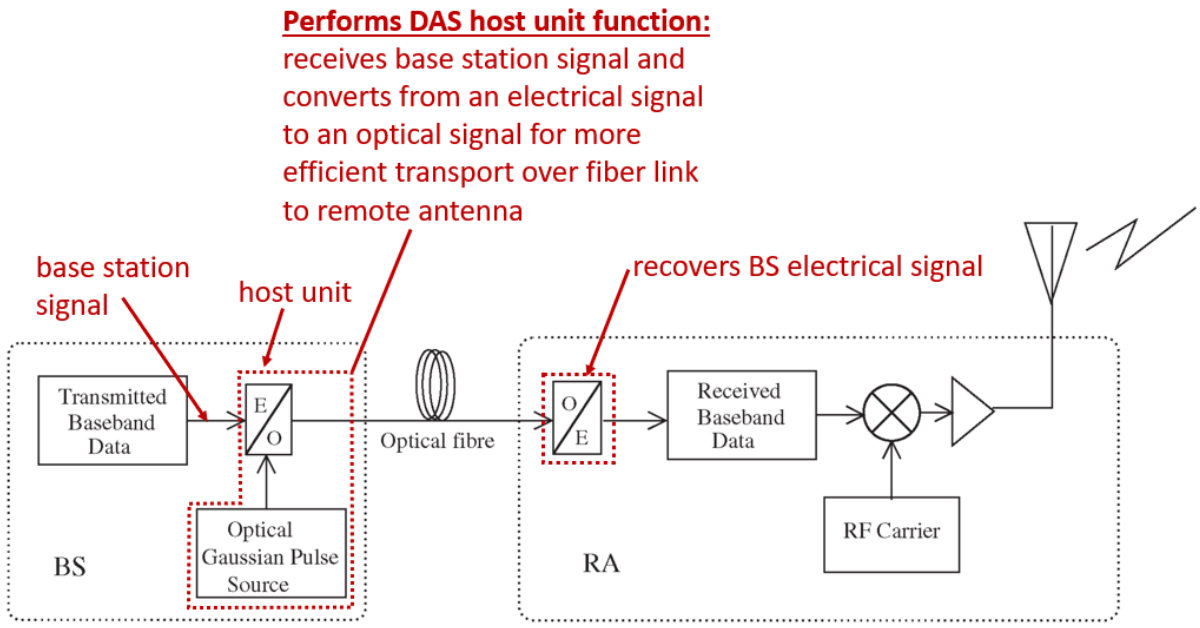
176. Since the third geographic footprint of Xu's cell 2 includes the antenna unit co-located with based station B4, the limitation added by claim 11 is satisfied. The location of any one of the seven antennas would satisfy "a location" of the first communications unit.



B. Ground 2: Xu alone or in combination Schwartz renders obvious claims 8, 15, 20 and 21

1. Claim 8

The method of claim 7 wherein the set of communications units includes a plurality of remote units in communication with a host unit.



177. Patent Owner may argue that the circuitry I have labeled "host unit" is not a host unit because the circuitry is not included within a separate housing forming a "unit" or the circuitry by itself does not satisfy the host unit limitation for some other reason. Regardless, based on Xu alone or in combination with Schwartz, it would have been obvious to include a host unit to facilitate the efficient and reliable transport of the base station signals to Xu's remote antenna units.

178. Motivation to employ a host unit in deploying Xu's system in densely populated areas. In densely populated, metropolitan areas the real estate necessary to house the base station equipment can be particularly costly or simply not available within every cell. A POSA would have known that, for this reason, it was common, particularly in densely populated areas, for the base stations to be

located, for example, at a "base station hotel" (Ex. 1001, 1:21), a long distance from the cell site, and that a host unit would "typically" be used to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. The prior art reinforces what the '358 patent states as background. *E.g.*, Ex. 1009 at 1:26-65; Ex. 1008 at 1: 34-40, Fig. 2; Ex. 1014 at ¶0005, Fig. 6; Ex. 1010 at Fig. 1. *See, e.g.*, Stratford the explaining the problem:

> This traditional approach of deploying all the cell site equipment locally at each remote site has several drawbacks that contribute to the expense of the infrastructure, and upgrades to the infrastructure. At each remote site, a BTS room or cabinet to host the large base station equipment is require, as well as additional electric power supplies for the base station. This increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment. …
>
> … To mitigate these problems, some cellular systems have been designed with a different architecture, as shown in FIG. 2. The base stations **240** for multiple remote sites **200** are centralized in a base station hotel **210,** while the antenna towers and antennas remain located at various remote sites at a distance from the base station hotel. Separating the base stations **240** from the antennas, however, makes it necessary to transport RF signals between the base station hotel and the various cell sites that it serves, typically using signal converters **250,** network interface equipment **260,** and a broadband communication network **220.** When broadband fiber optic cables are used, RF signals from the base stations are converted to optical format and communicated over the fiber optic cable and then converted back to analog RF signals at the remote sites. After the optical/RF conversion, the signal is sent to one of several sector

> transmitters **230** and radiated over the air via the antenna to provide cellular coverage.

Ex. 1009 at 1:26-65. *See also* Ex. 1008 at 1:34-40, Fig. 2.

179. Further, as noted in prior art discussed below, there are efficiency benefits to centralizing base station resources (such as ease of upgrading all the base stations when the equipment is centralized versus when that equipment is dispersed throughout a large metropolitan area) that would have also motivated a POSA to modify Xu's system by moving the base station equipment to a centralized location, such as a base station hotel, that is remote from the cell sites. *E.g.*, Stratford stating:

> The BTS hotel concept is **<u>especially valuable in metropolitan areas</u>** where fiber is abundant but equipment space comes at a premium. In these types of areas it is getting increasingly more difficult to deploy new cell sites due to a variety of factors including regulatory and space constraint issues.

Ex. 1009 at 1:60-65.

180. For deployments in which the base station had to be located a long distance from the cell and the remote antenna units, the well-known benefit of including a host unit (i.e., to facilitate the transport of the base station's RF signals of DAS links over long distances to the remote antenna cites) would have motivated a POSA to include a host unit that receives the base station signals and performs the appropriate functionality (e.g., converting the base station signals to

digital or optical signals) to more efficiently and reliably transporting the signals long distances over the DAS links to the remote antenna units. Using a host unit separate from a base station (not relying on a base station that includes host unit functionality) would also allow the system to work with existing base stations that may not include host unit functionality for converting communication frequencies to formats suitable for long-distance transport.

181. Alternatively, it would have been obvious in view of Xu and Schwartz to include a host unit as an interface to either or both DASs that serve Xu's cells 1 and 2.

182. Motivation based on Schwartz's teaching. Schwartz teaches the use of a common host unit that serves as the interface between (1) a centralized site that houses a collection of base stations and (2) a plurality of cells.

183. Based on Schwartz (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

184. Schwartz teaches the benefits of employing "a centralized base-station site containing a plurality of base-station units" (i.e., a base station hotel as described in the background) and "a means [router 22, a host unit] for transmitting

the traffic channel resources between the centralized base station site and the remote cells … .” Ex. 1008 at 3:22-27, Fig. 2; *see also* Ex. 1008 at 1:16-67 (describing the inefficiencies associated with locating a base station at the center of each cell and benefits to using a centralized base station site located remote from the cells sites).

185. Based on Schwartz, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems: (a) the base station equipment often must be located remote from the cell sites at a centralized location (commonly referred to as a Base Station Hotel as noted in the background of the ‘358 patent) and (b) for such deployments, a DAS host unit (e.g., router 22 of Schwartz Fig. 2) as taught by Schwartz would facilitate more efficient transport of radio resources to Xu’s cells.

186. For such deployments, Schwartz’s teaches to use a host unit (e.g. “RF router 22”) as an interface between one or more base stations (i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units. Ex. 1008 at Fig. 2, 6:24-41:

> FIG. 2 illustrates an exemplary embodiment of a cellular network according to the cellular network architecture of the present invention. By way of example, a centralized base-station site 20, including a group of base-station units 21 and **an RF router 22**, transmits multiple CDMA

signals to a plurality of remote cells, such as remote cells 23, 24, 25, via a cellular-distribution link 26. A management system 27 monitors the transmission of CDMA signals between the base-station units 21 and the RF router 22 through a set of traffic sensors, and derives from it the offered traffic in each cell. An optimization algorithm is executed and its results are used to instruct the **RF router on how to distribute the CDMA signals from the base-station units to the antennae in the remote cells**. The cellular-distribution link 26 can be one or more optical fibers along with corresponding units for making the conversion between cellular signals and optical signals and for multiplexing/de-multiplexing optical signals onto the optical fibers.

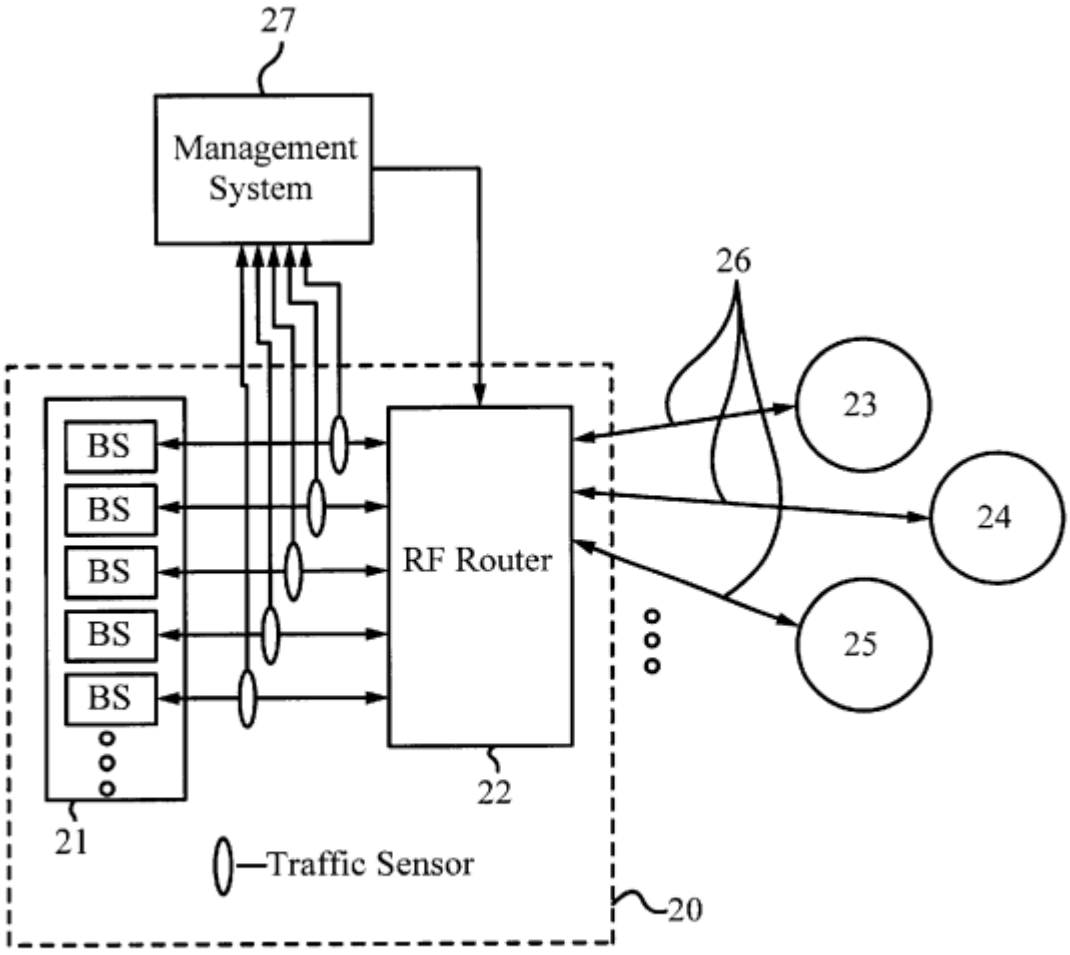


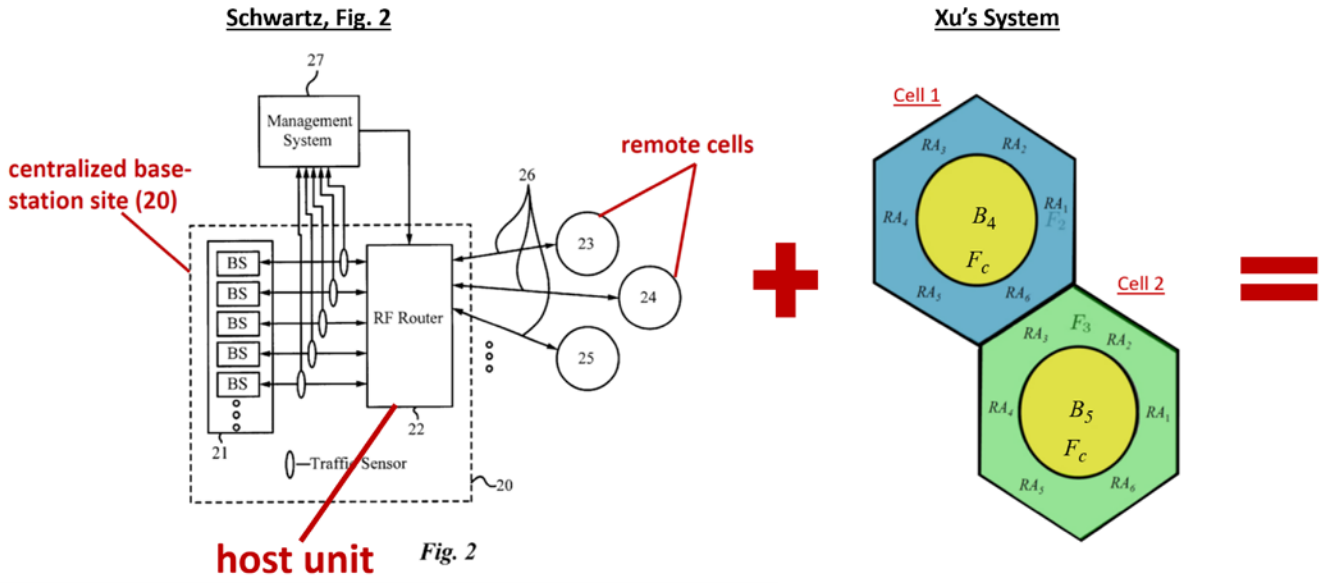
Fig. 2

187. Xu and Schwartz both disclose using optical fiber for the DAS link to the remote antenna units. Ex. 1008 at 6:65-66; Ex. 1005 at Fig. 2.

188. For those deployments requiring the base station equipment to be located remote from the cell sites, a POSA would have been motivated by the benefit of using a DAS host, as taught by Schwartz, in Xu's system to facilitate the transport of the base station signals to Xu's remote antenna units. I have illustrated

this combination of Xu and Schwartz below. Further, one of skill would be motivated to use a host unit as taught by Schwartz's router 22 that is not integral with one base station so that the host unit could serve and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

189. I have illustrated this combination of Xu and Schwartz below.



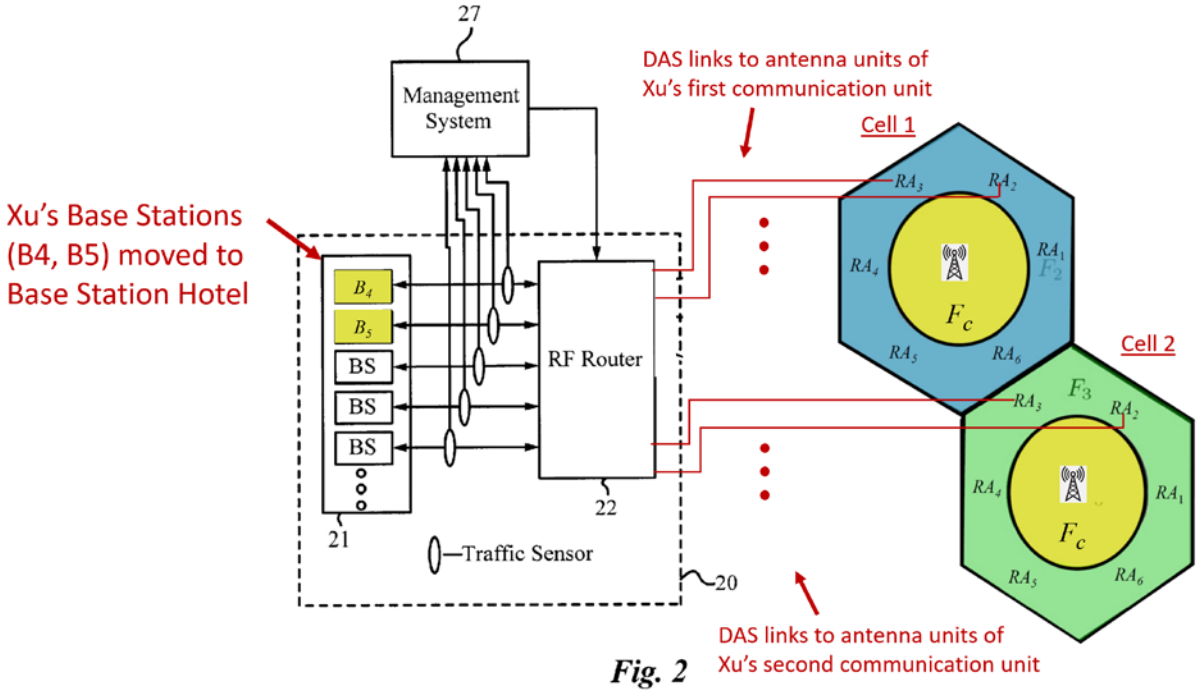


Fig. 2

190. Reasonable expectation of success of the proposed combination. A POSA would have a reasonable expectation that such a combination would be successful. That host units have been so long used in the art of DAS (Schwartz filed in 2000 more than a decade before the '358 patent) would lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that host units are "typical" in DAS deployments. Ex. 1001 at 1:17-18. One of reasons a DAS typically includes a host unit is to prepare the signals for successful transport over longer distances without degradation of the data carried on the signals. Moreover, a POSA would have understood the importance of including a host unit to ensure that the combination

would be successful for deployments in which long distance transport of the base station signals is required.

2. Claim 15

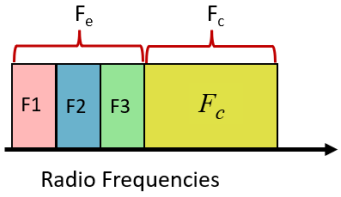
191. The claimed communication system of Claim 15 is similar to the claimed method of distributing communications frequencies of claim 7. Both require "a first communications unit" and "a second communications unit". Claim 15 further requires "a host unit" that is coupled to the first and second communications units. Xu discloses multiple host units, one that is coupled to a first communications unit and another that is coupled to a second communications unit. Xu does not disclose one host unit that is coupled to the first and second communications units (Element 15B). It would have been obvious based on Xu alone or in combination with Schwartz to include a common host unit that couples the base stations (e.g., located at a base station hotel) to the first and second communications units. The other limitations of claim 15 are disclosed by Xu for the same reasons that Xu discloses all the limitations of claim 7.

192. Element 15A (Communications system). Xu discloses a communication system that combines the techniques of DAS and fractional frequency reuse to mitigate inter-cell interference in a multi-cell communications network. Ex. 1005 at 4440, Fig. 1, Section II.A (describing "Multicell Multuser System Topology"). Fig. 1 from Xu is reproduced below (annotated). A map for

the abbreviations and annotations has been added (below, left side) to assist in understanding Xu's system of Fig. 1.

map for abbreviations used in Xu, Fig. 1

B = Base station (e.g., B_0, B_1, B_2 ...)
RAs = remote antennas (each cell includes 6 RAs to cover cell edge area)
N_r = number of RAs = 6 RAs in each cell. Xu, p 4440, Section A at ¶1 ("every cell has the same system configuration"), ¶2 ("A total of N_r RAs are employed in each cell")
F_c = cell center's frequency
F_e = "cell edge's frequency which is divided into three orthogonal bands" (**F1 F2 F3**).



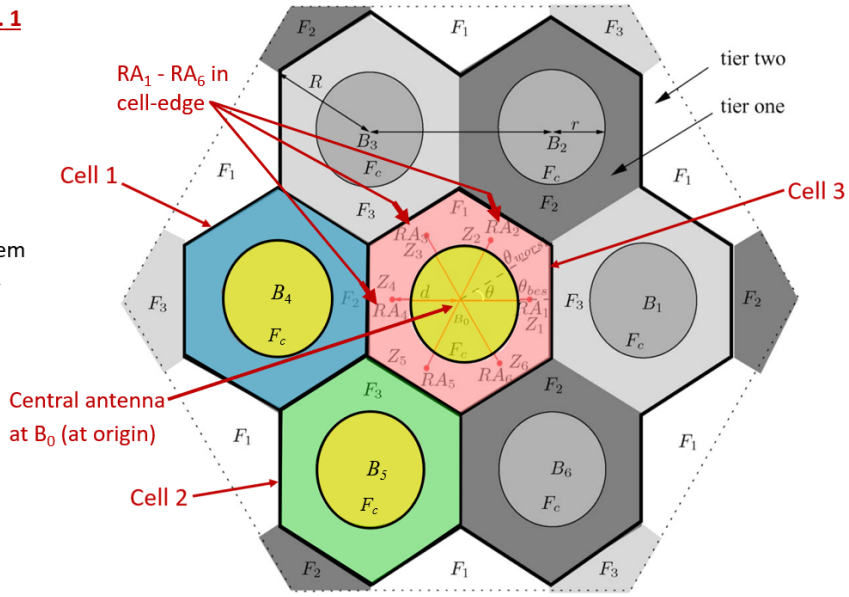
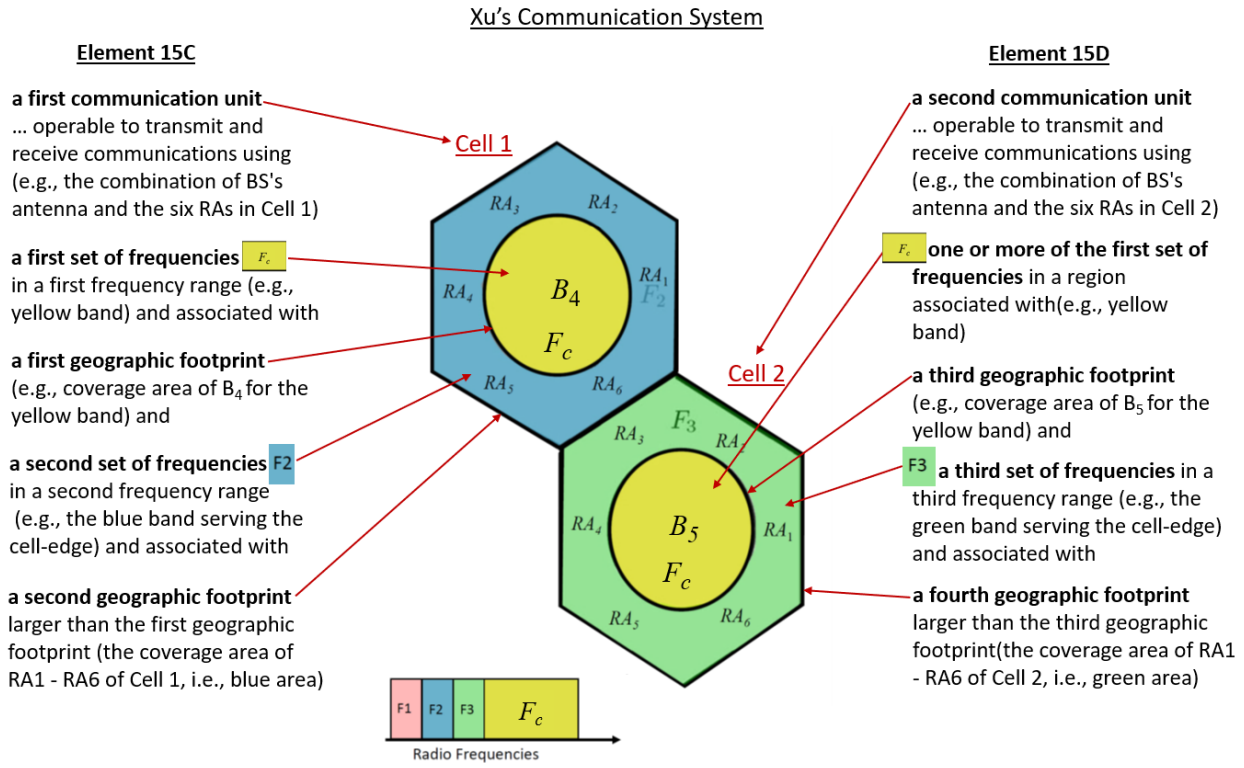


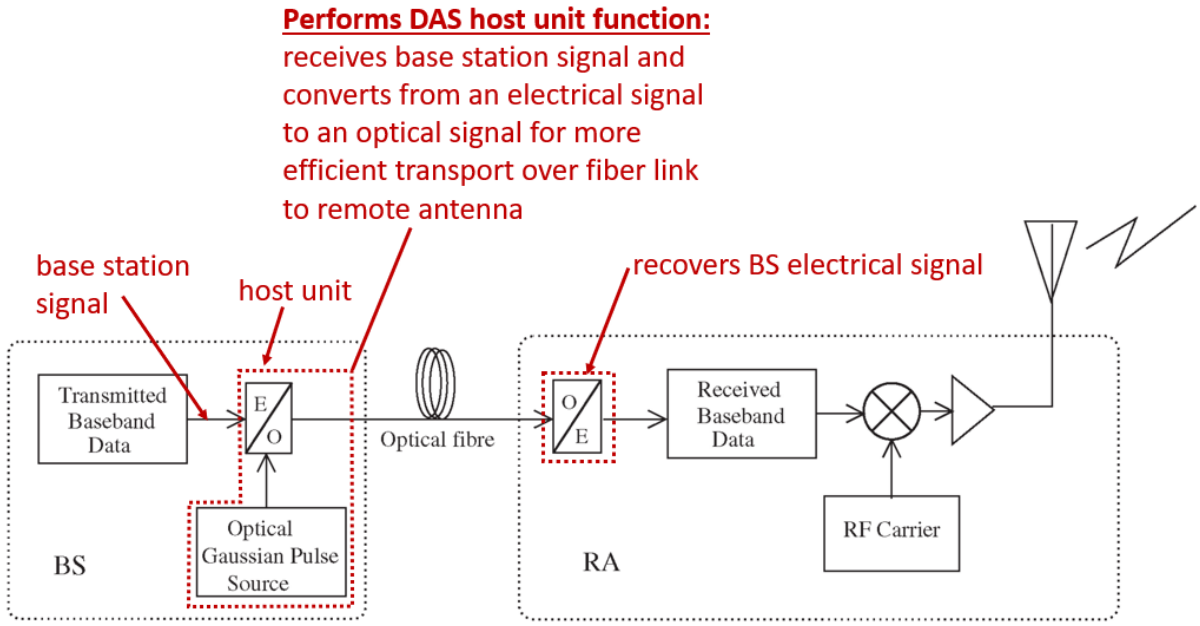
Fig. 1. Topology of two tiers of 19 cells relying on an FFR and DAS arrangement, where $N_r = 6$ RAs are employed. The structure of the cells in tier two is the same as that in tier one.

193. Elements 15C and 15D. As illustrated below, the limitations associated the "first communications unit" (Element 15C) and "second communications unit" (Element 15D) also read on Xu's system. Elements 15C and 15D are nearly identical to Elements 7C and 7D. The discussion in Section VIII.A. explaining that Xu discloses all the limitations of Element 7C and 7D also serves to explain that Xu discloses all the corresponding limitations of Elements 15C and 15D. The mapping below also shows how Xu discloses the limitations of Elements 15C and 15D.



194. **Element 15B: "a host unit" that is coupled to the first and second communications units.** It would have been obvious based on Xu alone or in combination of Schwartz to provide a common host unit that is coupled to the first communication unit of Xu's cell 1 and to the second communications unit of Xu's cell 2.

195. As discussed for claim 8, Xu discloses the use of a host unit as an interface between each cell's base station and the remote antenna units.



196. Motivation to employ a host unit in deploying Xu's system in densely populated areas. A POSA would have known the background to the claimed invention as provided in the '358 patent. A POSA would know, for example, that distributed antenna systems "were available" (Ex. 1001 at 1:16-17), had been "widely implemented in state-of-the art cellular communication systems" (col 6:53-55), and "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18). A POSA would also know that a "radio base station is often employed ***at the host unit location*** commonly known as a ***base station hotel***, and the DAS [i.e., host unit] provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

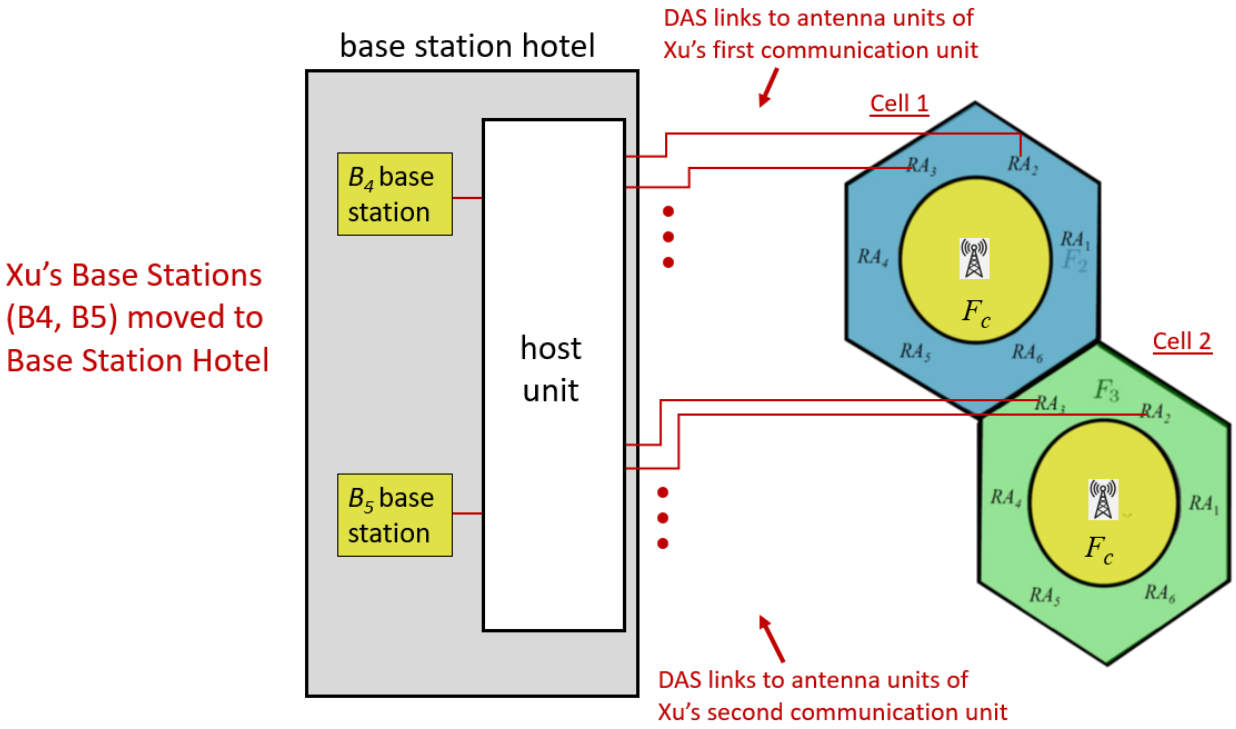
197. In densely populated, urban areas the real estate necessary to house the base station equipment can be particularly costly or simply not available within every cell. A POSA would have known that, for this reason, it was common, particularly in densely populated areas, for the base stations to be located, for example, at a "base station hotel" (Ex. 1001, 1:21) a long distance from the cell site and that a host unit would "typically" be used to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. The prior art reinforces what the '358 patent states as background. *E.g.*, Ex. 1009 at 1:26-65; Ex. 1008 at 1:34-40, Fig. 2; Ex. 1014 at ¶0005, Fig. 6; Ex. 1010 at Fig. 1. *See e.g.*, Stratford the explaining the problem:

> This traditional approach of deploying all the cell site equipment locally at each remote site has several drawbacks that contribute to the expense of the infrastructure, and upgrades to the infrastructure. At each remote site, a BTS room or cabinet to host the large base station equipment is require, as well as additional electric power supplies for the base station. This increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment. …
>
> … To mitigate these problems, some cellular systems have been designed with a different architecture, as shown in FIG. 2. The base stations **240** for multiple remote sites **200** are centralized in a base station hotel **210,** while the antenna towers and antennas remain located at various remote sites at a distance from the base station hotel. Separating the base stations **240** from the antennas, however, makes it necessary to transport RF signals between the base station hotel and the various cell

> sites that it serves, typically using signal converters **250,** network interface equipment **260,** and a broadband communication network **220.** When broadband fiber optic cables are used, RF signals from the base stations are converted to optical format and communicated over the fiber optic cable and then converted back to analog RF signals at the remote sites. After the optical/RF conversion, the signal is sent to one of several sector transmitters **230** and radiated over the air via the antenna to provide cellular coverage.

Ex. 1009 at 1:26-65. *See also* Ex. 1008 at 1:34-40, Fig. 2.

198. For deployments in which the base station had to be located a long distance from the remote antenna units, a POSA would have been motivated to locate the base stations of Xu at a remote base station hotel and use a common host unit as the interface to the first communication unit of Xu's cell 1 (the combination of central antenna and six periphery antennas of cell 1) and the second communication unit (the combination of central antenna and six periphery antennas of cell 2). I have illustrated that combination below.



199. The well-known benefit of including a host unit (i.e., to facilitate the transport of the base station's RF signals of DAS links over long distances to the remote antenna cites) would have motivated POSA to include a host unit that receives the base station signals and performs the appropriate functionality (e.g., converting the base station signals to digital or optical signals) for transporting the signals long distances over the DAS links to the remote units. Collecting the base stations at one location (at base station hotel site) also provided the efficiency that servicing the system could be performed by visiting only one site and did not require travel to multiple cell sites.

200. Alternatively, it would have been obvious in view of Xu and Schwartz to include a common host unit as an interface the first and second communications units of Xu's cells 1 and 2, respectively.

201. Motivation based on Schwartz. Based on Schwartz (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

202. Schwartz teaches the benefits of employing "a centralized base-station site containing a plurality of base-station units" (i.e., a base station hotel as described in the background) and "a means [router 22, a host unit] for transmitting the traffic channel resources between the centralized base station site and the remote cells … ." Ex. 1008 at 3:22-27, Fig. 2; *see also* Ex. 1008 at 1:16-67 (describing the inefficiencies associated with locating a base station at the center of each cell and benefits to using a centralized base station site located remote from the cells sites).

203. Based on Schwartz, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems: (a) the base station equipment often must be

located remote from the cell sites at a centralized location (commonly referred to as a Base Station Hotel as noted in the background of the '358 patent) and (b) for such deployments, a DAS host unit (e.g., router 22 of Schwartz Fig. 2) as taught by Schwartz would facilitate more efficient transport of radio resources to Xu's cells.

204. For such deployments, Schwartz's teaches to use a host unit (e.g. "RF router 22") as an interface between one or more base stations (i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units. Ex. 1008 at Fig. 2, 6:24-41:

> FIG. 2 illustrates an exemplary embodiment of a cellular network according to the cellular network architecture of the present invention. By way of example, a centralized base-station site 20, including a group of base-station units 21 and **an RF router 22**, transmits multiple CDMA signals to a plurality of remote cells, such as remote cells 23, 24, 25, via a cellular-distribution link 26. A management system 27 monitors the transmission of CDMA signals between the base-station units 21 and the RF router 22 through a set of traffic sensors, and derives from it the offered traffic in each cell. An optimization algorithm is executed and its results are used to instruct the **RF router on how to distribute the CDMA signals from the base-station units to the antennae in the remote cells**. The cellular-distribution link 26 can be one or more optical fibers along with corresponding units for making the conversion between cellular signals and optical signals and for multiplexing/de-multiplexing optical signals onto the optical fibers.

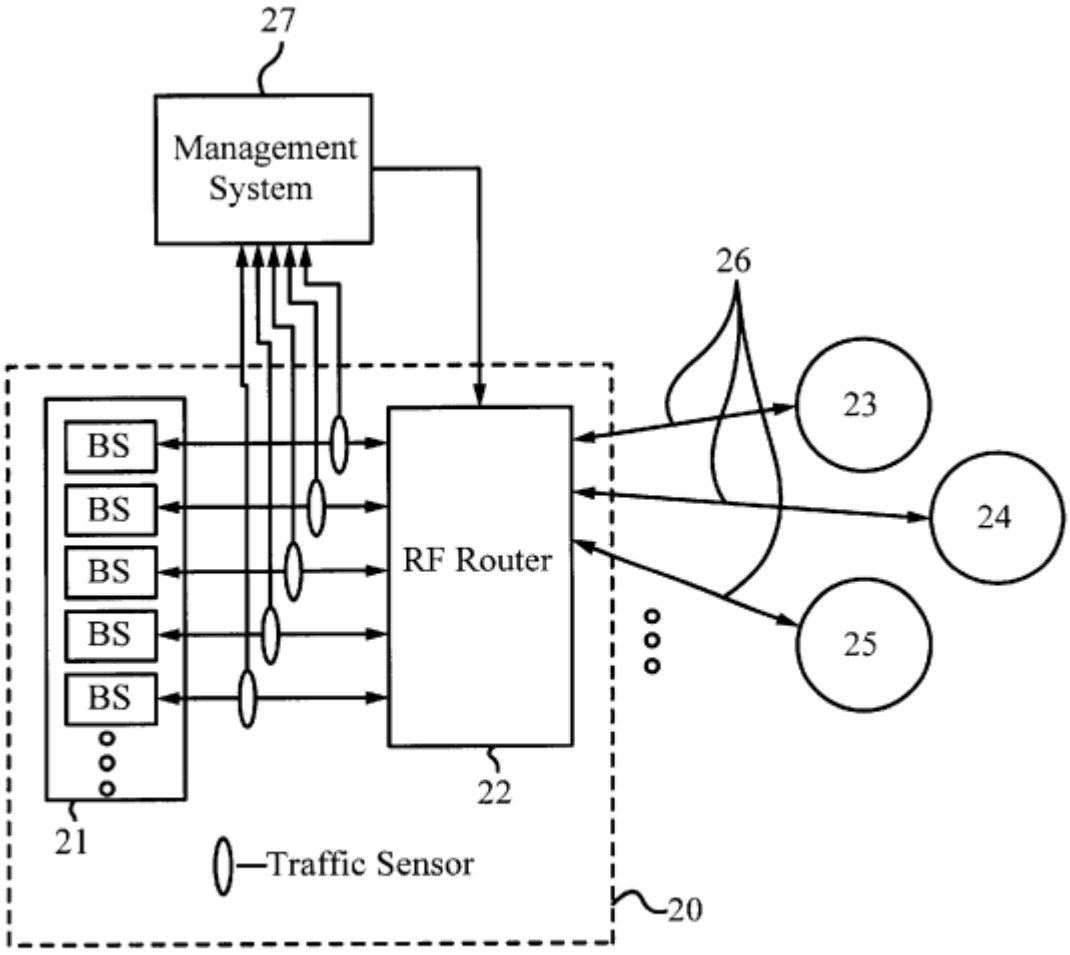


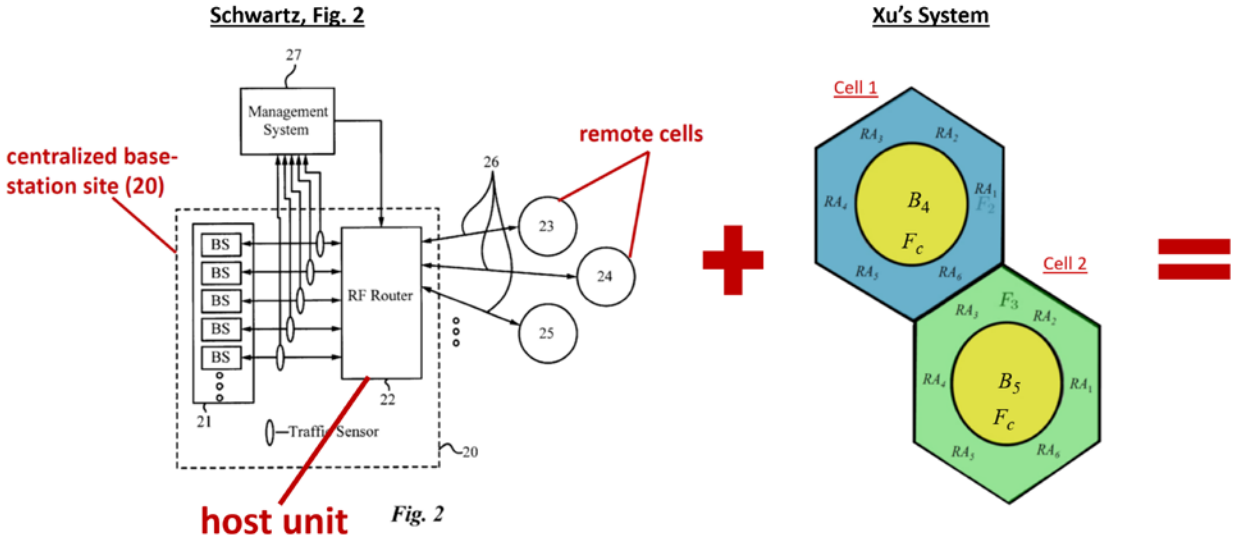
Fig. 2

205. Xu and Schwartz both disclose using optical fiber for the DAS link to the remote antenna units. Ex. 1008 at 6:65-66; Ex. 1005 at Fig. 2.

206. For those deployments requiring the base station equipment to be located remote from the cell sites, a POSA would have been motivated by the benefit of using a DAS host, as taught by Schwartz, in Xu's system to facilitate the transport of the base station signals to Xu's remote antenna units. I have illustrated

this combination of Xu and Schwartz below. Further, one of skill would be motivated to use a host unit as taught by Schwartz's router 22 that is not integral with one base station so that the host unit could serve and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

207. I have illustrated this combination of Xu and Schwartz below.



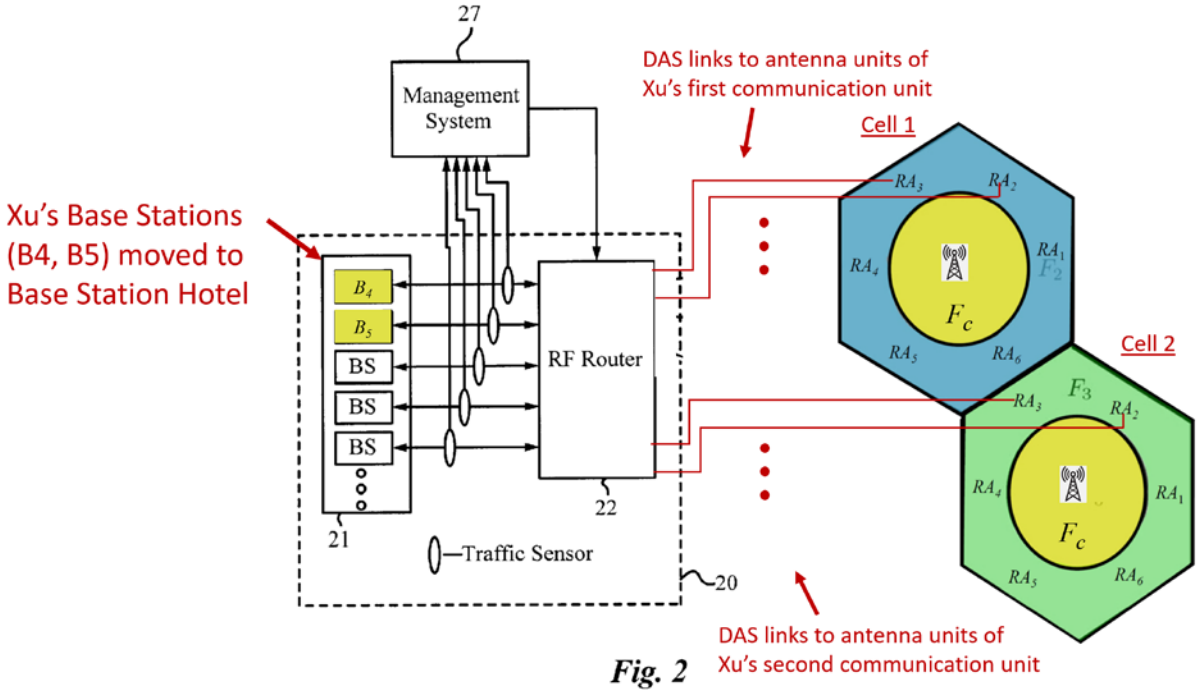


Fig. 2

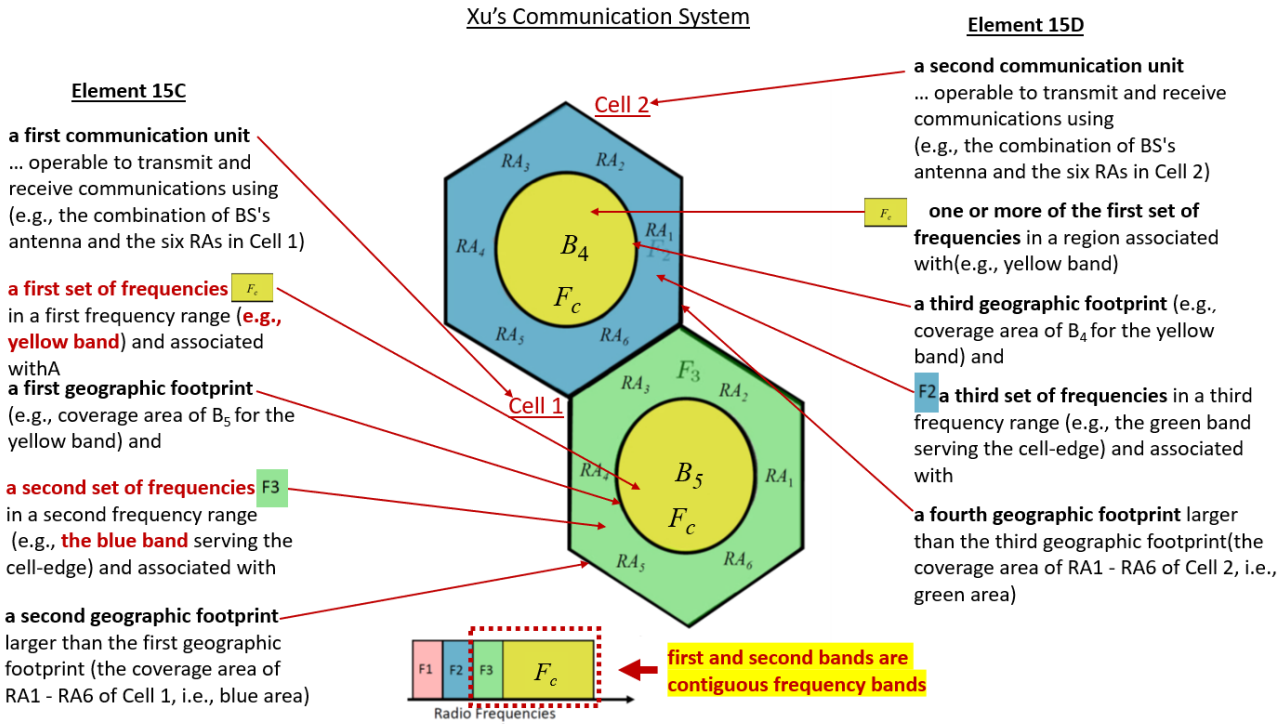
208. Reasonable expectation of success of the proposed combination. A POSA would have a reasonable expectation that such a combination would be successful. That host units have been so long used in the art of DAS (Schwartz filed in 2000 more than a decade before the '358 patent) would lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that host units are "typical" in DAS deployments. Ex. 1001 at 1:17-18. One of reasons a DAS typically includes a host unit is to prepare the signals for successful transport over longer distances without degradation of the data carried on the signals. Moreover, a POSA would have understood the importance of including a host unit to ensure that the combination

would be successful for deployments in which long distance transport of the base station signals is required.

3. Claim 20

The communications system of claim 15 wherein the first frequency band and the second frequency band are contiguous frequency bands.

209. Xu teaches the limitations added by claim 20. Here it is unclear what claim 20 is referring to as "**the** first frequency **band**" and "**the** second frequency **band**." There is no prior recitation of frequency bands in claim 15 or claim 20. If these are construed to be referring to the first and second frequency ranges introduced in claim 15, then this limitation is disclosed by Xu. Here I note that in the charts provided of Xu's cells, either of the cells could be designated cell 1. Below I have designated the cell associated with base station B_5 to be cell 1, and then mapped elements 15C and 15D to Xu's system. As shown, the first range (yellow) and the second range (green) are continuous.



4. Claim 21

The communications system of claim 15 wherein the first frequency range, the second frequency range, and the third frequency range include distinct frequencies.

210. Xu teaches the limitations added by claim 21 because in Xu system, the first frequency range (yellow band), the second frequency range (green), and the third frequency range (blue) include distinct frequencies.

C. Ground 3: Xu in combination with Schwartz and Huawei renders obvious claims 17 and 18

211. Xu alone or in combination with Schwartz renders the limitations of independent claim 15 for the reasons described above in the previous ground which I incorporate here. Claims 17 and 18 add the following limitation:

> 17. The communications system of claim 15 wherein the communications using the first set of frequencies in the first frequency range are associated with a first power level and the communications using the second set of frequencies in the second frequency range are associated with a second power level greater than the first power level.
>
> 18. The communications system of claim 15 wherein the communications using one or more of the first set of frequencies in the region associated with a third geographical footprint are associated with a first power level and the communications using the third set of frequencies in the third frequency range are associated with a second power level greater than the first power level.

212. Huawei (Ex. 1006) is a prior art publication entitled "Further Analysis of Soft Frequency Reuse" authored by Huawei for the 3GPP TSG RAN Working Group 1#42 in 2005.

213. Huawei teaches utilizing soft frequency reuse schemes to mitigate inter-cell interference.

> In the proposed soft frequency reuse scheme, sub-carriers are divided into two groups in every cell. One group is

called major sub-carriers group, and the other one is called minor sub-carriers group. For each group of sub-carriers, one maximum allowed transmission power is set for them. Normally, the maximum allowed transmission power for major sub-carriers is higher than minor sub-carriers. The transmission power on each sub-carrier shall not exceed this limitation. The major sub-carrier can be used to cover the whole cell area, while the minor sub-carrier is used only in the inner part of the cell, as is showed in figure 1(the blue represents the inner zones and the other colors represent the cell edges). Major subcarriers in neighboring cell are orthogonal (i.e. no overlap). The so called "Power Ratio" is the ratio between transmit power limitation of minor sub-carriers and major subcarriers. Power Ratio adjusted gradually from 0 to 1, the effective reuse factor changes from 3 to 1 smoothly. So, the SFR is the compromise of reuse 1 and reuse 3.

Ex. 1006 at 1. Huawei illustrates soft frequency reuse as shown in Figure 1.

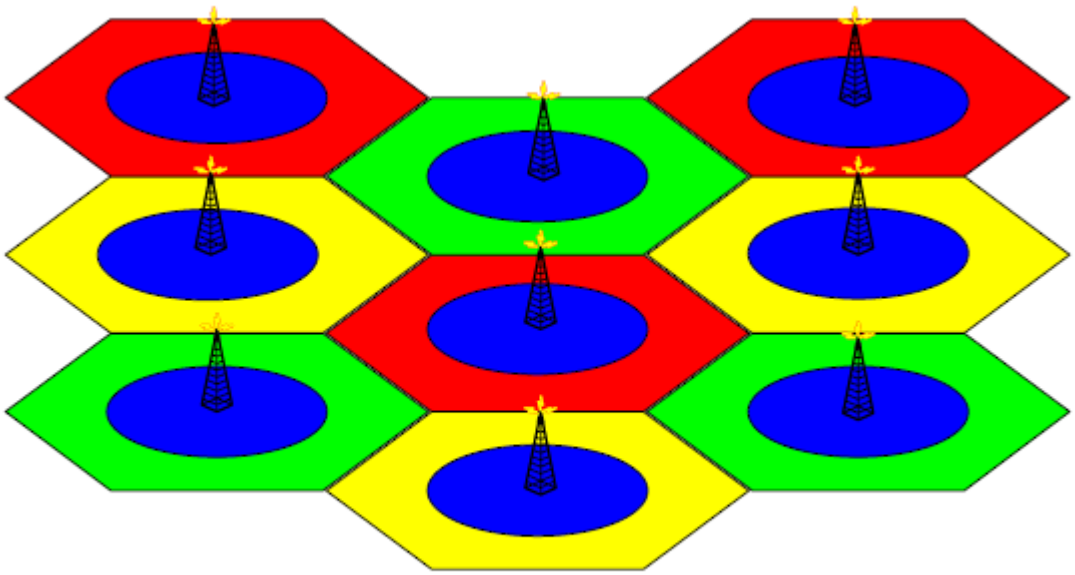


Figure 1, Cell deployment

Ex. 1006 at Fig. 1.

214. As shown in Figure one, the major subcarriers of adjacent cells are orthogonal, while the minor subcarriers within each cell are the same and reused in each cell. This is achieved by transmitting the minor subcarriers at lower power levels. The ratio of the power of the minor subcarriers to the power of the major subcarriers is defined by Huawei as the Power Ratio. Ex. 1006 at 1 ("The so called 'Power Ratio' is the ratio between transmit power limitation of minor sub-carriers and major subcarriers. Power Ratio adjusted gradually from 0 to 1, the effective reuse factor changes from 3 to 1 smoothly. So, the SFR is the compromise of reuse 1 and reuse 3.").

215. Huawei teaches that it is advantageous to reduce the Power Ratio (to values less than 1) when high traffic happens at the cell edge to improve the throughput for cell edge users.

> By adjusting the power ratio, SFR can adapt the variation of the service distribution in each cell. When the high traffic happens at the cell edge, the power ratio should be set to a relatively small value to get a high cell edge bit rate. On the contrary, when the traffic is mainly located at the inner part of the cell, a relatively large value for the power ratio is reasonable.

Ex. 1006 at 1.

216. When the Power Ratio is less than one, this means that communications using the **frequencies associated with the cell edge (the major**

subcarriers) are being transmitted at higher power levels than the communications using the frequencies associated with the inner zone.

217. Huawei includes simulation results that show the throughput at the cell edge increases when the power ratio is dropped.

> The figure 2, 3, 4 shows the cell edge throughout, the inner zone throughout and the total cell throughout varieties curves with the different Power Ratio. The X coordinate represents the transmission power ratio. When the power ratio is 1, the soft frequency reuse scheme is the same as the reuse factor 1, which means that the powers limitation for all the sub-carriers are same, when the power ratio is 0, it is equal to the reuse factor 3, which means that minor sub-carriers do not exist.

Ex. 1006 at 3.

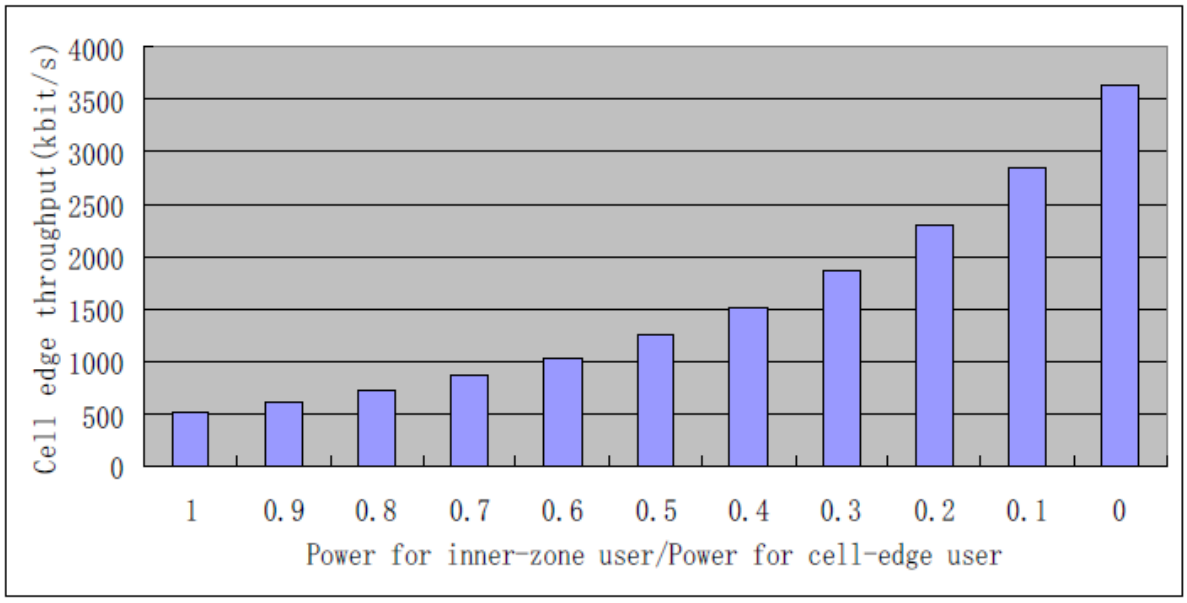


Figure 2, cell edge throughput in soft frequency reuse scheme

Ex. 1006 at Figure 2.

218. Although Huawei notes that the throughput of the inner portion of the cell will drop when the power ratio drops less than 1, Huawei teaches that when traffic load is highest at the cell edge, the tradeoff will result in better throughput performance.

219. Similarly, one of skill in the art would be motivated to improve Xu using Huawei by adjusting, when the traffic load is high in the cell edge areas, the power ratio of the communications in the Xu reference so that the power level of communications on the frequencies used by cell edge antenna units (RAs) of Xu is greater than the power level of communications on the frequencies used by the central base station antenna unit (e.g., at B_0) to obtain the benefit taught by Huawei which is to improve throughput in the cell edge areas. This modification would satisfy claim 17. One would have a reasonable expectation of success because power levels can be easily controlled using power amplifiers.

220. Therefore, in my opinion claim 17 would have been obvious in light of Xu, Schwartz and Huawei.

221. For the same reasons claim 18 would also have been obvious. The same approach would provide the same benefit if applied to each cell. Claim 18 is about the power levels in the second cell. Huawei's approach to vary the power levels so that the cell edge power level is greater than the cell inner area power

level would benefit the second cell, not just the first cell, when the second cell has high traffic in its cell edge area.

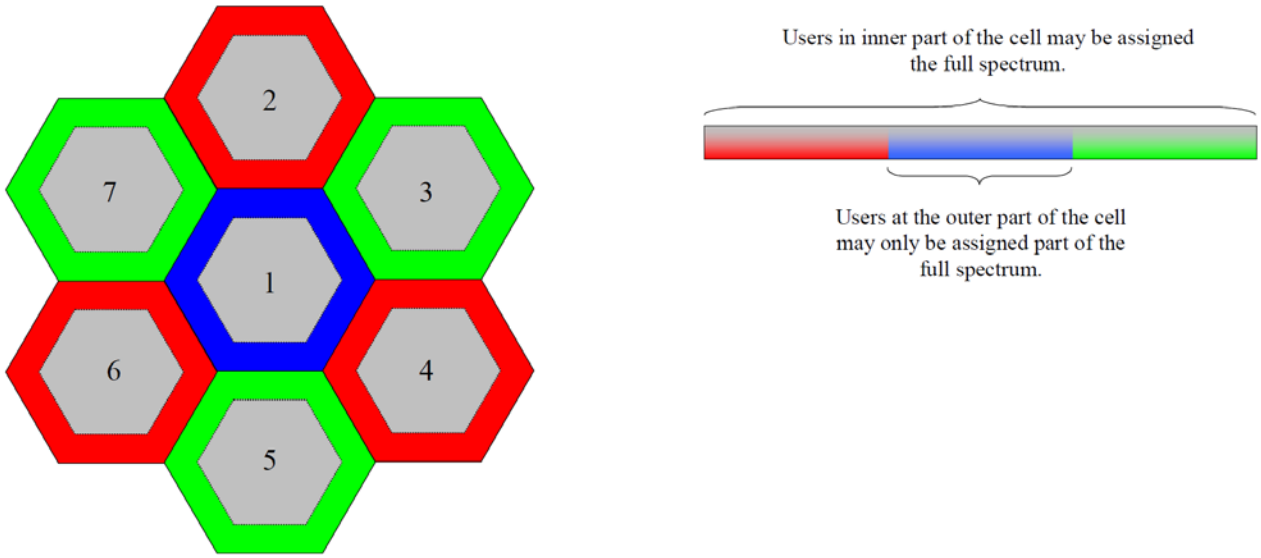
D. Ground 4: Ericsson anticipates claims 7, 9 and 11.

222. Ericsson (Ex. 1007) addresses the problem of inter-cell inference. In Section 3, Ericsson discloses a frequency reuse technique in which "only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users ... ." (see Ex. 1007 p. 2, Fig. 2, below). To achieve this, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area than bands used to cover a central area.

> Fractional reuse, also known as ***soft frequency reuse*** …, has been proposed as a means to increase the performance for cell-edge users. With fractional reuse, ***only a part of the total resources is used for transmission to/from cell-edge users***, thereby reducing the interference experienced by these users (at the cost of a reduced bandwidth). Typically, fractional reuse is implemented as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, ***only cell 1 is allowed to transmit with full power using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a reduced power***. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum

> in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2.



Ex. 1007 at 2, Fig. 2.

1. Claim 7

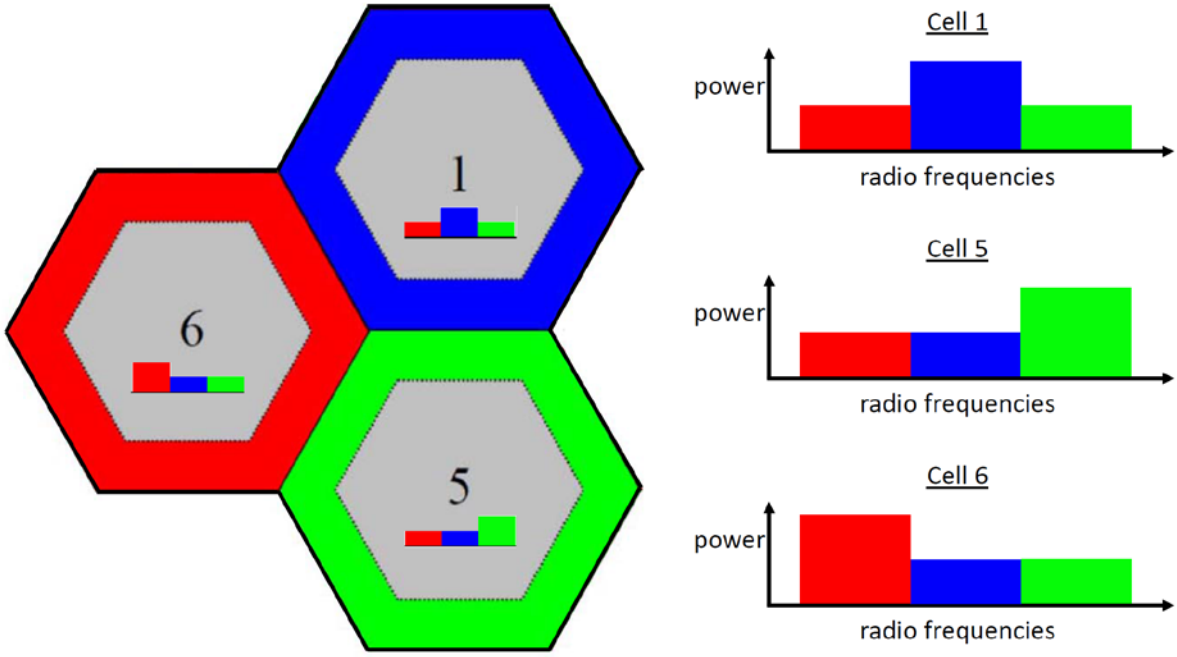
223. Claim 7 is the broadest claim. None of the limitations in the body of claim 7 require a DAS. Elements 7B, 7C, and 7D require providing a first and second communications units (a set of communications units) that implement frequency reuse in a first and third geographic footprints created by the first and second communications units, respectively. While the preamble (Element 7A) recites "distributing communications frequencies," the plain and ordinary meaning of that term does not in my opinion require a DAS. A system, such as a base

station, can distribute communications frequencies to its antenna unit and to user equipment in its coverage area without employing a distributed antenna system. A POSA reading the '358 patent specification would understand that the inventors knew how to require the concept of DAS, but chose a broader scope claim 7. See, e.g., the discussion of concept of "base station hotel" and employing a DAS as "a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

a. Element 7A (preamble)

"A method of distributing communications frequencies"

224. Ericsson discloses a cellular communication system that distributes communications frequencies in a way that implements a frequency reuse technique for "reducing the interference experienced by these users … ." Ex. 1007 at 2, Section 3. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme, i.e., soft frequency reuse (SFR) in the same way as Figs. 1C & 1F of the '358 patent. Ex. 1001 at 4:64 to 5:9. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ericsson at 2 (e.g., "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").

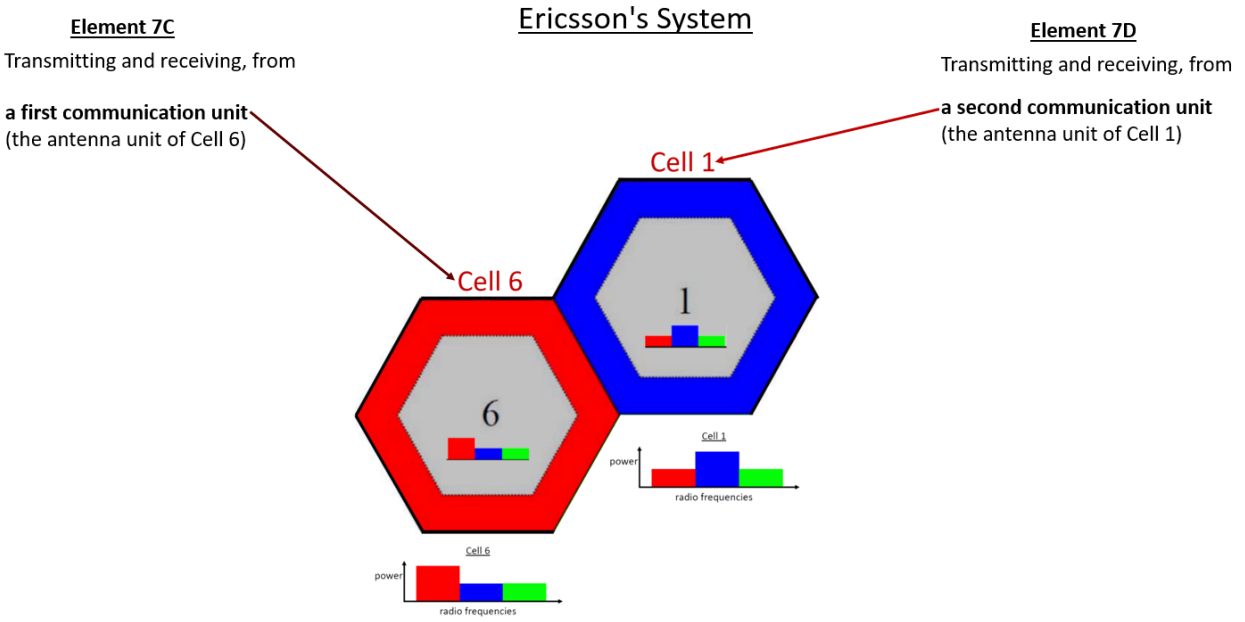


b. Element 7B

"providing a set of communications units;" that includes "a first communications unit" (from element 7C) and "a second communications unit" (from element 7D)

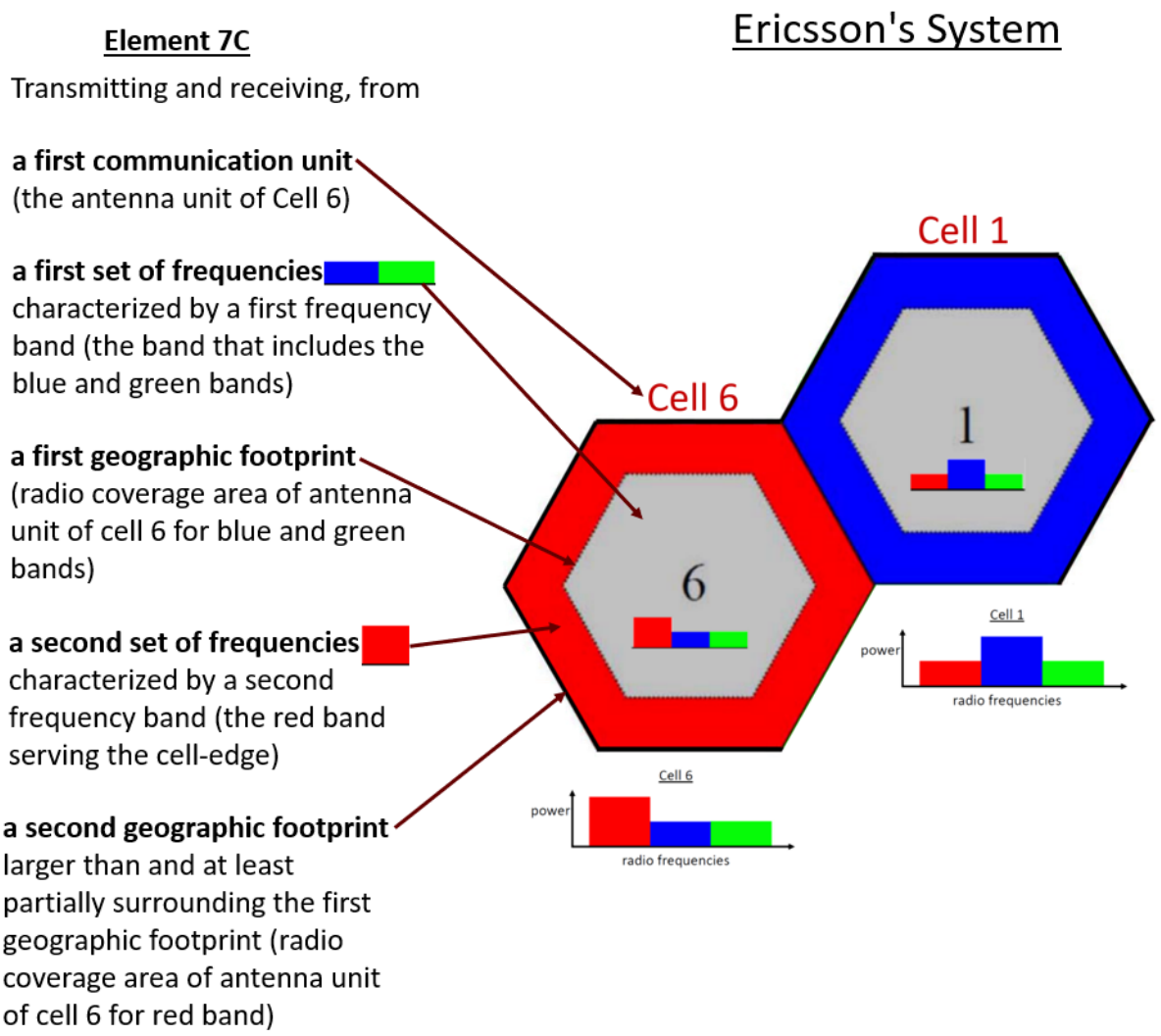
225. Cell 1 and Cell 6 from Ericsson's system are reproduced below (annotated) for comparing to the limitations of claim 7.

226. In Ericsson, the antenna unit that serves cell 6 is a "first communications unit" (below, left), and the antenna unit that serves cell 1 is a "second communications unit" (below, right). Ericsson's first and second communications units satisfy "a set of communications units" of Element 7B.



c. Element 7C

227. Below I have illustrated how Element 7C reads on Ericsson's system.



228. That Ericsson discloses Element 7C is consistent with the same logic and reason under which Element 7C reads on the second embodiment of the '358 patent. See mapping to of claim 7 to the second embodiment of the '358 patent at Section VI.D of my declaration.

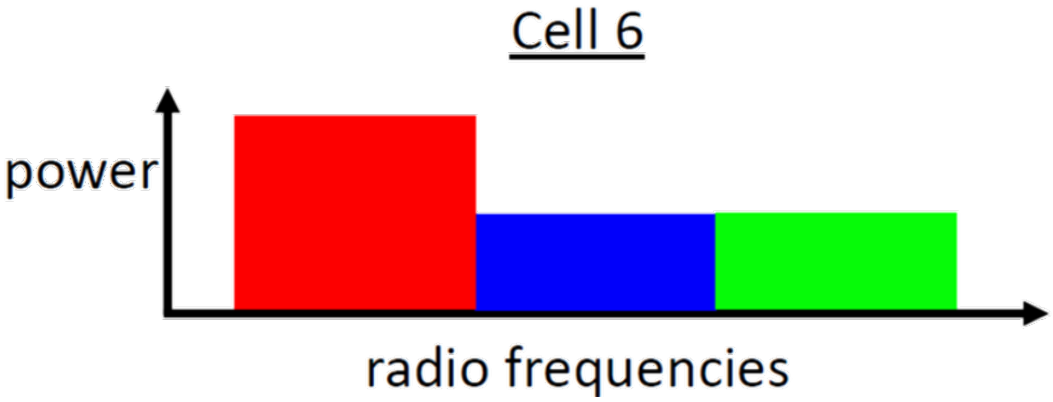
229. The first communications unit: The antenna unit that serves Ericsson's cell 6 (above), is "a first communications unit".

230. Transmitting and receiving ... a first set of frequencies characterized by a first frequency band: In Ericsson's system, cell 6's antenna unit transmits a first set of frequencies characterized by a first frequency band that includes the blue and green bands. Ex. 1007 at 2, Fig. 2.

231. Transmitting and receiving ... a first set of frequencies characterized by ... a first geographic footprint: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the blue and green bands is the "a first geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 6 (gray area) corresponds to the first geographic footprint.

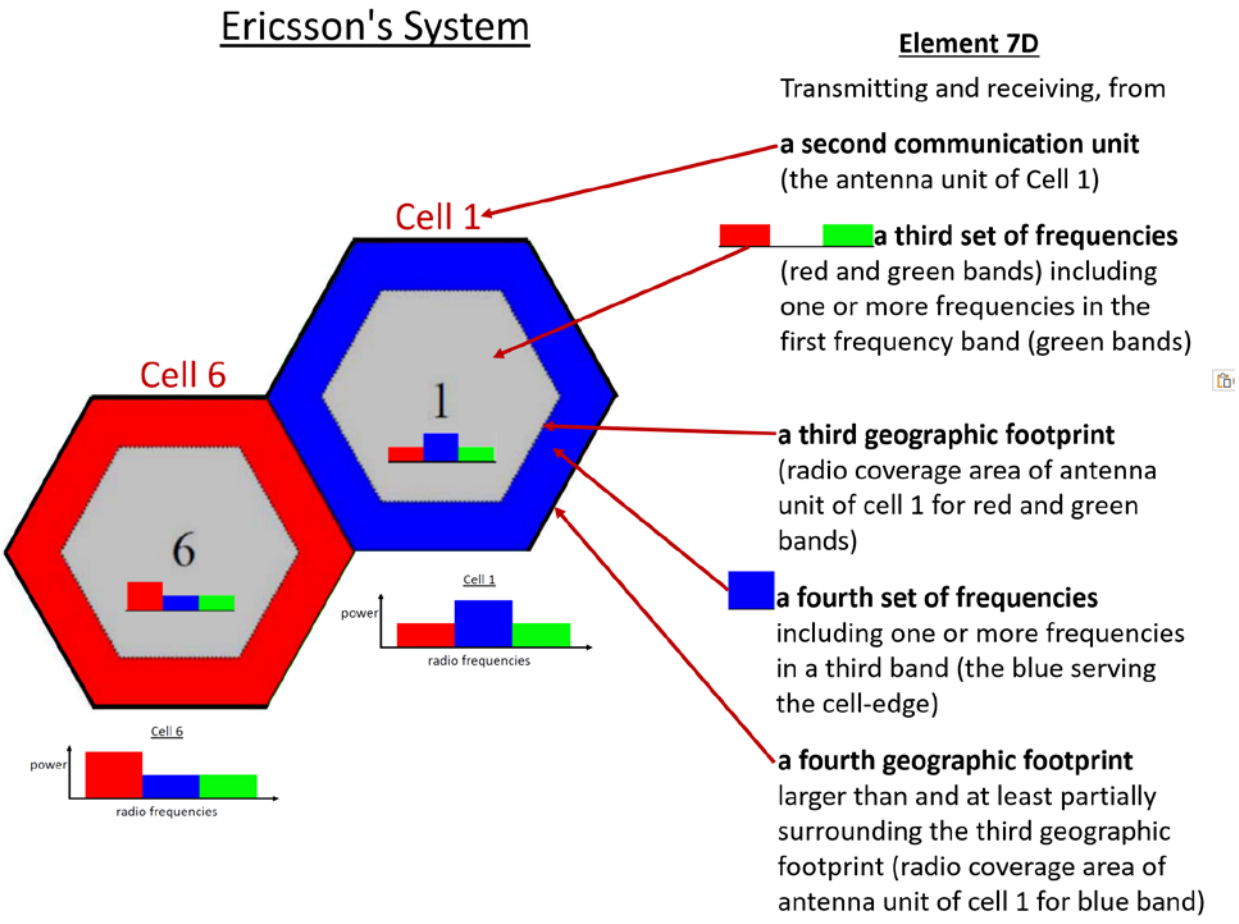
232. Transmitting and receiving ... a second set of frequencies characterized by a second frequency band: In Ericsson's system, cell 6's antenna unit transmits a second set of frequencies characterized by a second frequency band (red band). Ex. 1007 at 2, Fig. 2.

233. Transmitting and receiving ... a second set of frequencies characterized by ... a second geographic footprint larger than and at least partially surrounding the first geographic footprint: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the red band is "a second geographic footprint". As illustrated below, cell 6's antenna unit transmits the red band at a higher power resulting in resulting in larger coverage area for the second geographic footprint. Ex. 1007 at 2, Fig. 2.



d. Element 7D

234. Below I have illustrated how Element 7D reads on Ericsson's system.



235. That Ericsson discloses Element 7D is consistent with the same logic and reason under which Element 7D reads on the second embodiment of the '358 patent. See mapping to of claim 7 to the second embodiment of the '358 patent at Section VI.D of my declaration.

236. The second communications unit: The antenna unit that serves Ericsson's cell 1 (above), is "a second communications unit".

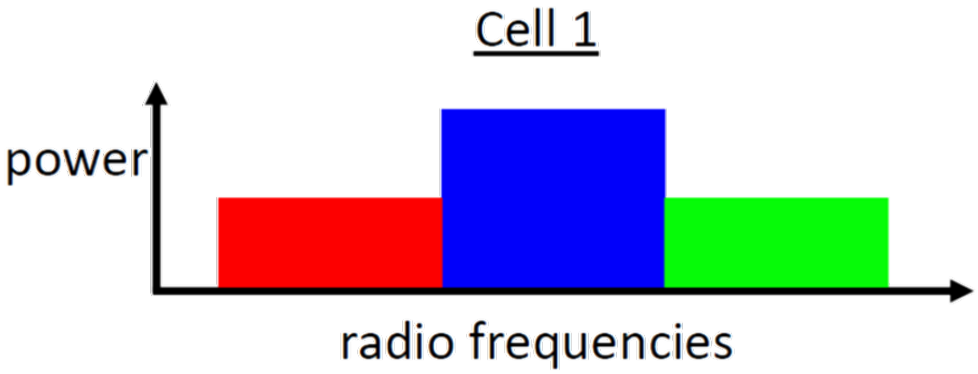
237. Transmitting and receiving ... a third set of frequencies including one or more frequencies in the first frequency band: In Ericsson's system, cell 1's

antenna unit transmits a third set of frequencies (red and green bands) that include one or more frequencies in the first frequency band (the green band). Ex. 1007 at 2, Fig. 2.

238. Transmitting and receiving ... a third set of frequencies ... in ... a third geographic footprint: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the red and green bands is "a third geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 1 (gray area) corresponds to the third geographic footprint.

239. Transmitting and receiving ... a fourth set of frequencies including one or more frequencies in a third band: In Ericsson's system, cell 1's antenna unit transmits a fourth set of frequencies including one or more frequencies in a third band (blue band serving the cell-edge area). Ex. 1007 at 2, Fig. 2.

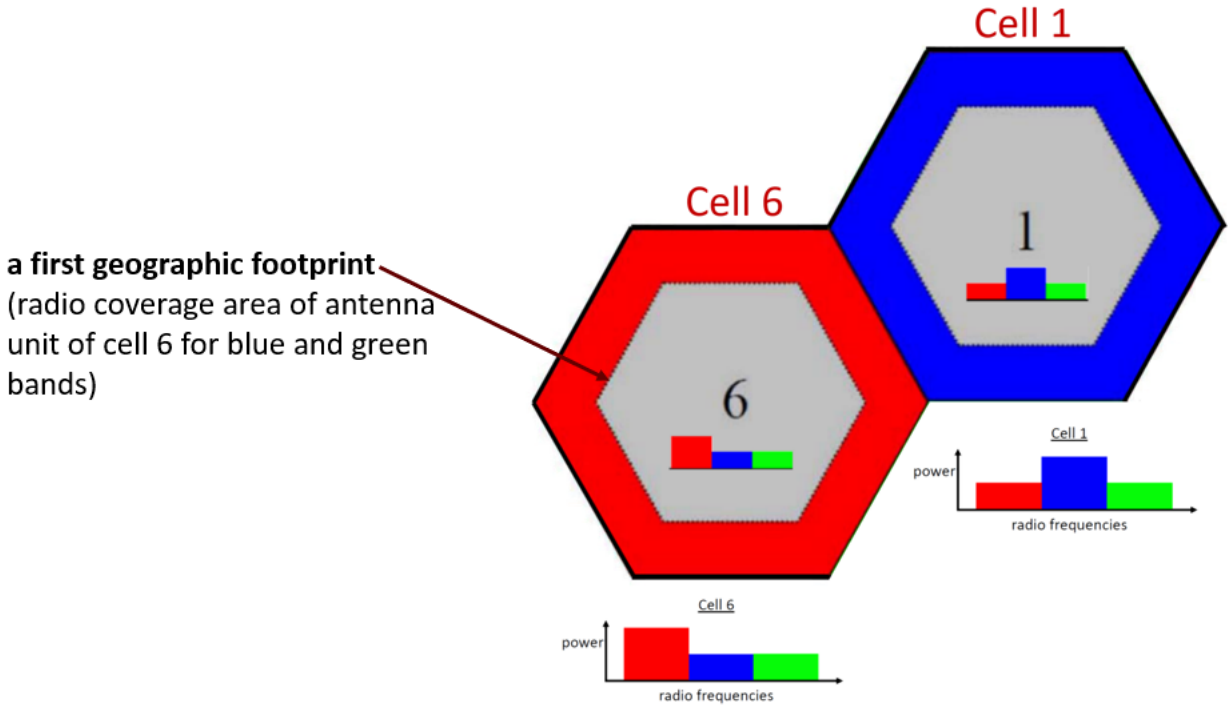
240. Transmitting and receiving ... a fourth set of frequencies ... in ... a fourth geographic footprint larger than and at least partially surrounding the third geographic footprint: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the blue band is "a fourth geographic footprint". As illustrated below, cell 1's antenna unit transmits the blue band at a higher power resulting in resulting in larger coverage area for the fourth geographic footprint. Ex. 1007 at 2, Fig. 2.



2. Claim 9

"the first geographic footprint includes a location of the first communications unit"

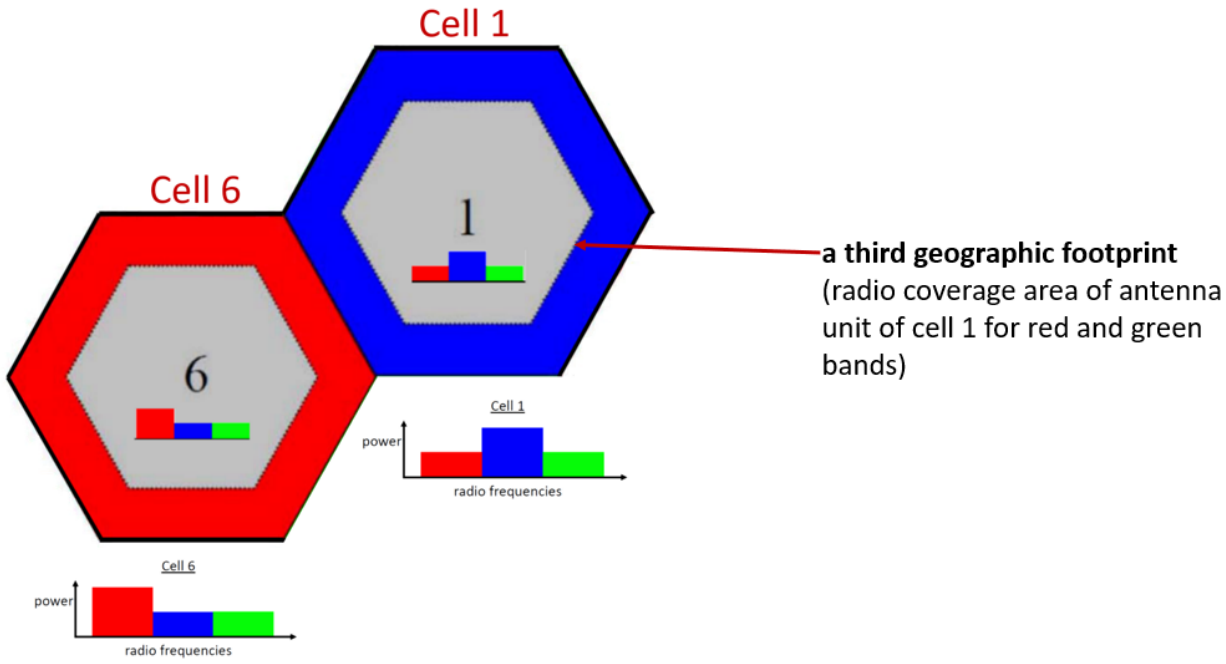
241. Since the first geographic footprint of Ericsson's cell 6 includes a location of cell 6's antenna unit, the limitation added by claim 9 is satisfied.



3. Claim 11

"the third geographical footprint includes a location of the second communications unit"

242. Since the third geographic footprint of Ericsson's cell 1 includes a location of cell 1's antenna unit, the limitation added by claim 11 is satisfied.



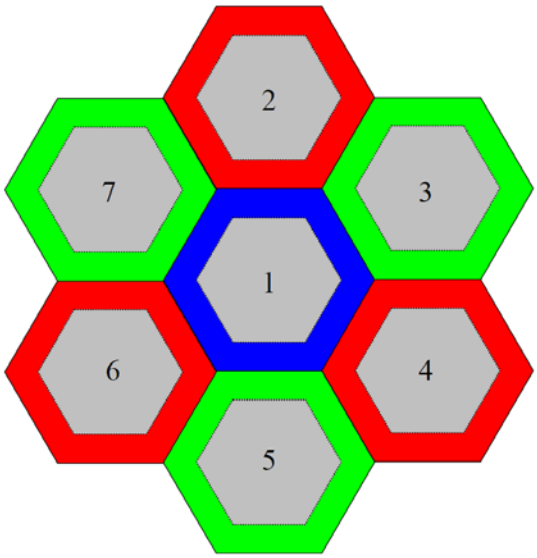
E. Ground 5: Ericsson alone or in combination with Schwartz renders claims 7, 8, 9, 11, 15, 17, 18, 20 and 21 obvious

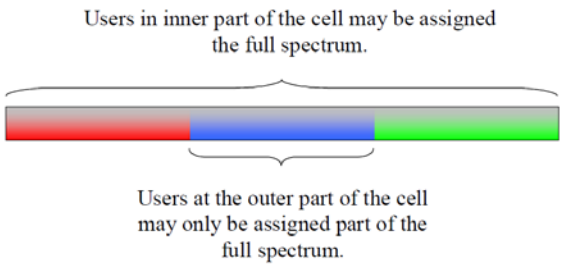
243. Ericsson (Ex. 1007) addresses the problem of inter-cell inference. In Section 3, Ericsson discloses a frequency reuse technique in which "only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users ... ." See Ex. 1007 at 2, Fig. 2 (below). To achieve this, each cell's centrally located antenna transmits a different

RF band at a higher power to cover a cell-edge area than bands used to cover a central area.

> Fractional reuse, also known as ***soft frequency reuse*** …, has been proposed as a means to increase the performance for cell-edge users. With fractional reuse, ***only a part of the total resources is used for transmission to/from cell-edge users***, thereby reducing the interference experienced by these users (at the cost of a reduced bandwidth). Typically, fractional reuse is implemented as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, ***only cell 1 is allowed to transmit with full power using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a reduced power***. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2 (emphasis added).





Ex. 1007 at 2, Fig. 2.

1. Claim 7

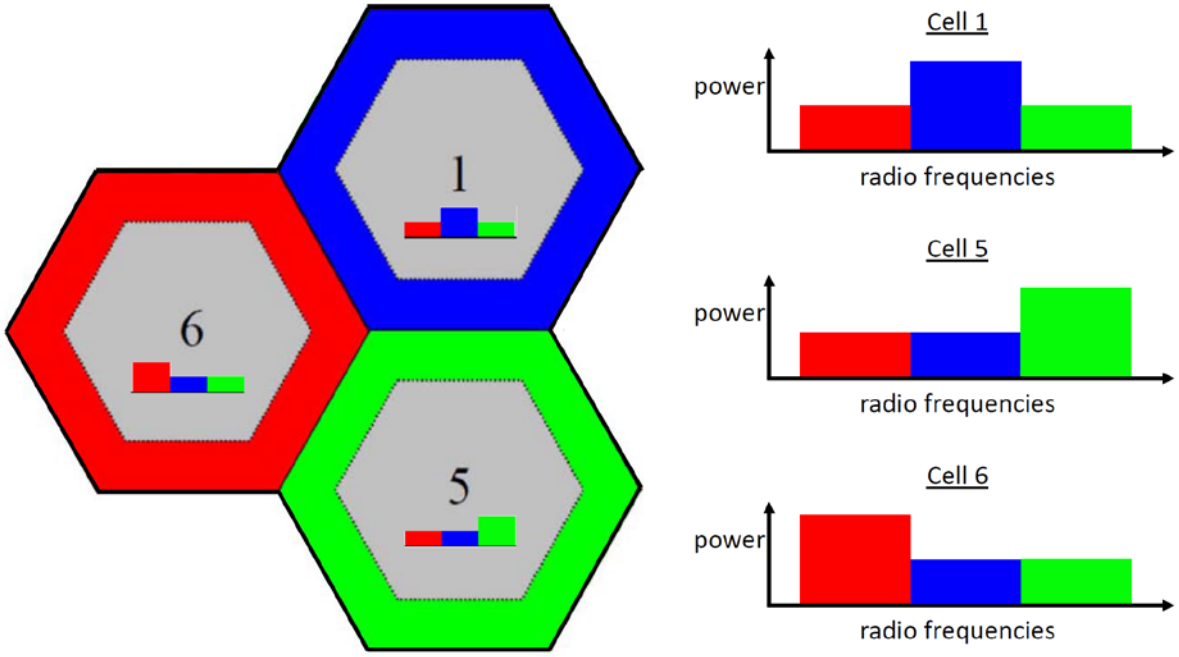
244. As discussed above in Section VIII.D, Ericsson discloses all the limitations of Elements 7B, 7C, and 7D. If the preamble (Element 7A) of claim 7 is construed to be limited to a distributed antenna system, then Ericsson's discussion of fractional reuse (Ex. 1007 at 2) does not show or describe the use of a DAS or a host unit (e.g., as required by claims 8, 15) to distribute radio resources from a remote location such as a base station hotel to each cell's respective antenna unit. However, based on Ericsson alone, it would have been obvious to modify Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a DAS that includes a DAS host and transport links for distributing radio resources to the distributed antenna units of

Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

a. Element 7A

"A method of distributing communications frequencies"

245. Ericsson discloses a cellular communication system that distributes communications frequencies in a way that implements a frequency reuse technique for "reducing the interference experienced by these users … ." Ex. 1007 at 2, Section 3. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme, i.e., soft frequency reuse (SFR) in the same way as Figs. 1C & 1F of the '358 patent. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ericsson at 2 (e.g., "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").



246. One of skill in the art reading Ericsson understands that the cells depicted by Ericsson inherently include one or more antenna units within each cell for wirelessly transmitting and receiving signals within the radio frequency bands shown in Figure 2. In addition, Ericsson's illustration of the Figure 2 of symmetrical concentric inner and outer areas for each cell in combination with the description that these are generated using two different power levels, would inherently indicate to one of skill in the art that each cell in Figure 2 includes a centrally located antenna unit that creates the concentric inner and outer coverage areas.

247. Motivation to modify Ericsson's system for deployments in densely populated areas. Based on Ericsson alone, it would have been obvious to modify

Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a DAS that includes a DAS host and transport links for distributing radio resources to the distributed antenna units of Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

248. Particularly in densely populated areas, a POSA would have known that, for cost and efficiency reasons as well as lack of access to cell site property, POSA in reviewing Ericsson would have understood (a) that it was common to locate the base station equipment remote from the cell sites (commonly known as a base station hotel) and (b) that a host unit would have been commonly employed at the base station hotel to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. This background is reinforced in the background section of the '358 patent.

> BACKGROUND OF THE INVENTION
>
> Wireless communication systems employing Distributed Antenna Systems (DAS) are available. A DAS typically includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units. A radio base station is often employed at the host unit location commonly known as a base station hotel, and the DAS provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units. The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable.

Ex. 1001 at 1:14-26.

249. That a POSA would have known that it was common in densely populated areas to house the base station equipment at a site remote from the cells and employ a DAS host and DAS links to transport the RF signal to the cell sites is also reinforced by the background DAS prior art. *See* Sabat (Ex. 1014); Schwartz (1008); Stratford (Ex. 1009) at 1:60-65 ("The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. In these types of areas it is getting increasingly more difficult to deploy new cell sites due to a variety of factors including regulatory and space constraint issues."); Stapleton (Ex. 1010) discussed above at Section VII.B.1.

250. For a deployment of an Ericsson system in which the base station had to be located a long distance from the remote antenna units, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

251. Alternatively, it would have been obvious in view of Schwartz to combine Ericsson with a DAS.

252. Motivation based on Schwartz. Based on Schwartz (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

253. Schwartz teaches the benefits of employing "a centralized base-station site containing a plurality of base-station units" (i.e., a base station hotel as described in the background) and "a means [router 22, a host unit] for transmitting the traffic channel resources between the centralized base station site and the remote cells … ." Ex. 1008 at 3:22-27, Fig. 2, 1:16-67 (describing the inefficiencies associated with locating a base station at the center of each cell and benefits to using a centralized base station site located remote from the cells sites).

254. Based on Schwartz, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems such as Ericsson's system: (a) the base station equipment often must be located remote from the cell sites (commonly referred to as a Base Station Hotel as noted in the background of the '358 patent) and (b) for such deployments, a DAS host unit (e.g., router 22 of Schwartz Fig. 2) as taught

by Schwartz would facilitate more efficient transport of radio resources to Ericsson's cells.

255. Based on Schwartz, for those deployments of Ericsson's system in which the base station had to be located a long distance from cell sites, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

256. For such deployments, Schwartz's teaches to use a host unit (e.g. "RF router 22") as an interface between one or more base stations (i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units. Ex. 1008 at Fig. 2, 6:24-41:

> FIG. 2 illustrates an exemplary embodiment of a cellular network according to the cellular network architecture of the present invention. By way of example, a centralized base-station site 20, including a group of base-station units 21 and **an RF router 22**, transmits multiple CDMA signals to a plurality of remote cells, such as remote cells 23, 24, 25, via a cellular-distribution link 26. A management system 27 monitors the transmission of CDMA signals between the base-station units 21 and the RF router 22 through a set of traffic sensors, and derives

from it the offered traffic in each cell. An optimization algorithm is executed and its results are used to instruct the **RF router on how to distribute the CDMA signals from the base-station units to the antennae in the remote cells**. The cellular-distribution link 26 can be one or more optical fibers along with corresponding units for making the conversion between cellular signals and optical signals and for multiplexing/de-multiplexing optical signals onto the optical fibers.

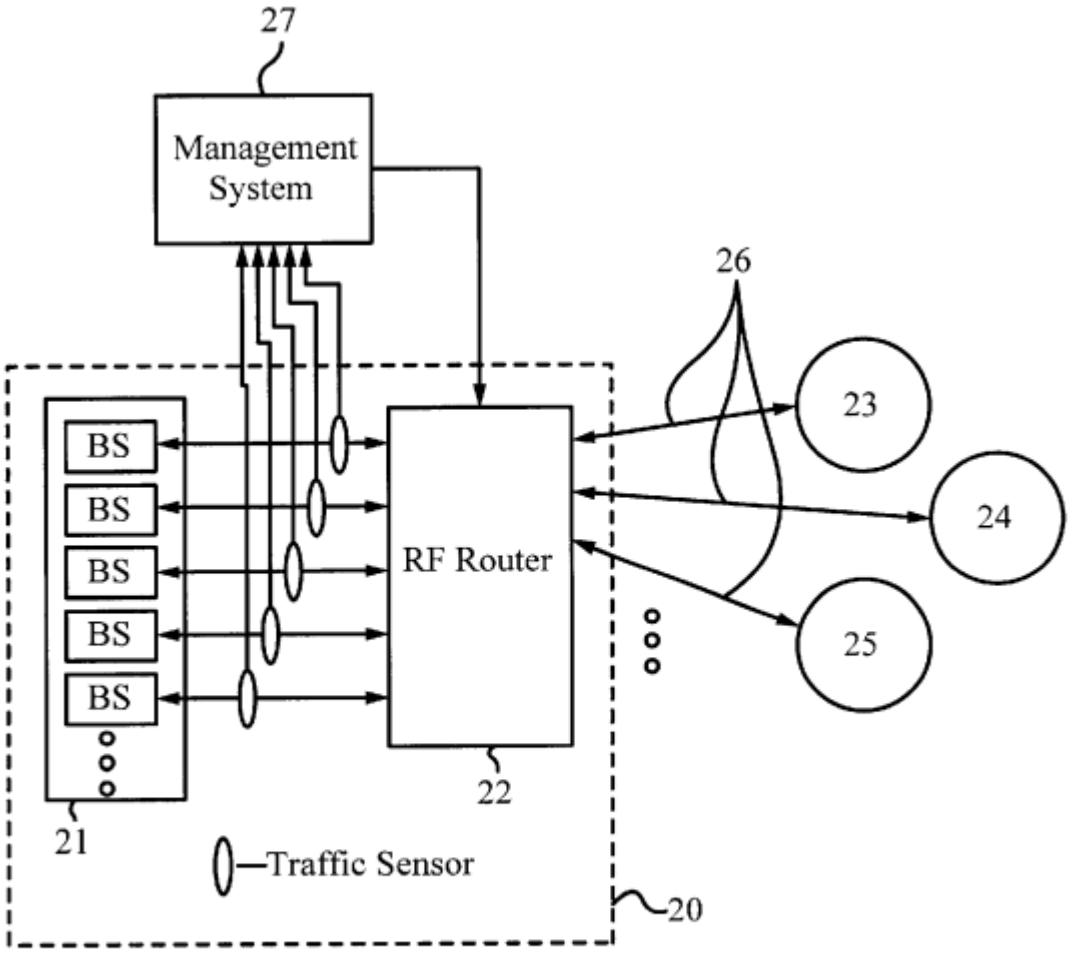
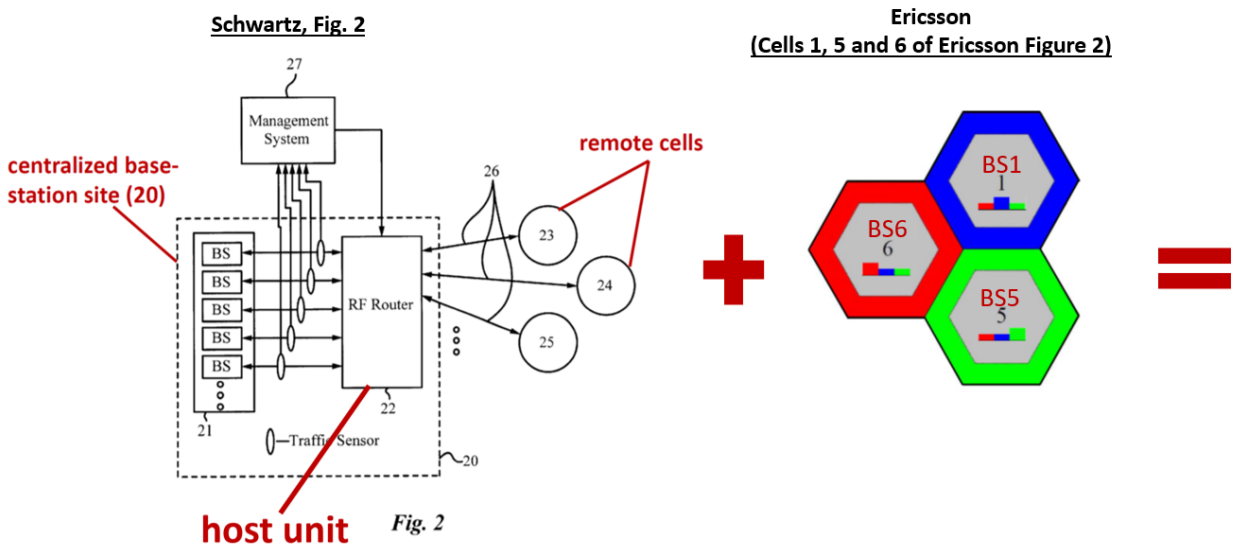


Fig. 2

257. I have illustrated this combination of Ericsson and Schwartz below. Further, one of skill would be motivated to use a host unit as taught by Schwartz's router 22 that is not integral with one base station so that the host unit could serve and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

258. I have illustrated this combination of Ericsson and Schwartz below.



Ericsson's Base Stations moved to Base Station Hotel, requiring long distance transport of base station signals over DAS Links to remote antenna units

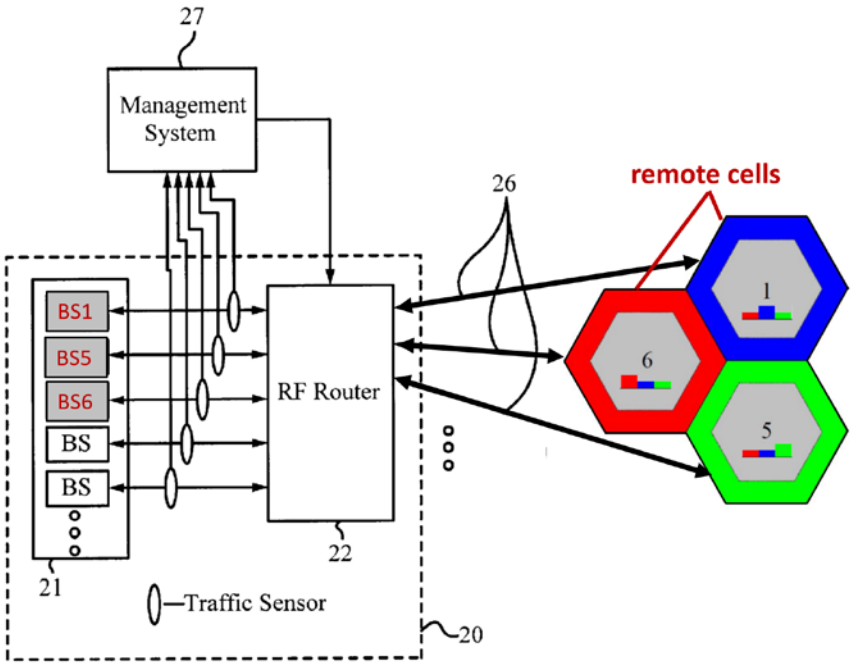


Fig. 2

259. Reasonable expectation of success of the proposed combination. A POSA would have a reasonable expectation that such a combination would be successful. That DAS host units and corresponding transport links have been so long used in the art of DAS (Schwartz filed in 2000 more than a decade before the '358 patent) would lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that DAS host units are "typical" in DAS deployments and commonly employed at base station hotel. Ex. 1001 at 1:14-26. One of the most common reasons to employ a DAS, including DAS host unit and DAS links, is to prepare the signals for successful transport over

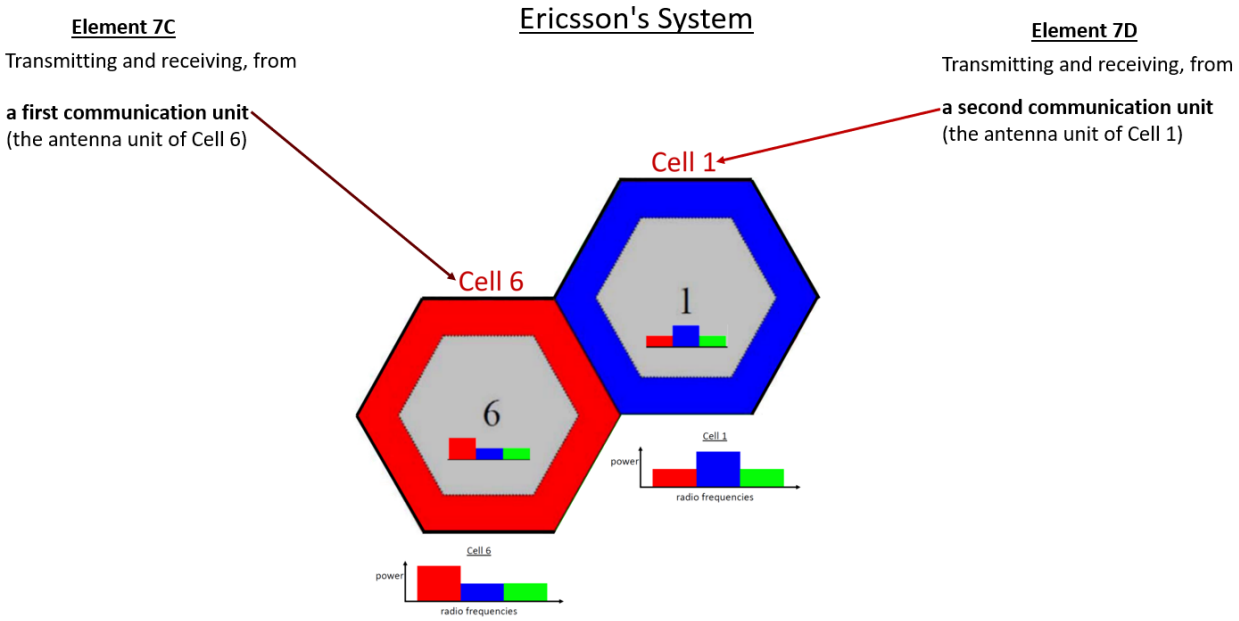
longer distances to remote cell sites without degradation of the data carried on the signals.

b. Element 7B

"providing a set of communications units;" that includes "a first communications unit" (from element 7C) and "a second communications unit" (from element 7D)

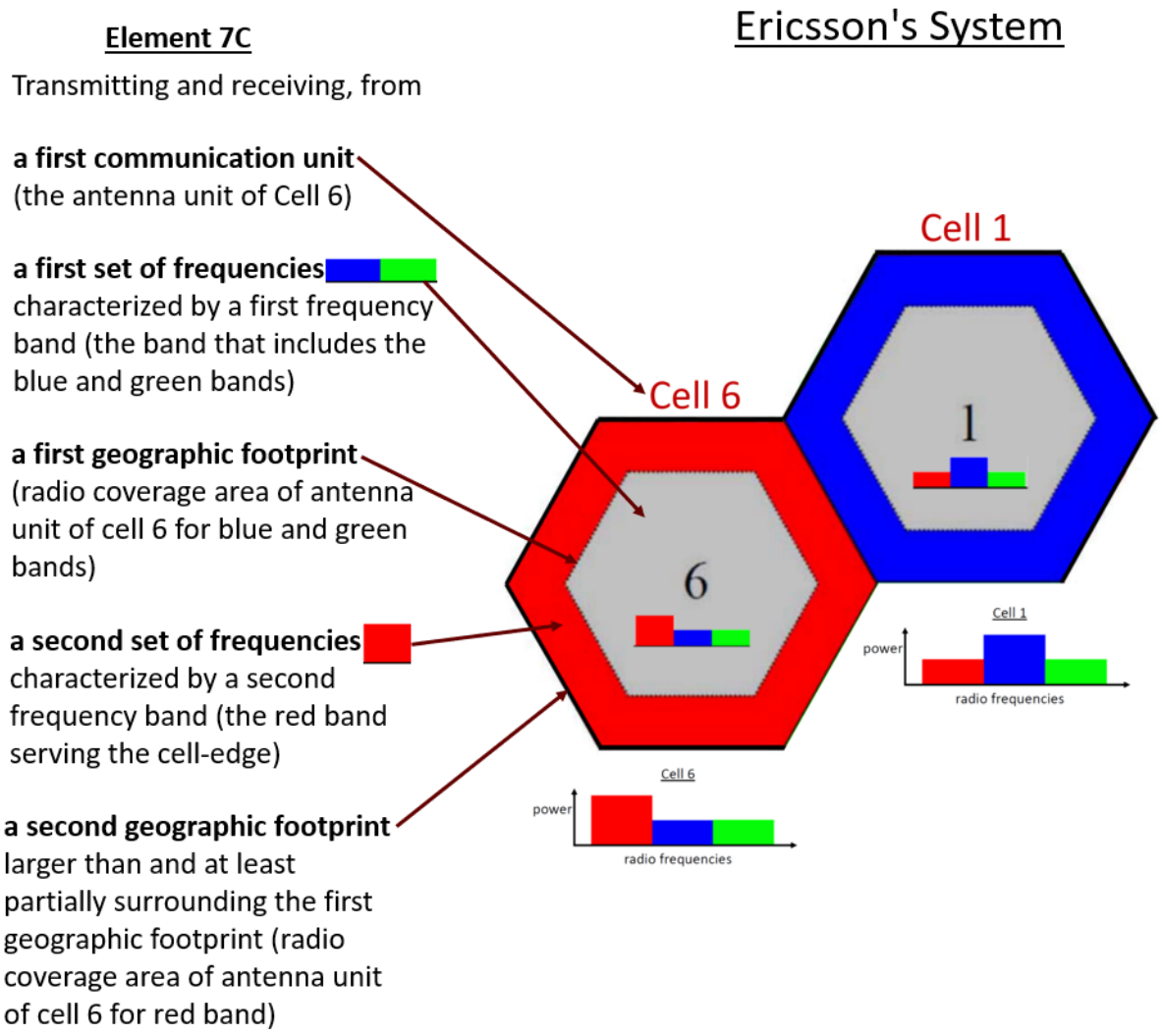
260. Cell 1 and Cell 6 from Ericsson's system are reproduced below (annotated) for comparing to the limitations of claim 7.

261. In Ericsson, the antenna unit that serves cell 6 is a "first communications unit" (below, left), and the antenna unit that serves cell 1 is a "second communications unit" (below, right). Ericsson's first and second communications units satisfy "a set of communications units" of Element 7B.



c. Element 7C

262. Below I have illustrated how Element 7C reads on Ericsson's system.



263. That Ericsson discloses Element 7C is consistent with the same logic and reason under which Element 7C reads on the second embodiment of the '358 patent. See mapping to of claim 7 to the second embodiment of the '358 patent at Section VI.D of my declaration.

264. The first communications unit: The antenna unit that serves Ericsson's cell 6 (above), is "a first communications unit".

265. Transmitting and receiving ... a first set of frequencies characterized by a first frequency band: In Ericsson's system, cell 6's antenna unit transmits a first set of frequencies characterized by a first frequency band that includes the blue and green bands. Ex. 1007 at 2, Fig. 2.

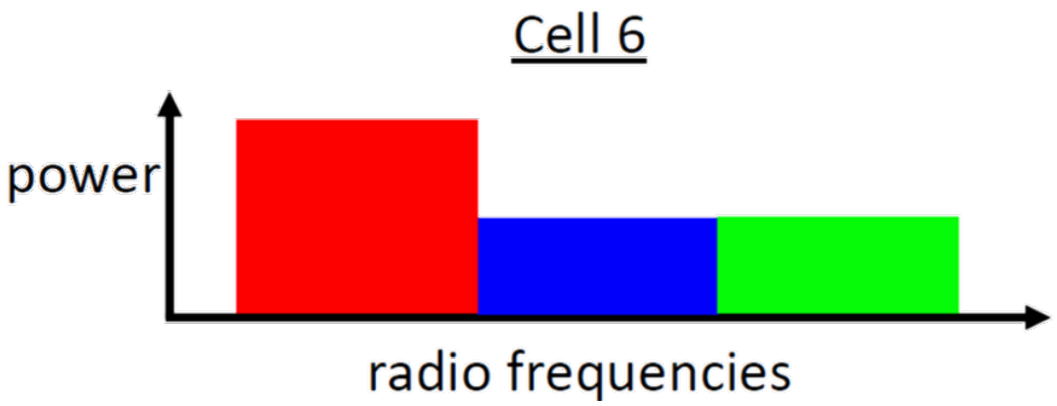
266. Transmitting and receiving ... a first set of frequencies characterized by ... a first geographic footprint: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the blue and green bands is the "a first geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 6 (gray area) corresponds to the first geographic footprint.

267. Transmitting and receiving ... a second set of frequencies characterized by a second frequency band: In Ericsson's system, cell 6's antenna unit transmits a second set of frequencies characterized by a second frequency band (red band). Ex. 1007 at 2, Fig. 2.

268. Transmitting and receiving ... a second set of frequencies characterized by ... a second geographic footprint larger than and at least partially surrounding the first geographic footprint: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the red band is "a second geographic footprint". As illustrated below, cell 6's antenna unit transmits the red band at a higher power

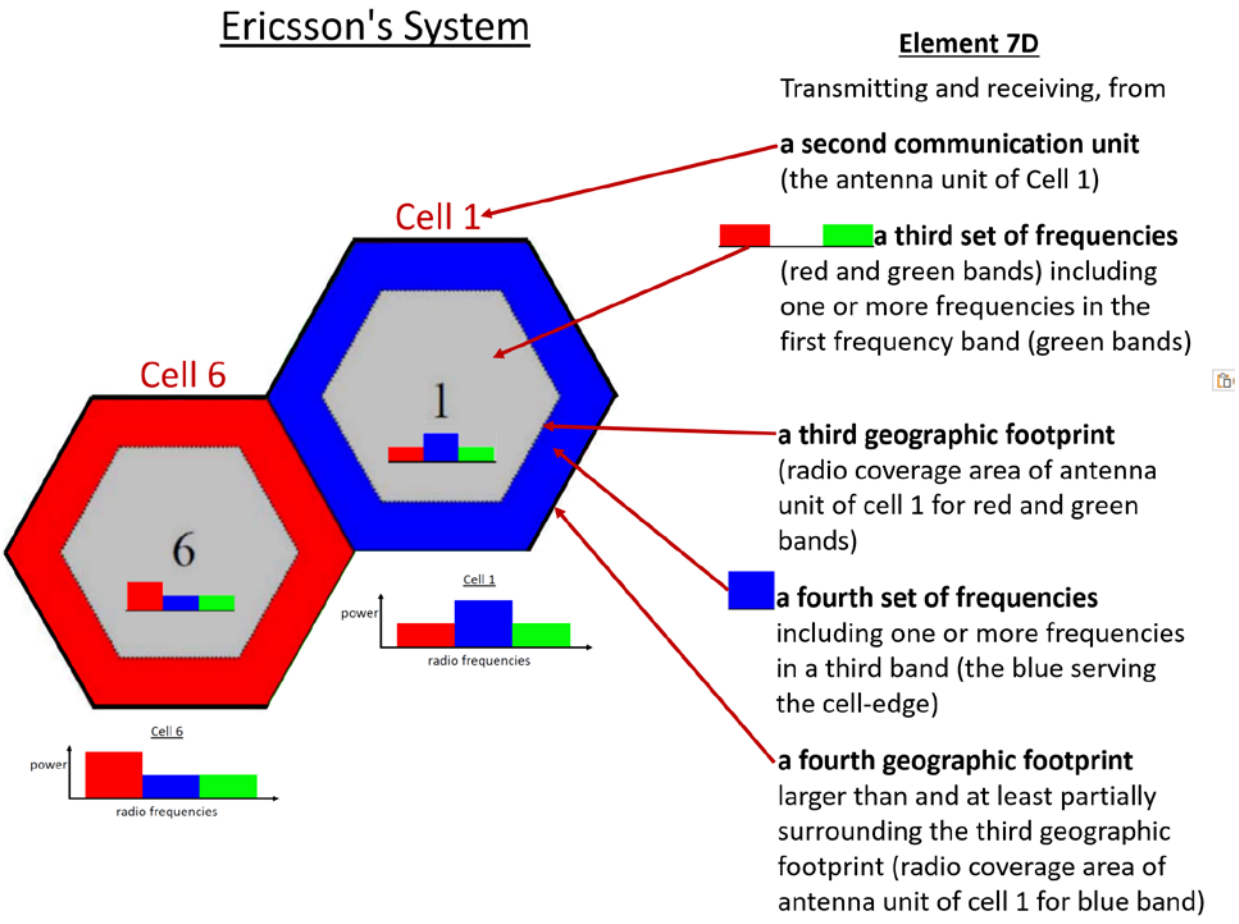
resulting in resulting in larger coverage area for the second geographic footprint.

Ex. 1007 at 2, Fig. 2.



d. Element 7D

269. Below I have illustrated how Element 7D reads on Ericsson's system.



270. That Ericsson discloses Element 7D is consistent with the same logic and reason under which Element 7D reads on the second embodiment of the '358 patent. See mapping to of claim 7 to the second embodiment of the '358 patent at Section VI.D of my declaration.

271. The second communications unit: The antenna unit that serves Ericsson's cell 1 (above), is "a second communications unit".

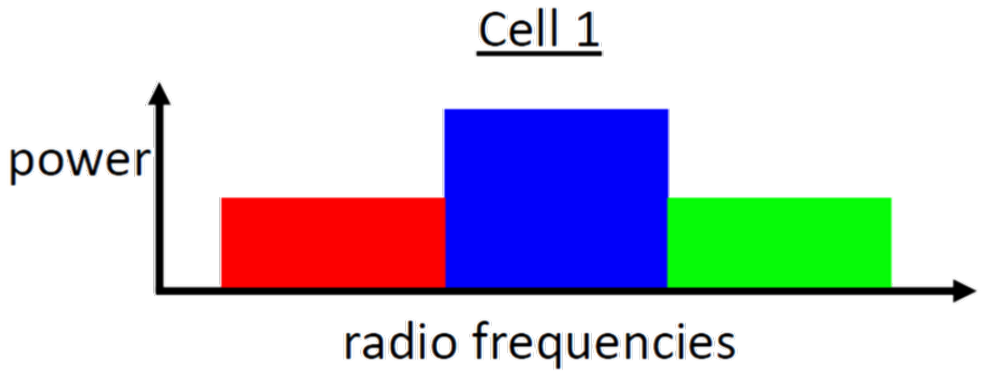
272. Transmitting and receiving ... a third set of frequencies including one or more frequencies in the first frequency band: In Ericsson's system, cell 1's

antenna unit transmits a third set of frequencies (red and green bands) that include one or more frequencies in the first frequency band (the green band). Ex. 1007 at 2, Fig. 2.

273. Transmitting and receiving ... a third set of frequencies ... in ... a third geographic footprint: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the red and green bands is "a third geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 1 (gray area) corresponds to the third geographic footprint.

274. Transmitting and receiving ... a fourth set of frequencies including one or more frequencies in a third band: In Ericsson's system, cell 1's antenna unit transmits a fourth set of frequencies including one or more frequencies in a third band (blue band serving the cell-edge area). Ex. 1007 at 2, Fig. 2.

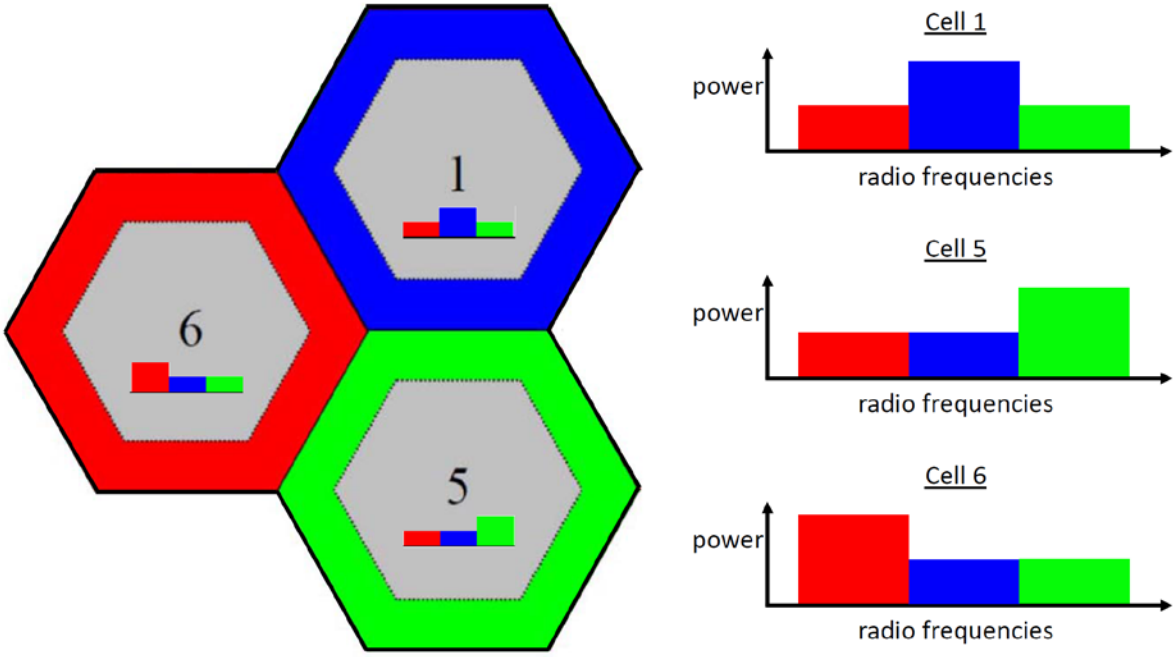
275. Transmitting and receiving ... a fourth set of frequencies ... in ... a fourth geographic footprint larger than and at least partially surrounding the third geographic footprint: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the blue band is "a fourth geographic footprint". As illustrated below, cell 1's antenna unit transmits the blue band at a higher power resulting in resulting in larger coverage area for the fourth geographic footprint. Ex. 1007 at 2, Fig. 2.



2. Claim 8

The method of claim 7 wherein the set of communications units includes a plurality of remote units in communication with a host unit.

276. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme, i.e., soft frequency reuse (SFR) in the same way as Figs. 1C & 1F of the '358 patent. *See* Ex. 1001 at Figs. 1C, 1F. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ericsson at 2 (*e.g.*, "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").



277. As discussed for element 7A of claim 7, in Ericsson's discussion of fractional reuse (Ex. 1007 at 2), Ericsson does not show or describe the use of a DAS or a DAS host to distribute radio resources from a remote location to the cell sites.

278. Motivation to modify Ericsson's system for deployments in densely populated areas. Based on Ericsson alone, it would have been obvious to modify Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a DAS that includes a DAS host and transport links for distributing radio resources to the distributed antenna units of Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

279. Particularly in densely populated areas, a POSA would have known that, for cost and efficiency reasons as well as lack of access to cell site property, POSA in reviewing Ericsson would have understood (a) that it was common to locate the base station equipment remote from the cell sites (commonly known as a base station hotel) and (b) that a host unit would have been commonly employed at the base station hotel to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. This background is reinforced in the background section of the '358 patent.

> BACKGROUND OF THE INVENTION
>
> Wireless communication systems employing Distributed Antenna Systems (DAS) are available. A DAS typically includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units. A radio base station is often employed at the host unit location commonly known as a base station hotel, and the DAS provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units. The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable.

Ex. 1001 at 1:14-26.

280. That a POSA would have known that it was common in densely populated areas to house the base station equipment at a site remote from the cells and employ a DAS host and DAS links to transport the RF signal to the cell sites is also reinforced by the background DAS prior art. *See* Sabat (Ex. 1014); Schwartz

(1008); Stratford (Ex. 1009); Stapleton (Ex. 1010) discussed above at Section VII.B.1.

281. For a deployment of an Ericsson's system in which the base station had to be located a long distance from the remote antenna units, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

282. Alternatively, it would have been obvious in view of Schwartz to combine Ericsson with a DAS.

283. Motivation based on Schwartz. Based on Schwartz (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

284. Schwartz teaches the benefits of employing "a centralized base-station site containing a plurality of base-station units" (i.e., a base station hotel as

described in the background) and "a means [router 22, a host unit] for transmitting the traffic channel resources between the centralized base station site and the remote cells … ." Ex. 1008 at 3:22-27, Fig. 2; *see also* Ex. 1008 at 1:16-67 (describing the inefficiencies associated with locating a base station at the center of each cell and benefits to using a centralized base station site located remote from the cells sites).

285. Based on Schwartz, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems such as Ericsson's system: (a) the base station equipment often must be located remote from the cell sites (commonly referred to as a Base Station Hotel as noted in the background of the '358 patent) and (b) for such deployments, a DAS host unit (e.g., router 22 of Schwartz Fig. 2) as taught by Schwartz would facilitate more efficient transport of radio resources to Ericsson's cells.

286. Based on Schwartz, for those deployments of Ericsson's system in which the base station had to be located a long distance from cell sites, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting

the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

287. For such deployments, Schwartz's teaches to use a host unit (e.g. "RF router 22") as an interface between one or more base stations (i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units. Ex. 1008 at Fig. 2, 6:24-41:

> FIG. 2 illustrates an exemplary embodiment of a cellular network according to the cellular network architecture of the present invention. By way of example, a centralized base-station site 20, including a group of base-station units 21 and **an RF router 22**, transmits multiple CDMA signals to a plurality of remote cells, such as remote cells 23, 24, 25, via a cellular-distribution link 26. A management system 27 monitors the transmission of CDMA signals between the base-station units 21 and the RF router 22 through a set of traffic sensors, and derives from it the offered traffic in each cell. An optimization algorithm is executed and its results are used to instruct the **RF router on how to distribute the CDMA signals from the base-station units to the antennae in the remote cells**. The cellular-distribution link 26 can be one or more optical fibers along with corresponding units for making the conversion between cellular signals and optical signals and for multiplexing/de-multiplexing optical signals onto the optical fibers.

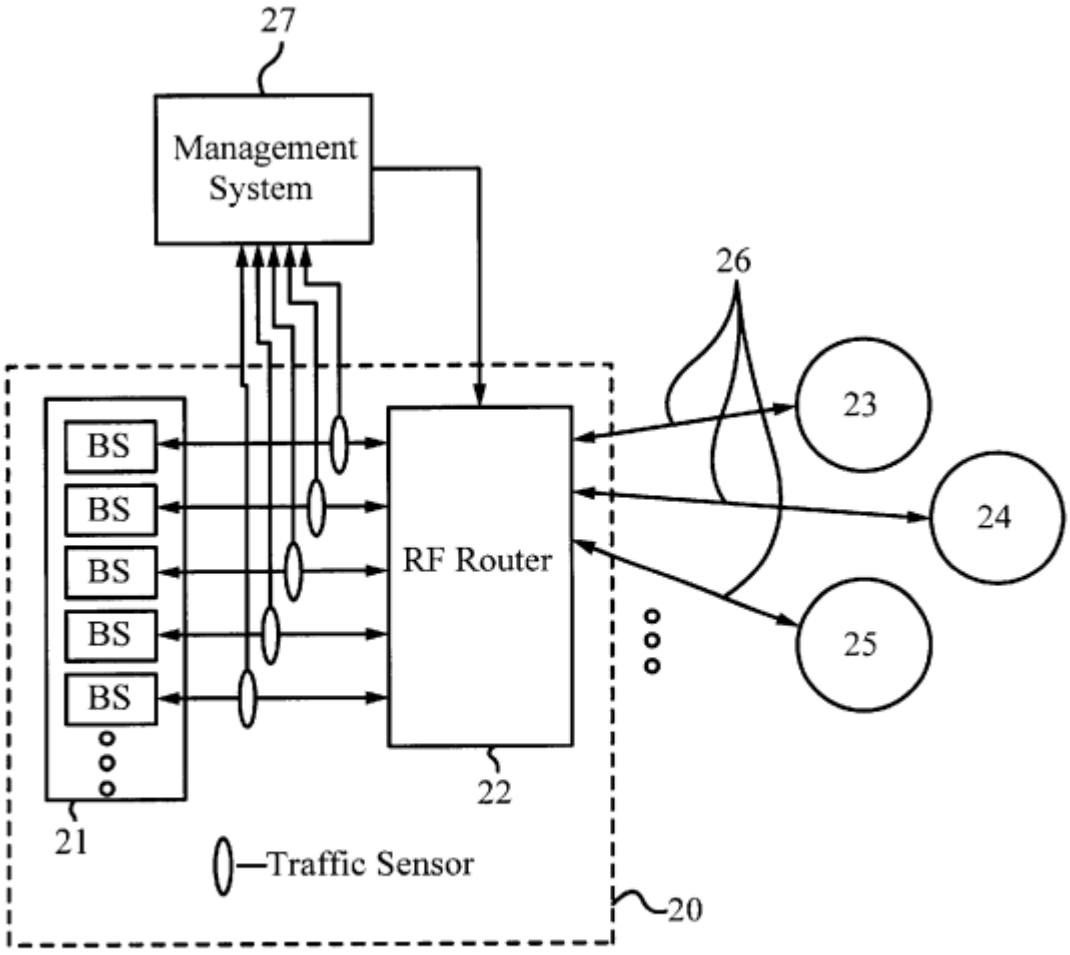
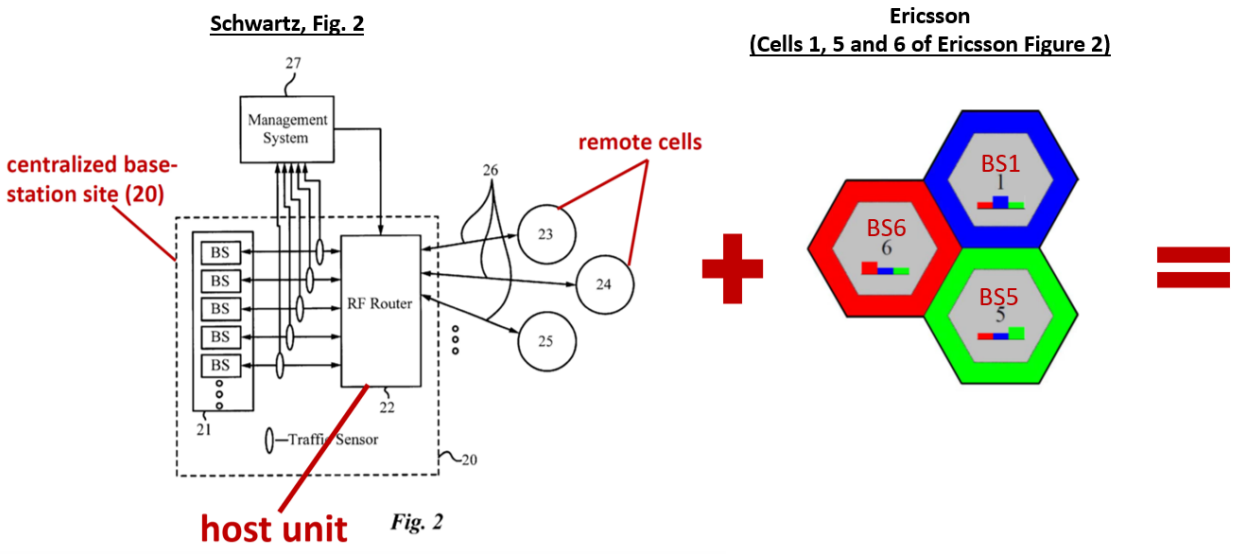
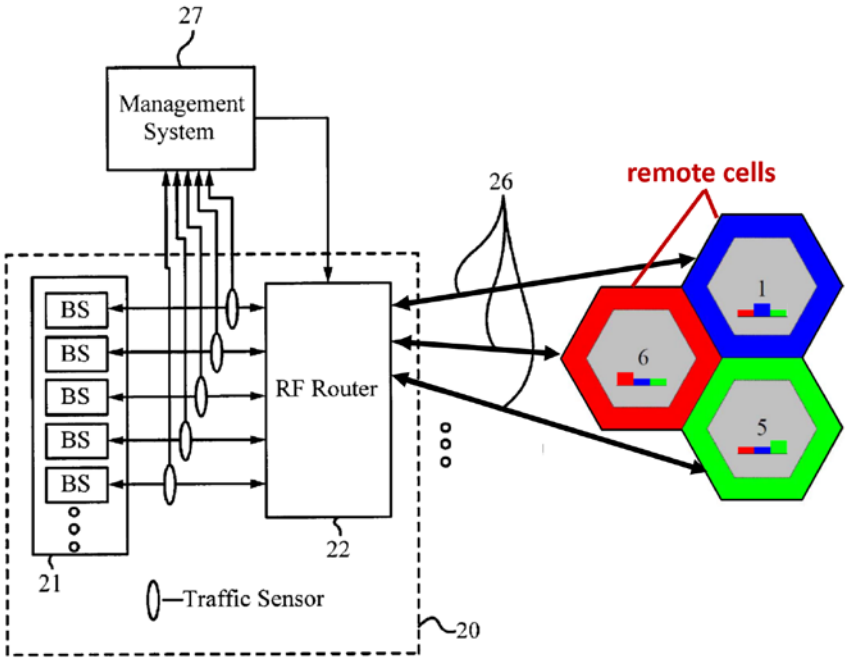


Fig. 2

288. I have illustrated this combination of Ericsson and Schwartz below. Further, one of skill would be motivated to use a host unit as taught by Schwartz's router 22 that is not integral with one base station so that the host unit could serve and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

289. I have illustrated this combination of Ericsson and Schwartz below.





Ericsson's base stations moved to BTS Hotel, requiring long distance transport of base station signals over DAS links to remote cell sites

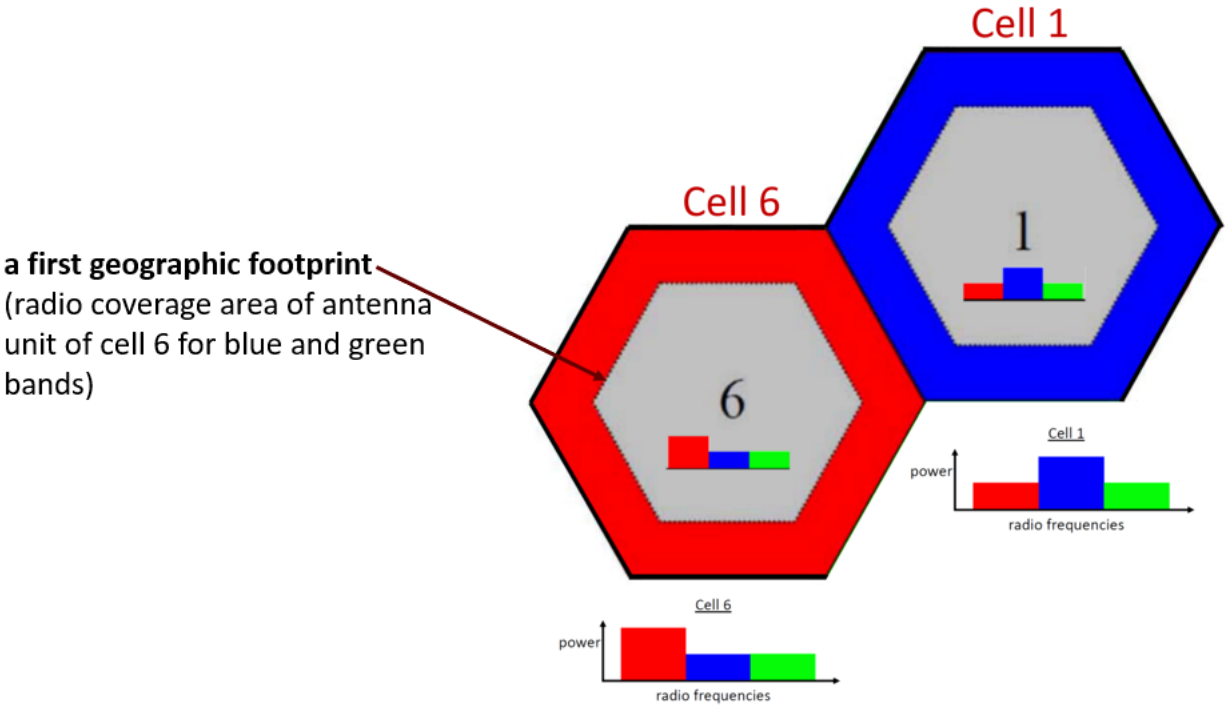
Fig. 2

290. Reasonable expectation of success of the proposed combination. A POSA would have a reasonable expectation that such a combination would be successful. That DAS host units and corresponding transport links have been so long used in the art of DAS (Schwartz filed in 2000 more than a decade before the '358 patent) would lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that DAS host units are "typical" in DAS deployments and commonly employed at base station hotel. Ex. 1001 at 1:14-26. One of the most common reasons to employ a DAS, including DAS host unit and DAS links, is to prepare the signals for successful transport over longer distances to remote cell sites without degradation of the data carried on the signals.

3. Claim 9

"the first geographic footprint includes a location of the first communications unit"

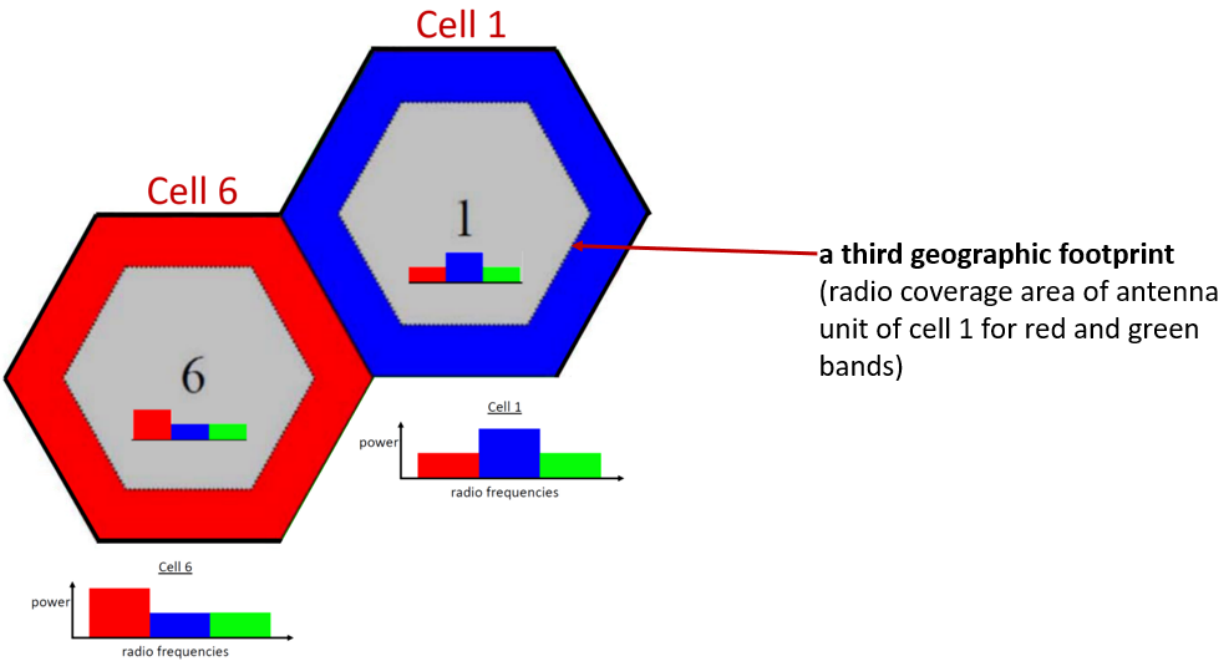
291. Since the first geographic footprint of Ericsson's cell 6 includes a location of cell 6's antenna unit, the limitation added by claim 9 is satisfied.



4. Claim 11

"the third geographical footprint includes a location of the second communications unit"

292. Since the third geographic footprint of Ericsson's cell 1 includes a location of cell 1's antenna unit, the limitation added by claim 11 is satisfied.



5. Claim 15

293. The claimed communication system of Claim 15 is similar to the claimed method of distributing communications frequencies of claim 7. Both require "a first communications unit" and "a second communications unit" and frequency reuse in Elements 15C and 15D. Claim 15 further requires "a host unit" that is coupled to the first and second communications units.

294. As discussed for claim 8, in Ericsson's discussion of fractional reuse (Ex. 1007, Section 3 and Fig. 2), Ericsson does not show or describe the use of a DAS or a DAS host unit to distribute radio resources from a remote location such as a base station hotel to cell's respective antenna units.

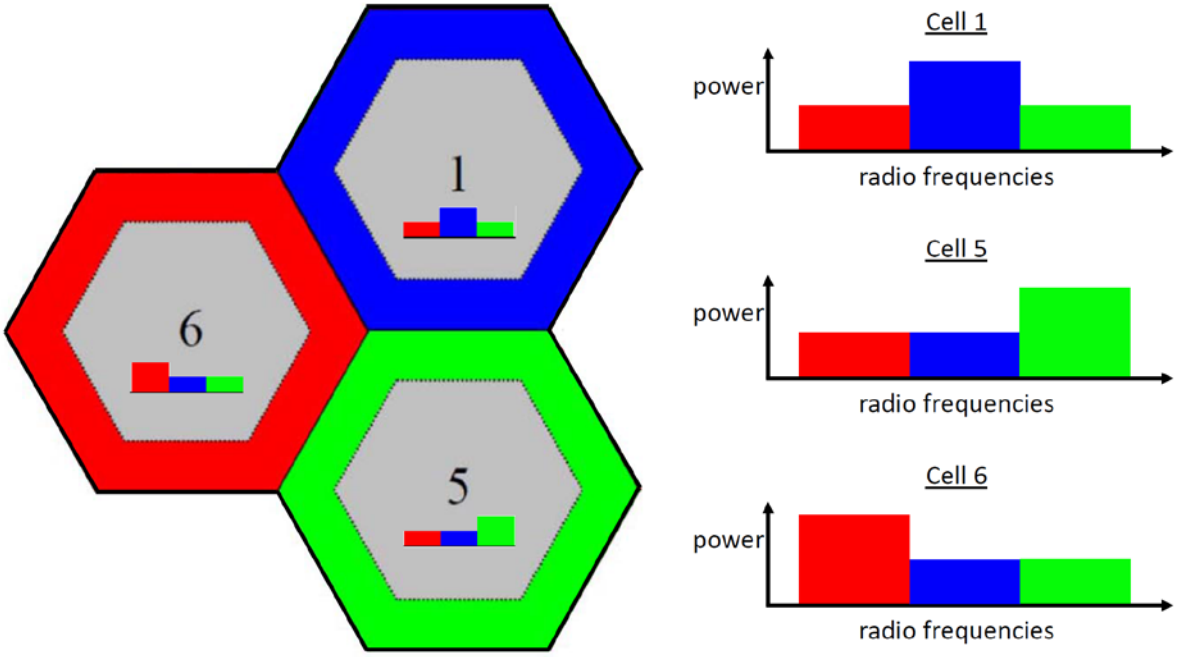
295. With the exception the "host unit," Ericsson discloses all the limitations of claim 15.

a. Element 15A

"a communication system"

296. Ericsson this element because it discloses a multi-cell wireless communication system for transporting wireless communications. Ericsson's proposed a cellular communication system distributes communications frequencies in a way that implements a frequency reuse technique for "reducing the interference experienced by these users … ." Ex. 1007 at 2, Section 3.

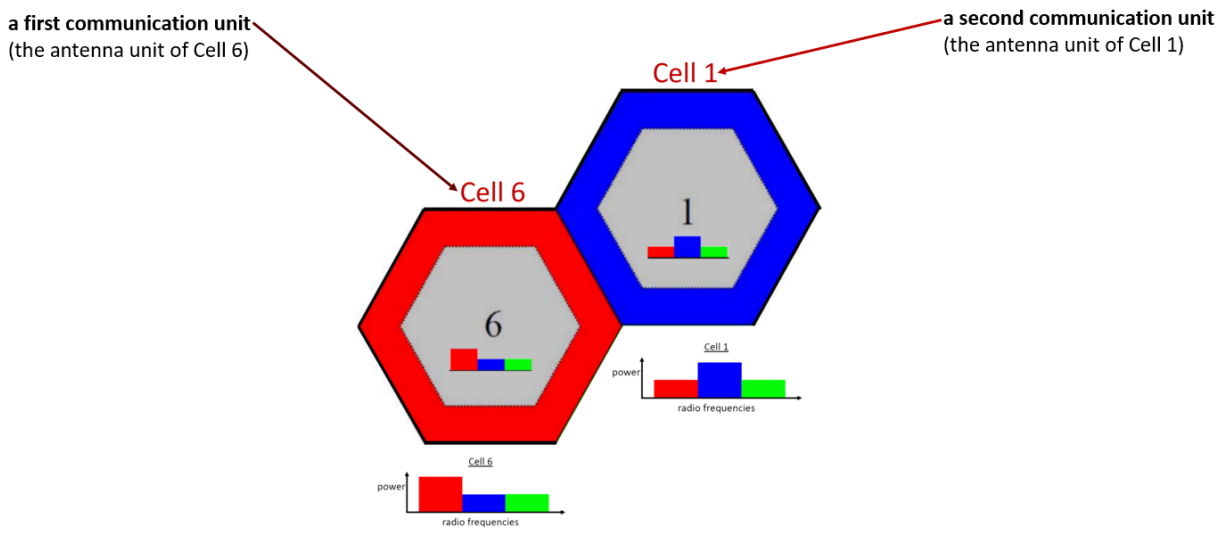
297. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme. Ericsson's system implements soft frequency reuse (SFR) in the same way as Figs. 1C & 1F of the '358 patent. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ex. 1007 at 2 (e.g., "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").



b. Element 15B ("a host unit") and first / second communications units "coupled to the host unit" (from Elements 15C and 15D)

298. Cell 1 and Cell 6 from Ericsson's system are reproduced below (annotated) for comparing to the limitations of claim 15.

299. In Ericsson, the antenna unit that serves cell 6 is a "first communications unit" (below, left), and the antenna unit that serves cell 1 is a "second communications unit" (below, right).



300. Ericsson does not show or describe the use of host unit to distribute radio resources from a remote location such as a base station hotel to cell's respective antenna units.

301. Motivation to modify Ericsson's system for deployments in densely populated areas. Based on Ericsson alone, it would have been obvious to modify Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a DAS that includes a DAS host and transport links for distributing radio resources to the antenna units of Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

302. Particularly in densely populated areas, a POSA would have known that, for cost and efficiency reasons as well as lack of access to cell site property, POSA in reviewing Ericsson would have understood (a) that it was common to

locate the base station equipment remote from the cell sites (commonly known as a base station hotel) and (b) that a host unit would have been commonly employed at the base station hotel to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. This background is reinforced in the background section of the '358 patent.

> BACKGROUND OF THE INVENTION
>
> Wireless communication systems employing Distributed Antenna Systems (DAS) are available. A DAS typically includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units. A radio base station is often employed at the host unit location commonly known as a base station hotel, and the DAS provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units. The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable.

Ex. 1001 at 1:14-26.

303. That a POSA would have known that it was common in densely populated areas to house the base station equipment at a site remote from the cells and employ a DAS host and DAS links to transport the RF signal to the cell sites is also reinforced by the background DAS prior art. See Sabat (Ex. 1014); Schwartz (Ex. 1008); Stratford (Ex. 1009); Stapleton (Ex. 1010) discussed above at Section VII.B.1.

304. For a deployment of an Ericsson's system in which the base station had to be located a long distance from the remote antenna units, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

305. Alternatively, it would have been obvious in view of Schwartz to combine Ericsson with a DAS.

306. Motivation based on Schwartz. Based on Schwartz (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

307. Schwartz teaches the benefits of employing "a centralized base-station site containing a plurality of base-station units" (i.e., a base station hotel as described in the background) and "a means [router 22, a host unit] for transmitting the traffic channel resources between the centralized base station site and the

remote cells … .” Ex. 1008 at 3:22-27, Fig. 2; *see also* Ex. 1008 at 1:16-67 (describing the inefficiencies associated with locating a base station at the center of each cell and benefits to using a centralized base station site located remote from the cells sites).

308. Based on Schwartz, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems such as Ericsson’s system: (a) the base station equipment often must be located remote from the cell sites (commonly referred to as a Base Station Hotel as noted in the background of the ‘358 patent) and (b) for such deployments, a DAS host unit (e.g., router 22 of Schwartz Fig. 2) as taught by Schwartz would facilitate more efficient transport of radio resources to Ericsson’s cells.

309. Based on Schwartz, for those deployments of Ericsson’s system in which the base station had to be located a long distance from cell sites, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station’s RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson’s system.

310. For such deployments, Schwartz's teaches to use a host unit (e.g. "RF router 22") as an interface between one or more base stations (i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units. Ex. 1008 at Fig. 2, 6:24-41:

> FIG. 2 illustrates an exemplary embodiment of a cellular network according to the cellular network architecture of the present invention. By way of example, a centralized base-station site 20, including a group of base-station units 21 and **an RF router 22**, transmits multiple CDMA signals to a plurality of remote cells, such as remote cells 23, 24, 25, via a cellular-distribution link 26. A management system 27 monitors the transmission of CDMA signals between the base-station units 21 and the RF router 22 through a set of traffic sensors, and derives from it the offered traffic in each cell. An optimization algorithm is executed and its results are used to instruct the **RF router on how to distribute the CDMA signals from the base-station units to the antennae in the remote cells**. The cellular-distribution link 26 can be one or more optical fibers along with corresponding units for making the conversion between cellular signals and optical signals and for multiplexing/de-multiplexing optical signals onto the optical fibers.

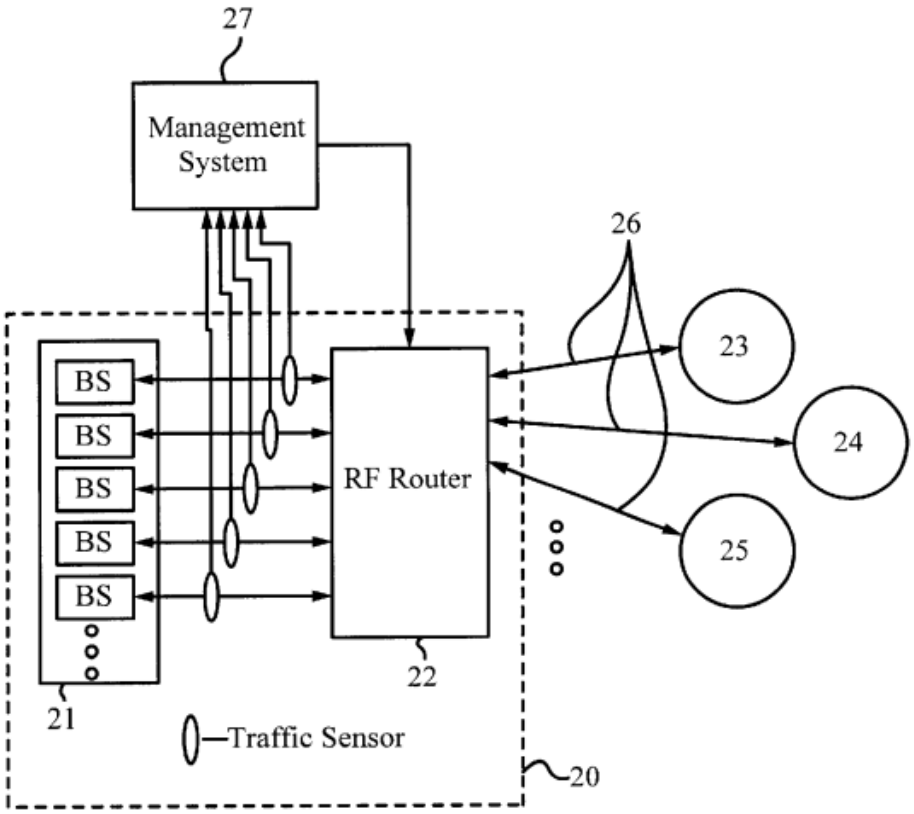
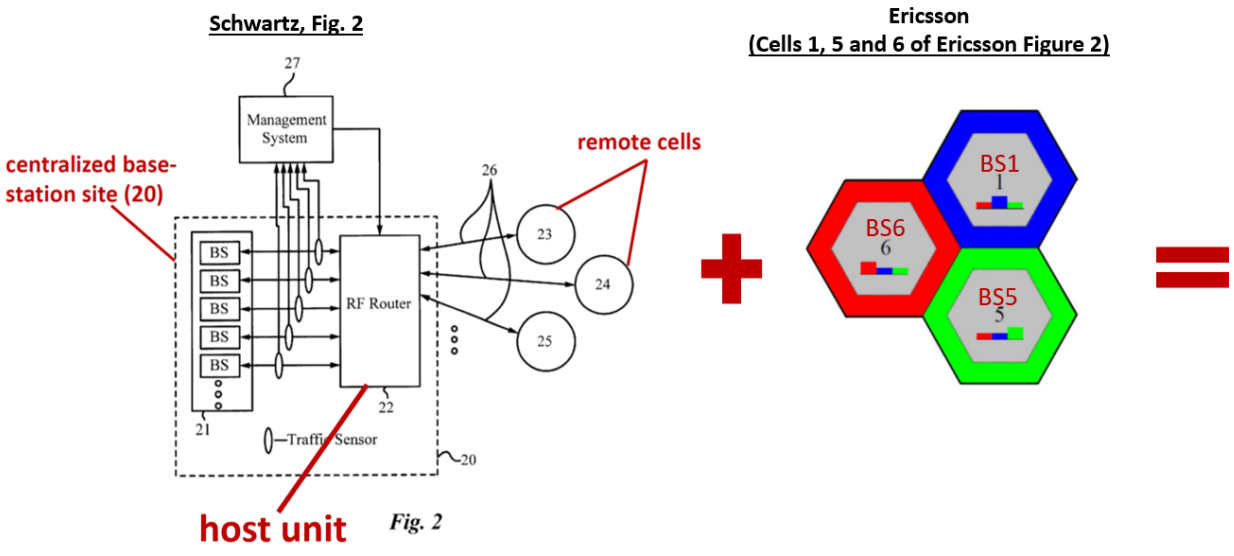


Fig. 2

311. I have illustrated this combination of Ericsson and Schwartz below. Further, one of skill would be motivated to use a host unit as taught by Schwartz's router 22 that is not integral with one base station so that the host unit could serve and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

312. I have illustrated this combination of Ericsson and Schwartz below.



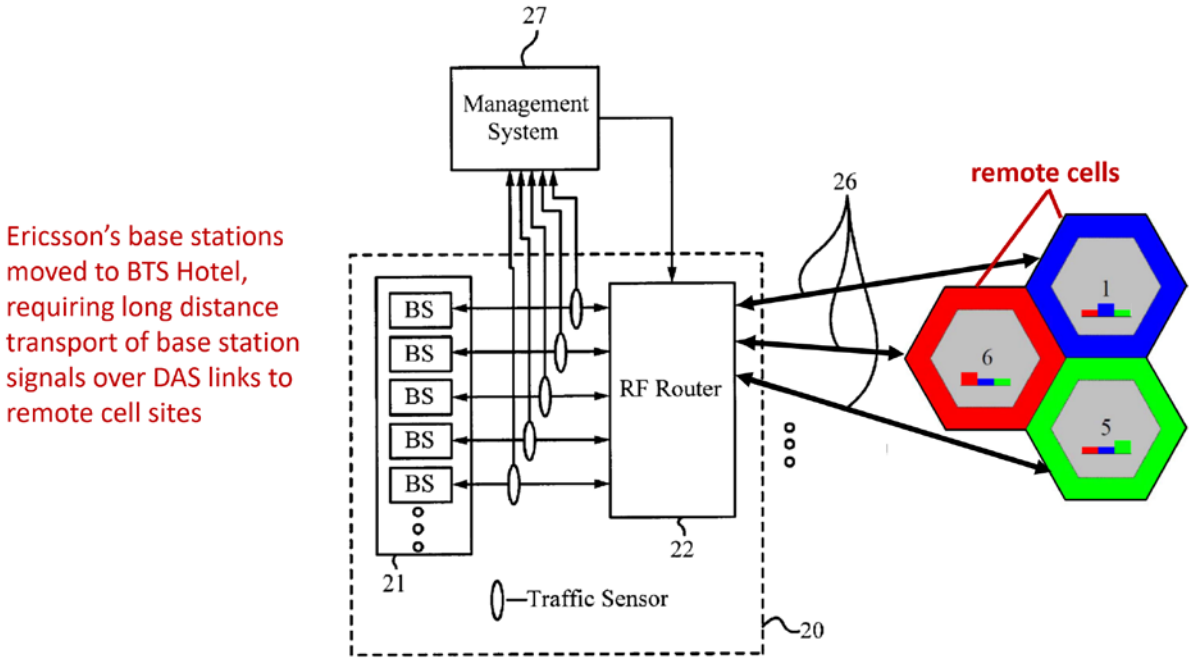


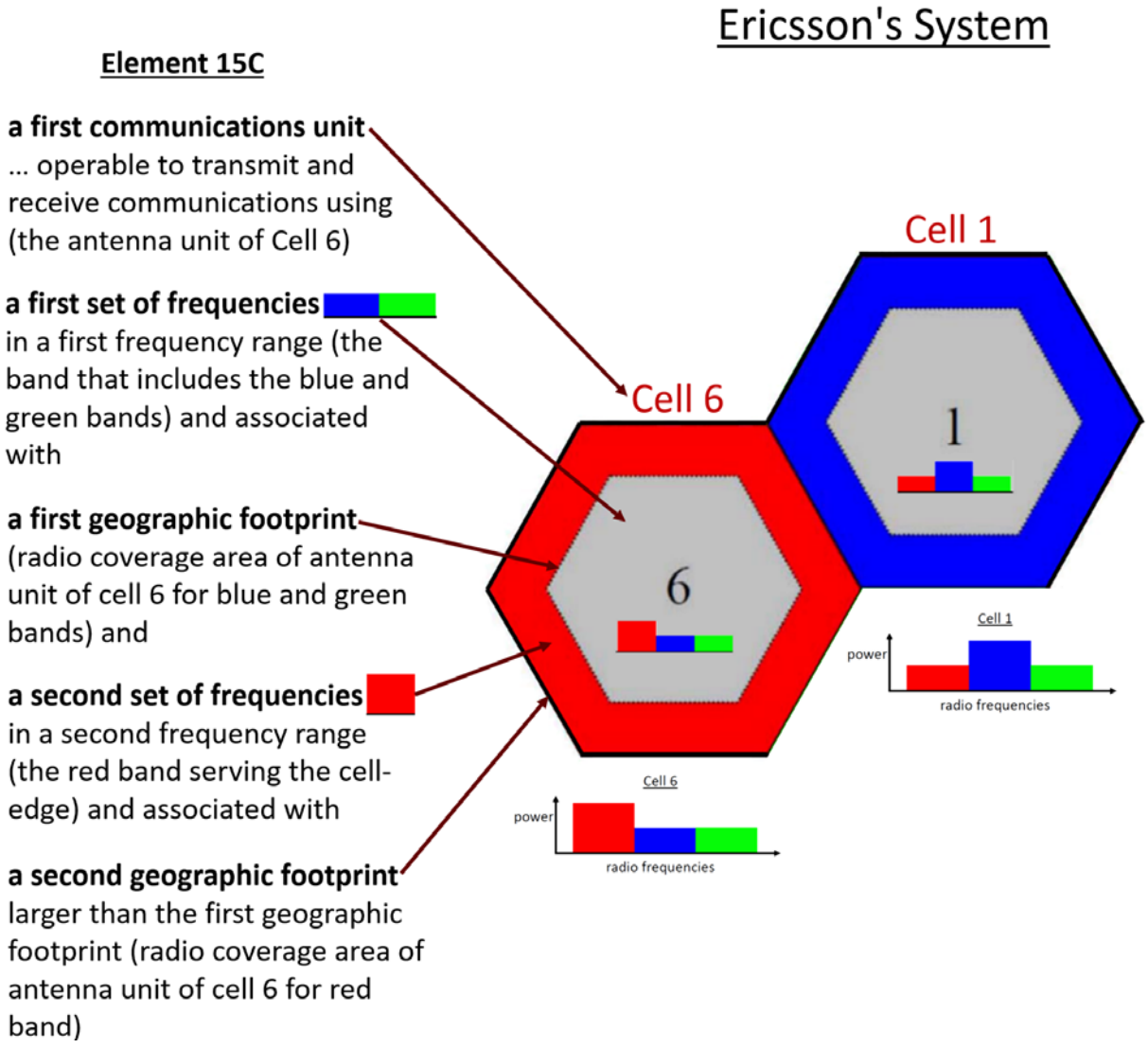
Fig. 2

313. Reasonable expectation of success of the proposed combination. A POSA would have a reasonable expectation that such a combination would be

successful. That DAS host units and corresponding transport links have been so long used in the art of DAS (Schwartz filed in 2000 more than a decade before the '358 patent) would lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that DAS host units are "typical" in DAS deployments and commonly employed at base station hotel. Ex. 1001 at 1:14-26. One of the most common reasons to employ a DAS, including DAS host unit and DAS links, is to prepare the signals for successful transport over longer distances to remote cell sites without degradation of the data carried on the signals.

c. Element 15C

314. Below I have illustrated how Element 15C reads on Ericsson's system.



315. That Ericsson discloses Element 15C is consistent with the same logic and reason under which Element 15C reads on the second embodiment of the '358 patent.

316. The first communications unit: The antenna unit that serves Ericsson's cell 6 (above), is "a first communications unit".

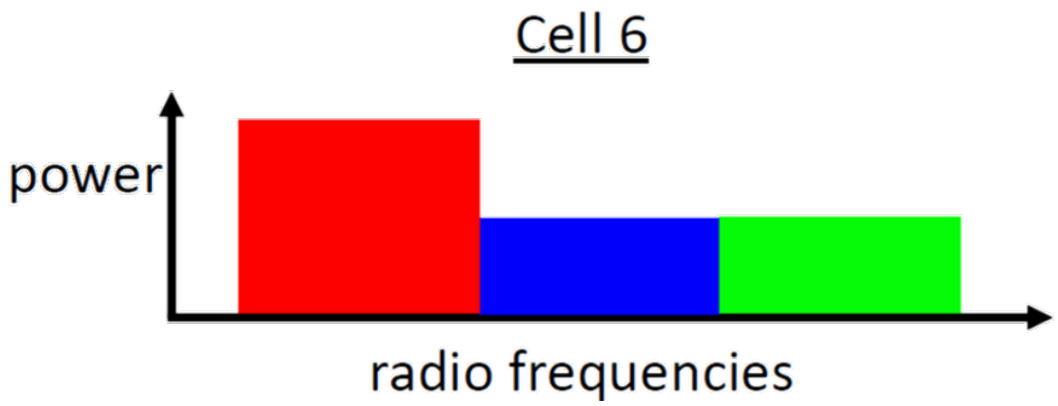
317. The first communications unit … operable to transmit and receive communications using **a first set of frequencies** in a first frequency range: In Ericsson's system, cell 6's antenna unit transmits a first set of frequencies in a first frequency range that includes blue and green bands. Ex. 1007 at 2, Fig. 2.

318. The first communications unit … operable to transmit and receive communications using a first set of frequencies in a first frequency range and associated with **a first geographic footprint**: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the blue and green bands is the "a first geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 6 (gray area) corresponds to the first geographic footprint.

319. The first communications unit … operable to transmit and receive communications using … **a second set of frequencies** in a second frequency range: In Ericsson's system, cell 6's antenna unit transmits a second set of frequencies in a second frequency range that includes the red band. Ex. 1007 at 2, Fig. 2.

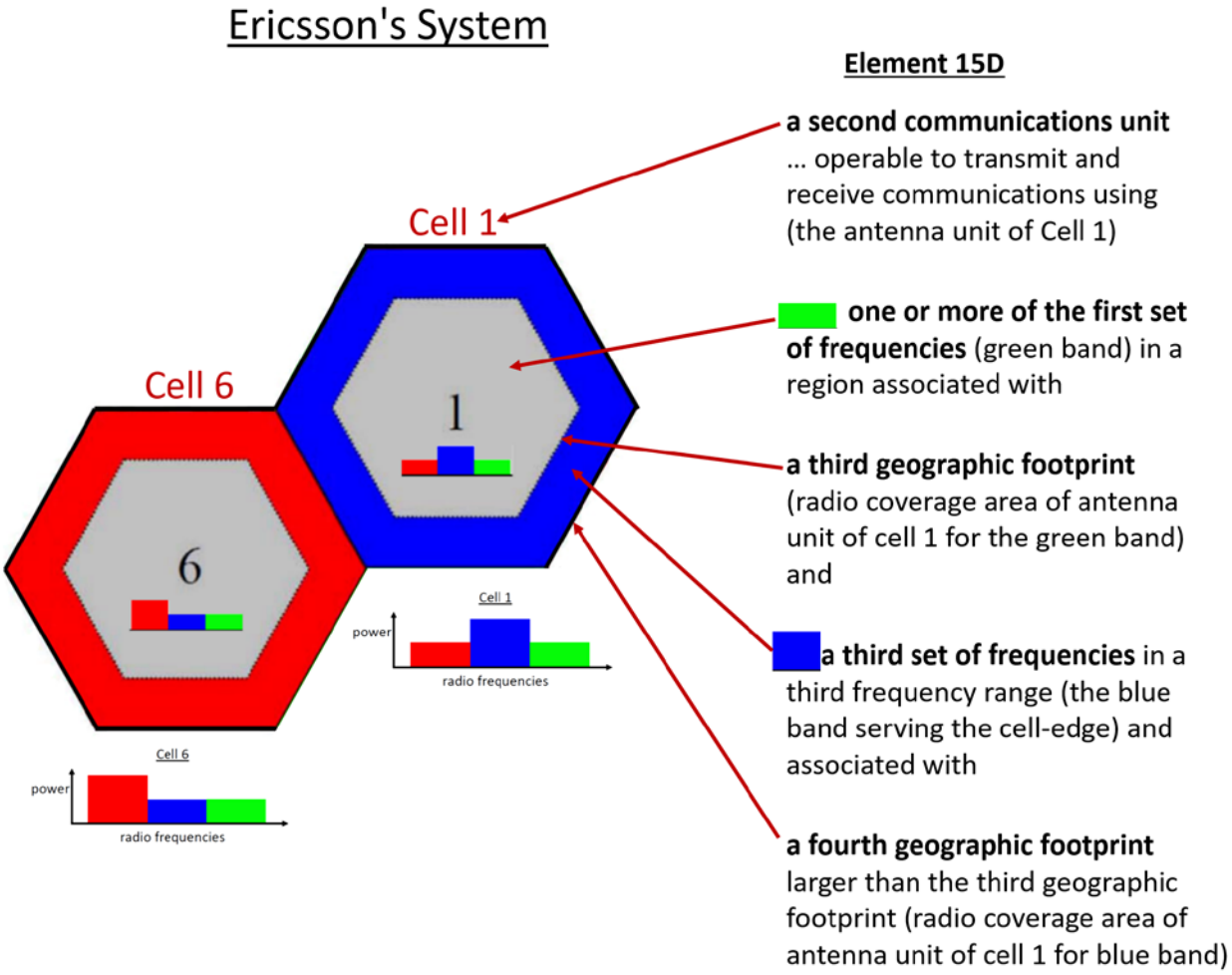
320. The first communications unit … operable to transmit and receive communications using … a second set of frequencies in a second frequency range and associated with **a second geographic footprint**: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the red band is "a second geographic footprint". As illustrated below, cell 6's antenna unit transmits the red band at a

higher power resulting in resulting in larger coverage area for the second geographic footprint. Ex. 1007 at 2, Fig. 2.



d. Element 15D

321. Below I have illustrated how Element 15D reads on Ericsson's system.



322. That Ericsson discloses Element 15D is consistent with the same logic and reason under which Element 15 reads on the second embodiment of the '358 patent.

323. The second communications unit: The antenna unit that serves Ericsson's cell 1 (above), is "a second communications unit".

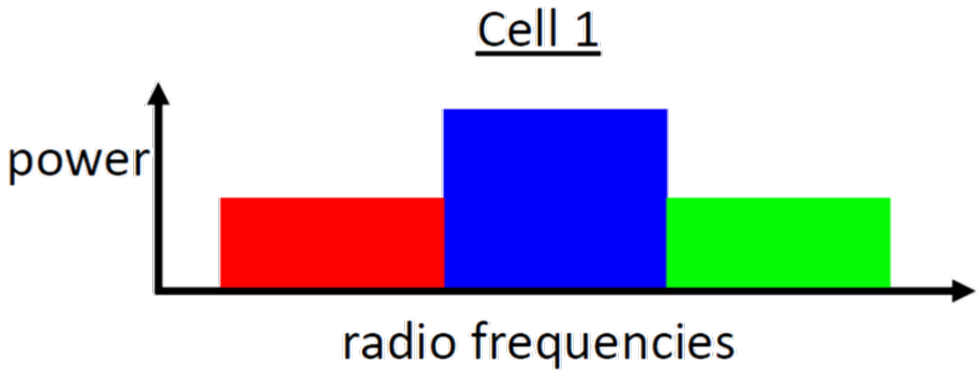
324. The second communications unit … operable to transmit and receive communications using **one or more of the first set of frequencies**: In Ericsson's

system, cell 1's antenna unit transmits one or more of the first set of frequencies (the green band). Ex. 1007 at 2, Fig. 2.

325. The second communications unit … operable to transmit and receive communications using one or more of the first set of frequencies in a region associated with **a third geographic footprint**: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the green band is "a third geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 1 (gray area) corresponds to the third geographic footprint.

326. The second communications unit … operable to transmit and receive communications using … **a fourth set of frequencies** including one or more frequencies in a third band: In Ericsson's system, cell 1's antenna unit transmits a fourth set of frequencies including one or more frequencies in a third band (blue band serving the cell-edge area). Ex. 1007 at 2, Fig. 2.

327. The second communications unit … operable to transmit and receive communications using … a fourth set of frequencies … and associated with **a fourth geographic footprint**: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the blue band is "a fourth geographic footprint". As illustrated below, cell 1's antenna unit transmits the blue band at a higher power resulting in resulting in larger coverage area for the fourth geographic footprint. Ex. 1007 at 2, Fig. 2.



6. Claim 17

17. The communications system of claim 15 wherein the communications using the first set of frequencies in the first frequency range are associated with a first power level and the communications using the second set of frequencies in the second frequency range are associated with a second power level greater than the first power level.

328. Ericsson discloses the limitations of claim 17 because cell 6's antenna unit transmits the red band at a power level that is higher than the power level used to transmit the blue and green bands. This results in the antenna unit having a larger radio coverage for the red band. Ex. 1007 at 2 (Section 3). Ericsson therefore discloses the limitations of claim 17.

7. Claim 18

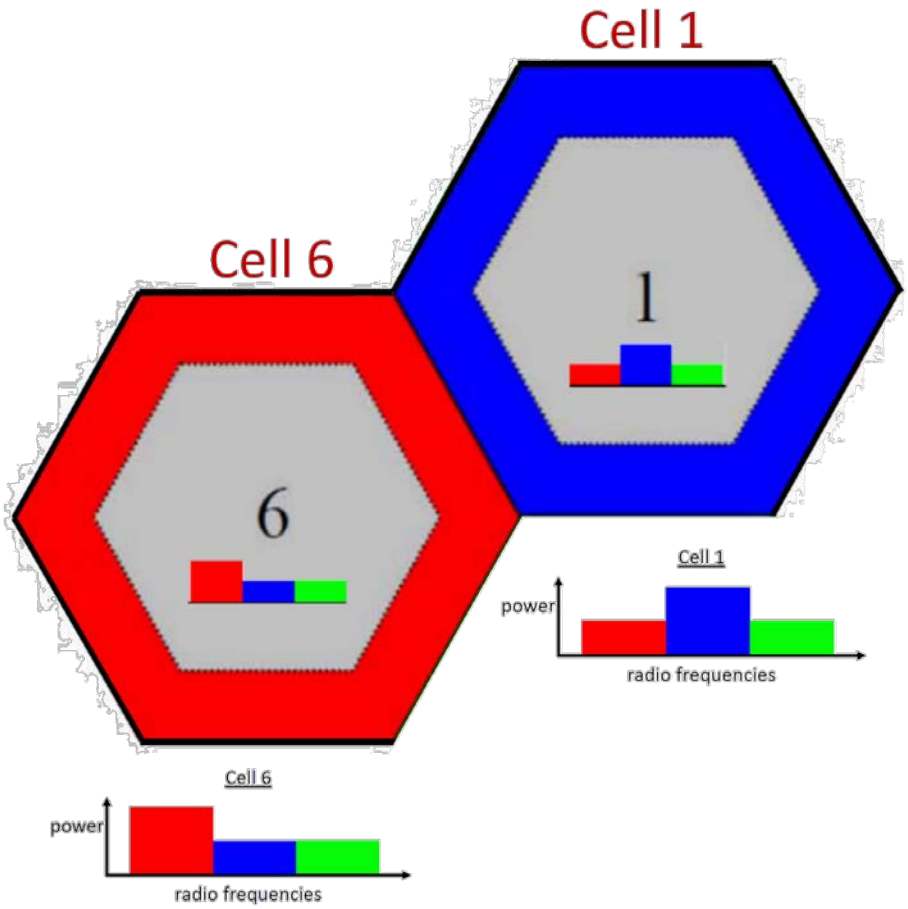
18. The communications system of claim 15 wherein the communications using one or more of the first set of frequencies in the region associated with a third geographical footprint are associated with a first power level and the communications using the third set of frequencies in the third frequency range are associated with a second power level greater than the first power level.

329. Ericsson discloses the limitations of claim 18 because cell 1's antenna unit transmits the blue band at a power level that is higher than the power level used to transmit the green band. This results in the antenna unit having a larger radio coverage for the blue band. Ex. 1007 at 2 (Section 3). Ericsson therefore discloses the limitations of claim 18.

8. Claim 20

The communications system of claim 15 wherein the first frequency band and the second frequency band are contiguous frequency bands.

330. Here it is unclear what claim 20 is referring to as "the first frequency band" and "the second frequency band." There is no prior recitation of frequency bands in claim 15 or claim 20. If these are construed to be referring to the first and second frequency ranges introduced in claim 15, then this limitation is disclosed by Ericsson. Ericsson discloses the limitations of claim 20 because, looking at the bands transmitted and received by cell 6's antenna unit, the first frequency band (the blue and green bands) and the second frequency band (the red band) are contiguous frequency bands.



9. Claim 21

The communications system of claim 15 wherein the first frequency range, the second frequency range, and the third frequency range include distinct frequencies.

331. Ericsson discloses the limitations of claim 21 because the first frequency band/range (blue and green bands), the second frequency band/range (red band), and the third frequency band/range (blue band) include distinct frequencies, i.e., green, red and blue respectively.

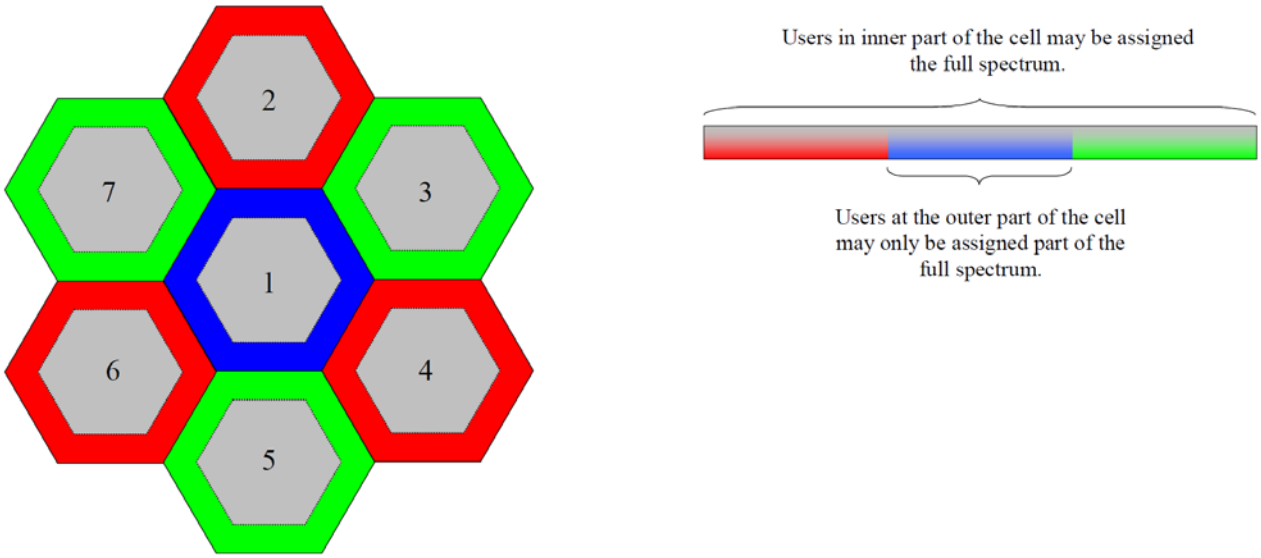
F. Ground 6: Ericsson in combination with Stratford renders claims 7, 8, 9, 11, 15, 17, 18, 20 and 21 obvious

332. Ericsson (Ex. 1007) addresses the problem of inter-cell inference. In Section 3, Ericsson discloses a frequency reuse technique in which "only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users ... ." *See* Ex. 1007 at 2, Fig. 2 (below). To achieve this, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area than bands used to cover a central area.

> Fractional reuse, also known as ***soft frequency reuse*** …, has been proposed as a means to increase the performance for cell-edge users. With fractional reuse, ***only a part of the total resources is used for transmission to/from cell-edge users***, thereby reducing the interference experienced by these users (at the cost of a reduced bandwidth). Typically, fractional reuse is implemented as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, ***only cell 1 is allowed to transmit with full power using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a reduced power***. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full

part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2 (emphasis added).



Ex. 1007 at 2, Fig. 2.

1. Claim 7

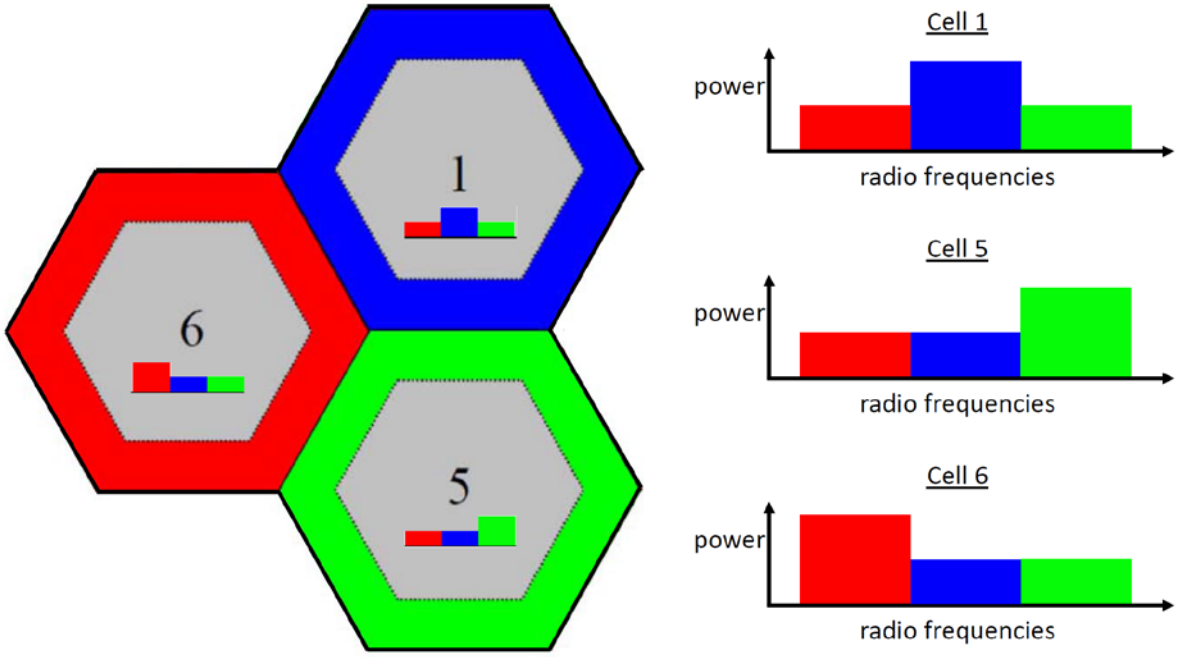
333. Ericsson discloses all the limitations of Elements 7B, 7C, and 7D. If the preamble (Element 7A) of claim 7 is construed to be limited to a distributed antenna system, then Ericsson's discussion of fractional reuse (Ex. 1007 at 2) does not show or describe the use of a DAS or a host unit (e.g., as required by claims 8, 15) to distribute radio resources from a remote location such as a base station hotel to each cell's respective antenna unit. However, based on Ericsson alone, it would have been obvious to modify Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a

DAS that includes a DAS host and transport links for distributing radio resources to the distributed antenna units of Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

a. Element 7A

"A method of distributing communications frequencies"

334. Ericsson discloses a cellular communication system that distributes communications frequencies in a way that implements a frequency reuse technique for "reducing the interference experienced by these users … ." Ex. 1007 at 2 (Section 3). Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme, i.e., soft frequency reuse (SFR) in the same way as Figs. 1C & 1F of the '358 patent. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ericsson at 2 (e.g., "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").



335. One of skill in the art reading Ericsson understands that the cells depicted by Ericsson inherently include one or more antenna units within each cell for wirelessly transmitting and receiving signals within the radio frequency bands shown in Figure 2. In addition, Ericsson's illustration of the Figure 2 of symmetrical concentric inner and outer areas for each cell in combination with the description that these are generated using two different power levels, would inherently indicate to one of skill in the art that each cell in Figure 2 includes a centrally located antenna unit that creates the concentric inner and outer coverage areas.

336. If the preamble of claim 7 is construed to be limited to a distributed antenna system, Ericsson's discussion of fractional reuse (Ex. 1007 at 2) does not

show or describe the use of a DAS or a DAS host to distribute radio resources from a remote location such as a base station hotel to each cell's respective antenna unit. However, based on Ericsson alone, it would have been obvious to modify Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a DAS that includes a DAS host and transport links for distributing radio resources to the distributed antenna units of Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

337. Particularly in densely populated areas (e.g., metropolitan areas) a POSA would have known that, for cost and efficiency reasons as well as lack of access to cell site property, POSA in reviewing Ericsson would have understood (a) that it was common to locate the base station equipment remote from the cell sites (commonly known as a base station hotel) and (b) that a host unit would have been commonly employed at the base station hotel to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. This background is reinforced in the background section of the '358 patent.

BACKGROUND OF THE INVENTION

> Wireless communication systems employing Distributed Antenna Systems (DAS) are available. A DAS typically includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units. A radio base station is often employed at the host unit location commonly known as a

> base station hotel, and the DAS provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units. The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable.

Ex. 1001 at 1:14-26.

338. That a POSA would have known that it was common in densely populated areas to house the base station equipment at a site remote from the cells and employ a DAS host and DAS links to transport the RF signal to the cell sites is also reinforced by the background DAS prior art. *See* Sabat (Ex. 1014); Schwartz (Ex. 1008); Stratford (Ex. 1009) ("The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. In these types of areas it is getting increasingly more difficult to deploy new cell sites due to a variety of factors including regulatory and space constraint issues."); Stapleton (Ex. 1010) discussed above at Section VII.B.1.

339. For a deployment of an Ericsson system in which the base station had to be located a long distance from the remote antenna units, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

340. Alternatively, it would have been obvious in view of Stratford combine Ericsson with a DAS.

341. Based on Stratford (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

342. Based on Stratford, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems such as Ericsson's system: (a) the base station equipment often must be located remote from the cell sites (commonly referred to as a Base Station Hotel as noted in the background of the '358 patent) and (b) for such deployments, a DAS host unit (e.g., "Digital Hub 310" of Stratford Fig. 3) as taught by Stratford would facilitate more efficient transport of radio resources to Ericsson's cells. Stratford explains the problem:

> Traditionally, a cellular communications system includes multiple remote sites, each providing wireless service to a geographic service area, or cell. As shown in FIG. 1, a cellular base station (BTS) is normally located in each remote site 100 together with an antenna tower, antennas, an equipment room, and a number of other relevant components. This traditional approach of deploying all

> the cell site equipment locally at each remote site has several drawbacks that contribute to the expense of the infrastructure, and upgrades to the infrastructure. At each remote site, a BTS room or cabinet to host the large base station equipment is required, as well as additional electric power supplies for the base station. This increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment. The remote cell site equipment must be designed for future coverage and capacity growth, and upgrades to the equipment require physical access to the remote site.

Ex. 1009 at 1:26-43.

343. To mitigate these problems, Stratford teaches to house the base stations at a remote location (i.e., a base station hotel) and employ a DAS that includes a DAS hub or host unit and DAS transport links for distributing radio resources to the antenna units of the remote cell sites.

> To mitigate these problems, some cellular systems have been designed with a different architecture, as shown in FIG. 2. The base stations 240 for multiple remote sites 200 are centralized in a base station hotel 210, while the antenna towers and antennas remain located at various remote sites at a distance from the base station hotel. Separating the base stations 240 from the antennas, however, makes it necessary to transport RF signals between the base station hotel and the various cell sites that it serves, typically using signal converters 250, network interface equipment 260, and a broadband communication network 220. When broadband fiber optic cables are used, RF signals from the base stations are converted to optical format and communicated over the fiber optic cable and then converted back to analog RF signals at the remote sites. After the optical/RF conversion, the signal is sent to one of several sector

> transmitters 230 and radiated over the air via the antenna to provide cellular coverage. The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. In these types of areas it is getting increasingly more difficult to deploy new cell sites due to a variety of factors including regulatory and space constraint issues.

Ex. 1009 at 1:44-65.

344. As in the background of the '358 patent, Stratford teaches that the DAS host or hub can be employed at the base station hotel.

> In one aspect of the invention, a method of downlink wireless communication is implemented by a system comprising a base station hotel, at least one remote site, and a digital data network (e.g., a fiber optic network) connecting the hotel to the remote site. The base station hotel houses a plurality of base stations and a digital hub which connects the base stations to the digital network.

Ex. 1009 at 3:9-15, Figs. 3, 6.

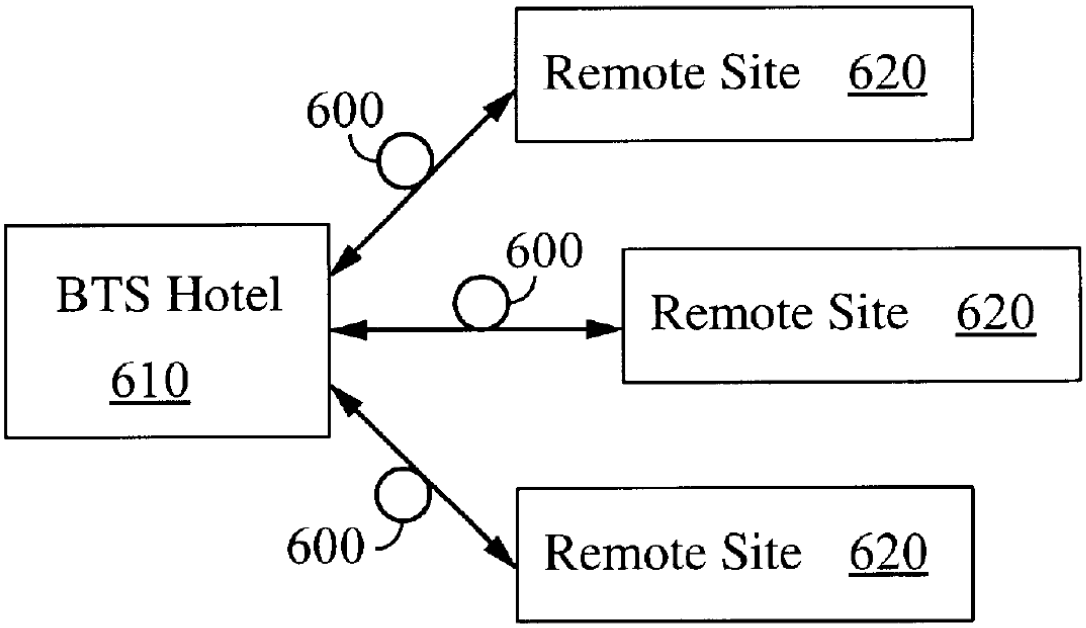


FIG. 6

Ex. 1009 at Fig. 6.

345. Based on Stratford, for those deployments of Ericsson's system in which the base station had to be located a long distance from cell sites (i.e., metropolitan areas as discussed in Stratford), the well-known benefit of including a DAS host unit and DAS links to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

346. For such deployments, Stratford's teaches to use a digital hub or host unit (e.g., "Digital Hub 310") as an interface between one or more base stations (i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units.

> A block diagram of a wireless communication system implementing the techniques of a preferred embodiment of the present invention is shown in FIG. 3. A series of base stations (BTS) reside in a BTS hotel 300. The base stations are connected to a digital hub 310 that also resides in the BTS hotel. The digital hub 310 is connected via a digital network 320 to one or more remote sites 330.

Ex. 1009 at 6:29-35, Figs. 3.

347. Stratford explains the purpose of including a digital hub at the base station hotel.

> The digital hub acts as the interface between the base stations and the digital network. Its main purpose is to convert downlink analog RF signals into a digital format that is compatible with the network, and to extract uplink digital signals from the network and convert them back to analog RF signals.

Ex. 1009 at 13:10-15.

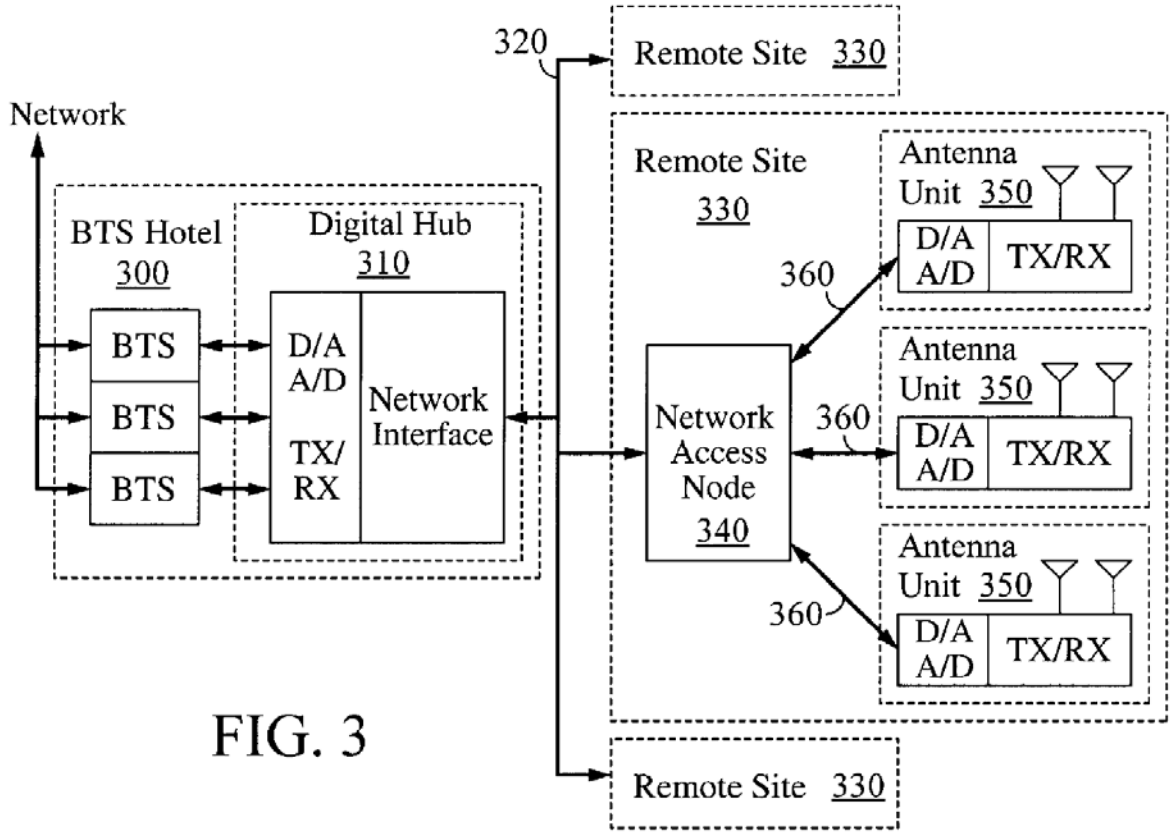


FIG. 3

348. In describing the preferred embodiment, Stratford indicates that each remote site 330 has "**one** or more sector antenna units 350 … ." Ex. 1009 at 8:50-51.

349. The antenna unit 350 within a first remote cell site is a first communication unit of claim 7. The antenna unit 350 within a second remote cell site is a second communication unit according to claim 7. Together they are an example of "providing a set of communications units" according to claim 7.

350. I have annotated Figure 3 from Stratford below to identify the communications units (annotated to show only one antenna unit at middle remote site 330). Note that for simplicity, I have assumed there is one antenna unit in each of two remote sites as taught by Stratford where he teaches "one or more" antenna units at each remote cell site. Ex. 1009 at 8:45-53. However, the claims are obvious whether applied to Stratford's teaching of one antenna unit at the cell site or multiple antenna units at the cell site. In other words, the first communications unit can be a single antenna unit 350 at the cell site or can be a collection of multiple antenna units 350 at the cell site.

Annotated Figure 3 where each remote cell site has one antenna unit 350.

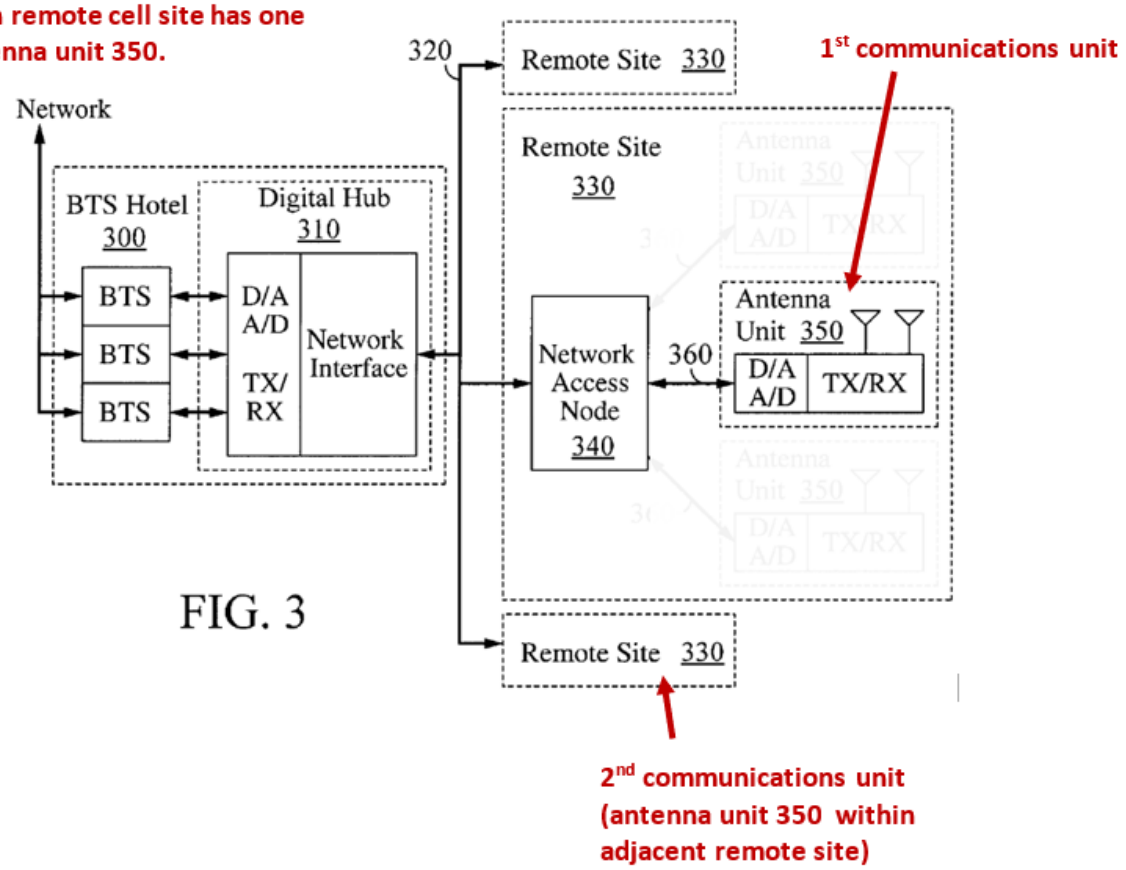
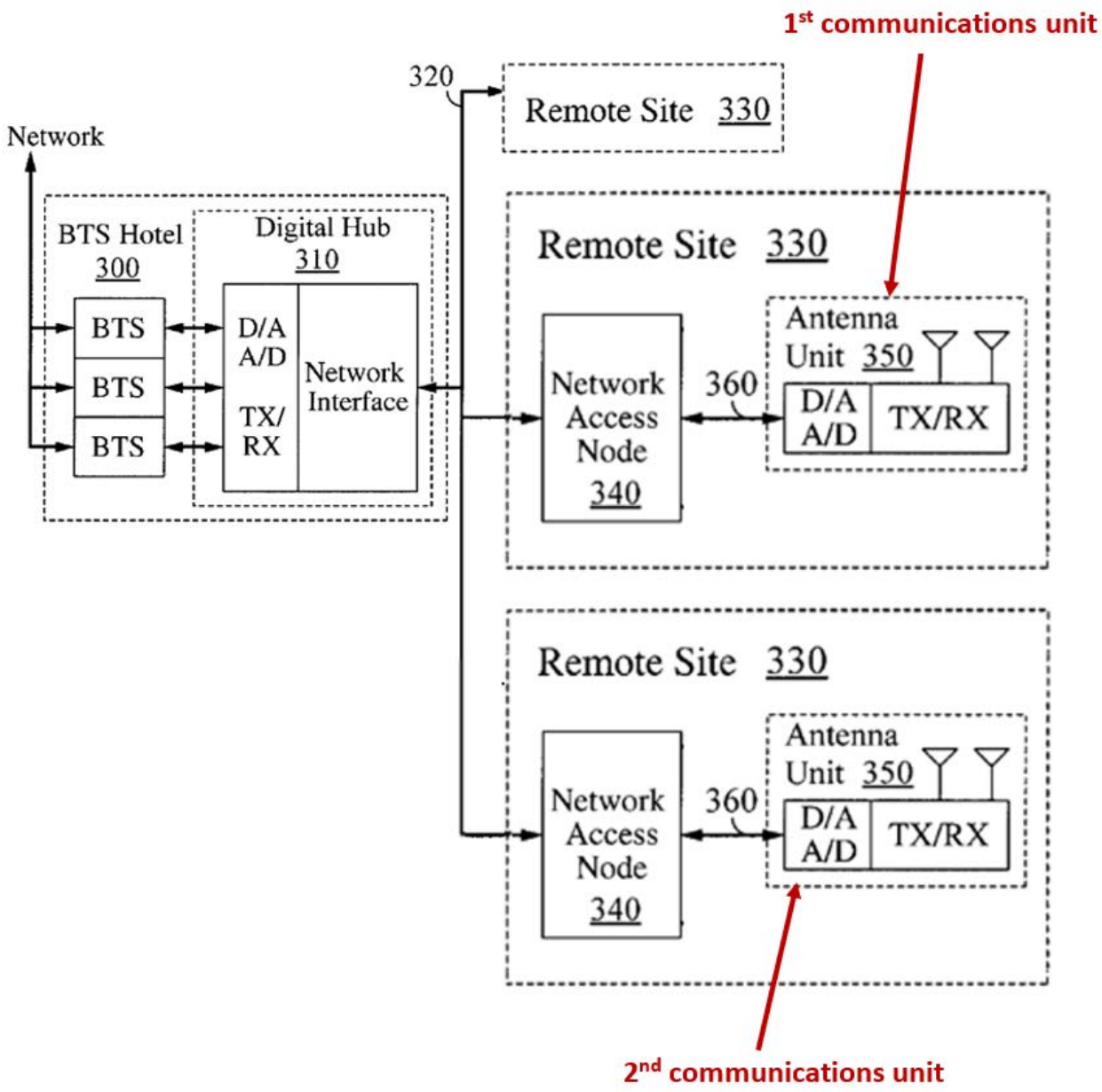


FIG. 3

351. The same set of communications units can be illustrated by simply repeating the details given for the first remote site inside the second remote site as I have illustrated below.



352. Together the first and second antenna units identified above constitute a set of communications units according to claim element 7B.

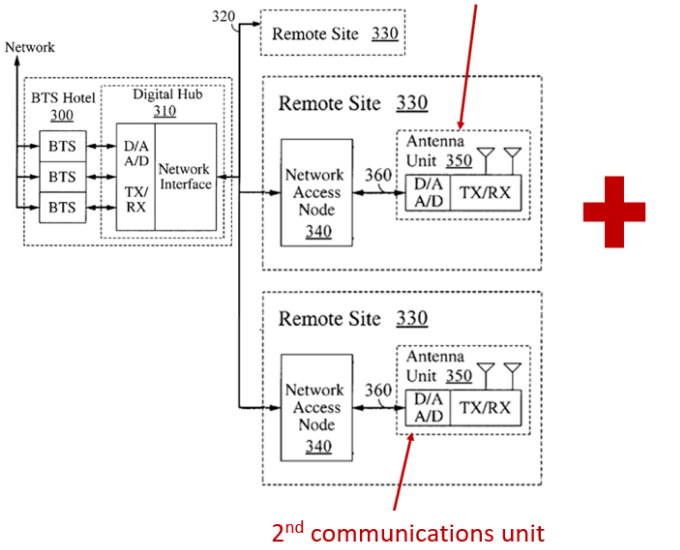
353. I have illustrated this combination of Ericsson and Stratford below. Further, one of skill would be motivated to use a host unit or hub as taught by Stratford that is not integral with one base station so that the host unit could serve

and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

354. I have illustrated this combination of Ericsson and Stratford below.

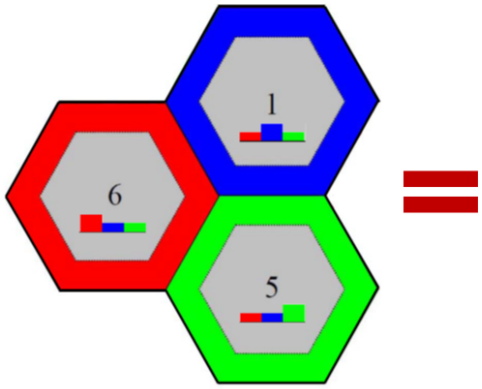
Stratford

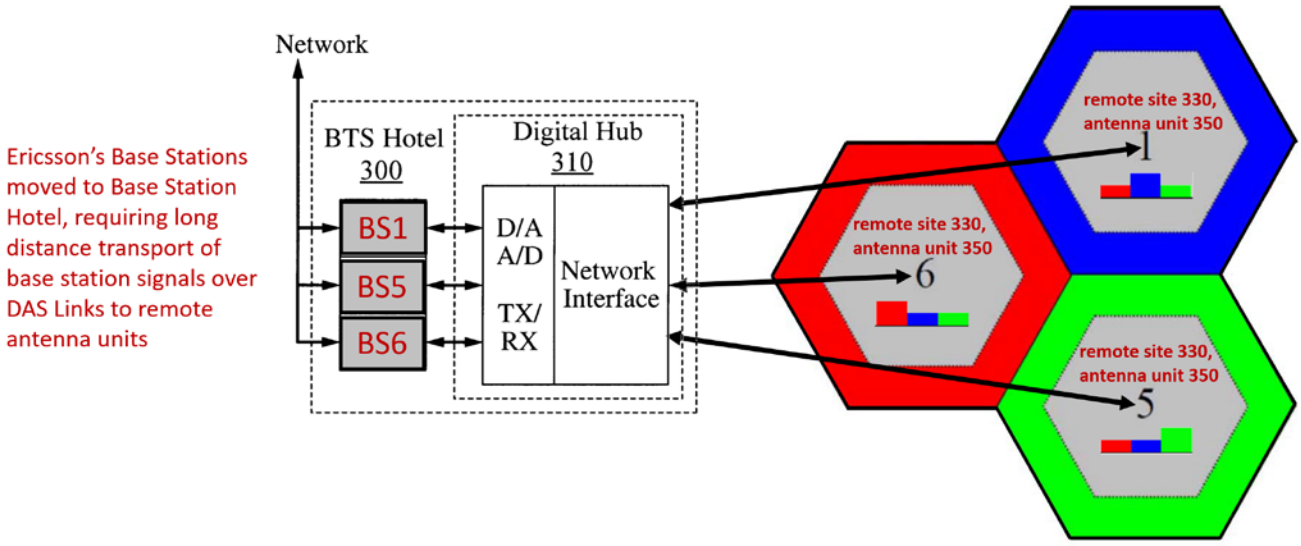
(illustrated to show each remote site 330 having one antenna unit, e.g., col. 8:45-51 stating: "At each remote site 330, the NAN 340 branches out to **one** or more sector antenna units … .")



Ericsson

(Cells 1, 5 and 6 of Ericsson Figure 2)





355. Reasonable expectation of success of the proposed combination. That a POSA would have a reasonable expectation that such a combination would be successful is reinforced by Stratford, stating that the "BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium." Ex. 1009 at 1:60-63. That DAS host units and corresponding transport links have been so long used in the art of DAS (Stratford filed in 2002 and Schwartz filed in 2000) would also lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that DAS host units are "typical" in DAS deployments and commonly employed at base station hotel. Ex. 1001 at 1:14-26. One of the most common reasons to employ a DAS, including DAS host unit and DAS links, is to

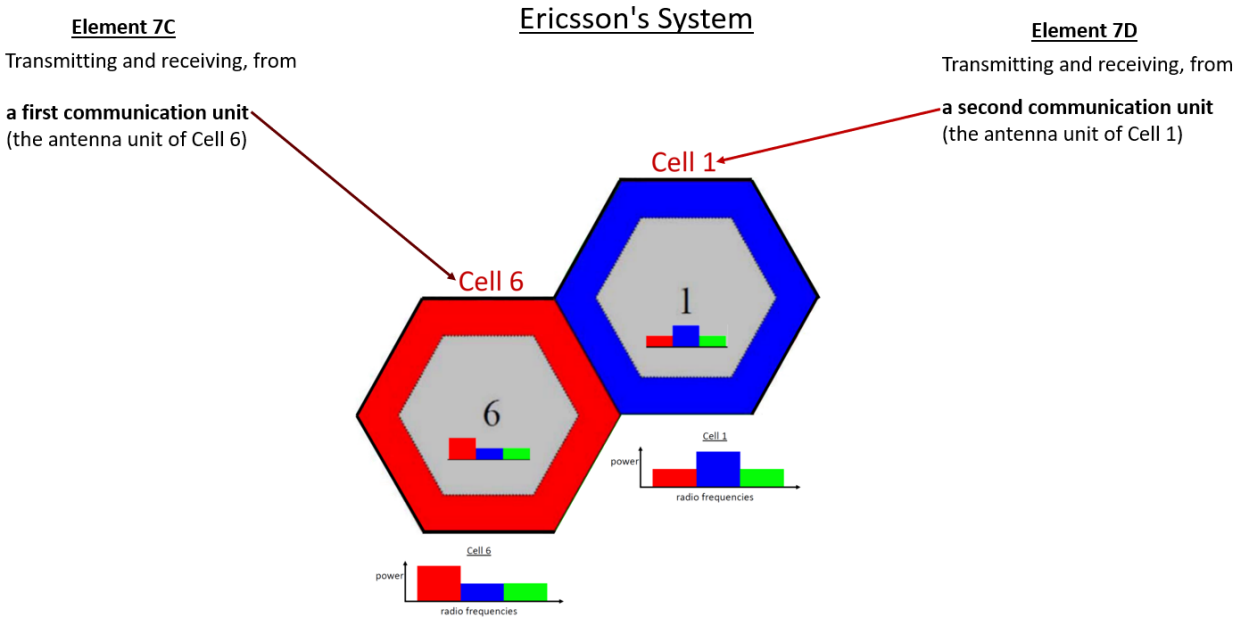
prepare the signals for successful transport over longer distances to remote cell sites without degradation of the data carried on the signals.

b. Element 7B

"providing a set of communications units;" that includes "a first communications unit" (from element 7C) and "a second communications unit" (from element 7D)

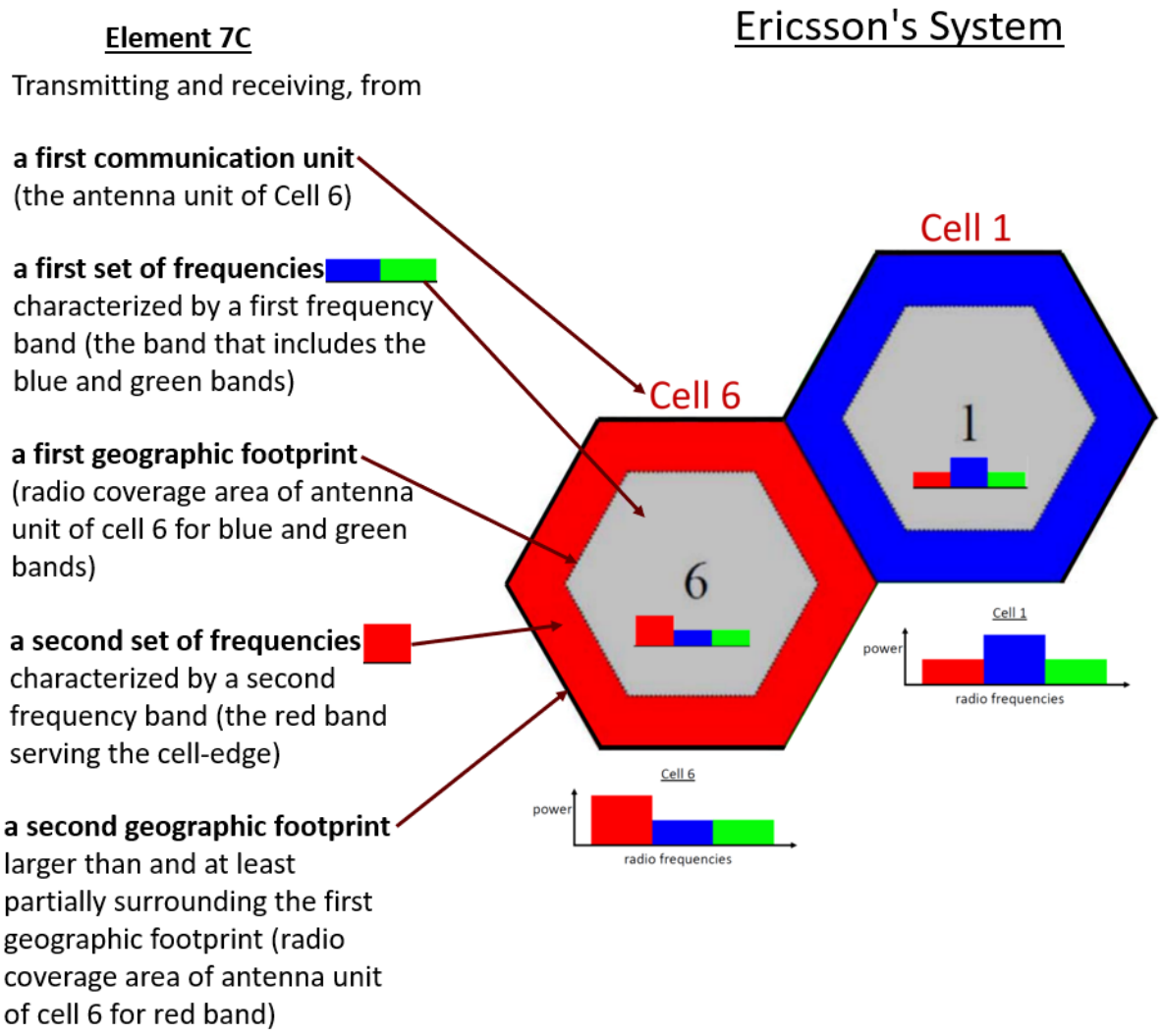
356. Cell 1 and Cell 6 from Ericsson's system are reproduced below (annotated) for comparing to the limitations of claim 7.

357. In Ericsson, the antenna unit that serves cell 6 is a "first communications unit" (below, left), and the antenna unit that serves cell 1 is a "second communications unit" (below, right). Ericsson's first and second communications units satisfy "a set of communications units" of Element 7B.



c. Element 7C

358. Below I have illustrated how Element 7C reads on Ericsson's system.



359. That Ericsson discloses Element 7C is consistent with the same logic and reason under which Element 7C reads on the second embodiment of the '358 patent. See mapping to of claim 7 to the second embodiment of the '358 patent at Section VI.D of my declaration.

360. The first communications unit: The antenna unit that serves Ericsson's cell 6 (above), is "a first communications unit".

361. Transmitting and receiving ... a first set of frequencies characterized by a first frequency band: In Ericsson's system, cell 6's antenna unit transmits a first set of frequencies characterized by a first frequency band that includes the blue and green bands. Ex. 1007 at 2, Fig. 2.

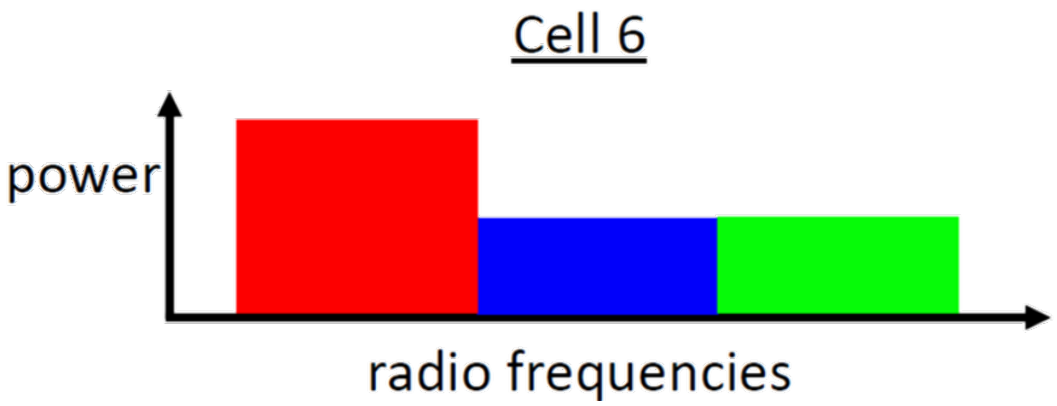
362. Transmitting and receiving ... a first set of frequencies characterized by ... a first geographic footprint: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the blue and green bands is the "a first geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 6 (gray area) corresponds to the first geographic footprint.

363. Transmitting and receiving ... a second set of frequencies characterized by a second frequency band: In Ericsson's system, cell 6's antenna unit transmits a second set of frequencies characterized by a second frequency band (red band). Ex. 1007 at 2, Fig. 2.

364. Transmitting and receiving ... a second set of frequencies characterized by ... a second geographic footprint larger than and at least partially surrounding the first geographic footprint: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the red band is "a second geographic footprint". As illustrated below, cell 6's antenna unit transmits the red band at a higher power

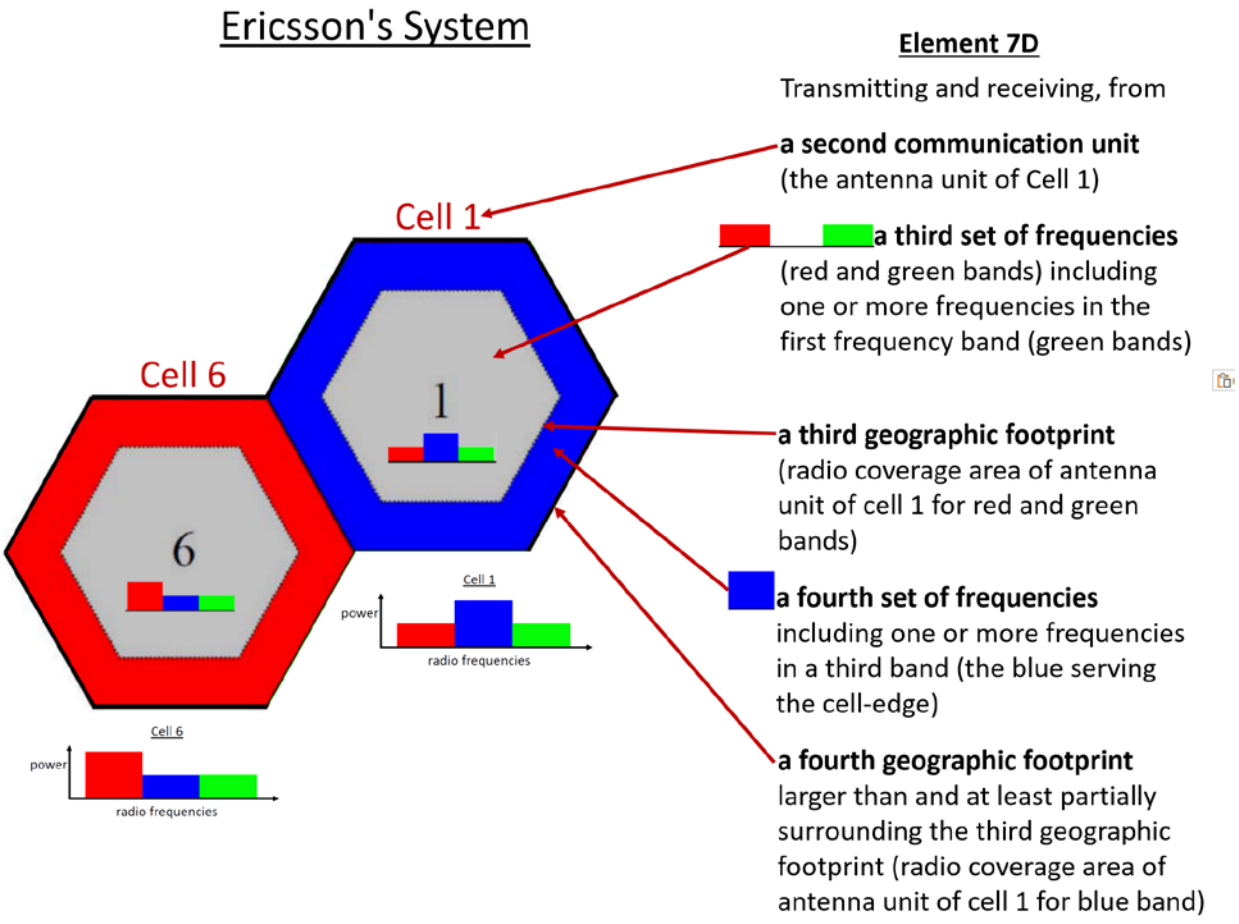
resulting in resulting in larger coverage area for the second geographic footprint.

Ex. 1007 at 2, Fig. 2.



d. Element 7D

365. Below I have illustrated how Element 7D reads on Ericsson's system.



366. That Ericsson discloses Element 7D is consistent with the same logic and reason under which Element 7D reads on the second embodiment of the '358 patent. See mapping to of claim 7 to the second embodiment of the '358 patent at Section VI.D of my declaration.

367. The second communications unit: The antenna unit that serves Ericsson's cell 1 (above), is "a second communications unit".

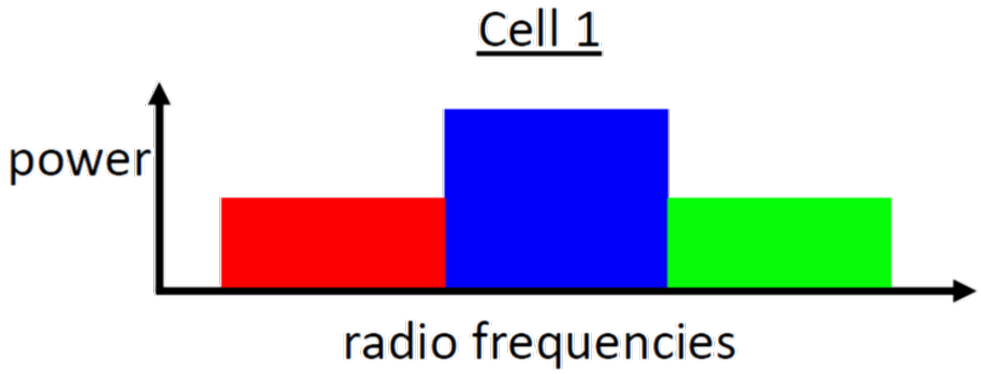
368. Transmitting and receiving ... a third set of frequencies including one or more frequencies in the first frequency band: In Ericsson's system, cell 1's

antenna unit transmits a third set of frequencies (red and green bands) that include one or more frequencies in the first frequency band (the green band). Ex. 1007 at 2, Fig. 2.

369. Transmitting and receiving ... a third set of frequencies ... in ... a third geographic footprint: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the red and green bands is "a third geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 1 (gray area) corresponds to the third geographic footprint.

370. Transmitting and receiving ... a fourth set of frequencies including one or more frequencies in a third band: In Ericsson's system, cell 1's antenna unit transmits a fourth set of frequencies including one or more frequencies in a third band (blue band serving the cell-edge area). Ex. 1007 at 2, Fig. 2.

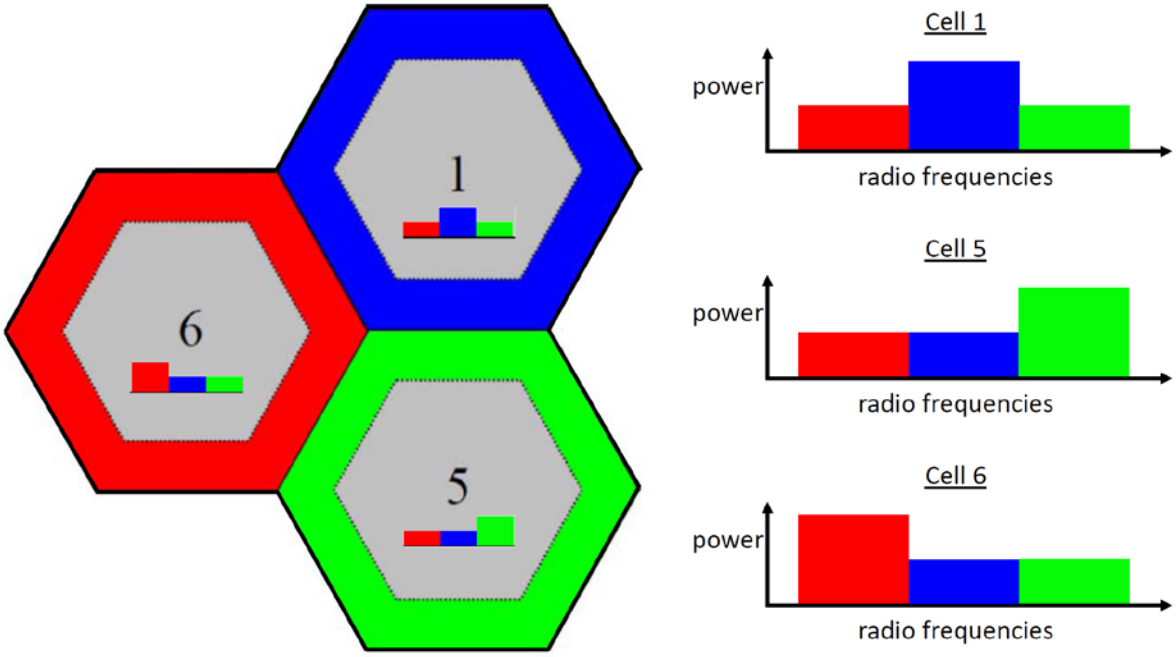
371. Transmitting and receiving ... a fourth set of frequencies ... in ... a fourth geographic footprint larger than and at least partially surrounding the third geographic footprint: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the blue band is "a fourth geographic footprint". As illustrated below, cell 1's antenna unit transmits the blue band at a higher power resulting in resulting in larger coverage area for the fourth geographic footprint. Ex. 1007 at 2, Fig. 2.



2. Claim 8

The method of claim 7 wherein the set of communications units includes a plurality of remote units in communication with a host unit.

372. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme, i.e., soft frequency reuse (SFR) in the same way as Figs. 1C & 1F of the '358 patent. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ericsson at 2 (e.g., "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").



373. As discussed for Element 7A of claim 7, in Ericsson's discussion of fractional reuse (Ex. 1007 at 2), Ericsson does not show or describe the use of a DAS or a DAS host to distribute radio resources from a remote location to the cell sites.

374. Based on Ericsson alone, it would have been obvious to modify Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a DAS that includes a DAS host and transport links for distributing radio resources to the distributed antenna units of Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

375. Particularly in densely populated areas, a POSA would have known that, for cost and efficiency reasons as well as lack of access to cell site property, POSA in reviewing Ericsson would have understood (a) that it was common to locate the base station equipment remote from the cell sites (commonly known as a base station hotel) and (b) that a host unit would have been commonly employed at the base station hotel to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. This background is reinforced in the background section of the '358 patent.

> BACKGROUND OF THE INVENTION
>
> Wireless communication systems employing Distributed Antenna Systems (DAS) are available. A DAS typically includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units. A radio base station is often employed at the host unit location commonly known as a base station hotel, and the DAS provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units. The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable.

Ex. 1001 at 1:14-26.

376. That a POSA would have known that it was common in densely populated areas to house the base station equipment at a site remote from the cells and employ a DAS host and DAS links to transport the RF signal to the cell sites is also reinforced by the background DAS prior art. *See* Sabat (Ex. 1014); Schwartz

(Ex. 1008); Stratford (Ex. 1009); Stapleton (Ex. 1010) discussed above at Section VII.B.1.

377. For a deployment of an Ericsson system in which the base station had to be located a long distance from the remote antenna units, the well-known benefit of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

378. Alternatively, it would have been obvious in view of Stratford combine Ericsson with a DAS.

379. Based on Stratford (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

380. Based on Stratford, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems such as Ericsson's system: (a) the base station

equipment often must be located remote from the cell sites (commonly referred to as a Base Station Hotel as noted in the background of the '358 patent) and (b) for such deployments, a DAS host unit (e.g., "Digital Hub 310" of Stratford Fig. 3) as taught by Stratford would facilitate more efficient transport of radio resources to Ericsson's cells. Stratford explains the problem:

> Traditionally, a cellular communications system includes multiple remote sites, each providing wireless service to a geographic service area, or cell. As shown in FIG. 1, a cellular base station (BTS) is normally located in each remote site 100 together with an antenna tower, antennas, an equipment room, and a number of other relevant components. This traditional approach of deploying all the cell site equipment locally at each remote site has several drawbacks that contribute to the expense of the infrastructure, and upgrades to the infrastructure. At each remote site, a BTS room or cabinet to host the large base station equipment is required, as well as additional electric power supplies for the base station. This increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment. The remote cell site equipment must be designed for future coverage and capacity growth, and upgrades to the equipment require physical access to the remote site.

Ex. 1009 at 1:26-43.

381. To mitigate these problems, Stratford teaches to house the base stations at a remote location (i.e., a base station hotel) and employ a DAS that includes a DAS hub or host unit and DAS transport links for distributing radio resources to the antenna units of the remote cell sites.

> To mitigate these problems, some cellular systems have been designed with a different architecture, as shown in FIG. 2. The base stations 240 for multiple remote sites 200 are centralized in a base station hotel 210, while the antenna towers and antennas remain located at various remote sites at a distance from the base station hotel. Separating the base stations 240 from the antennas, however, makes it necessary to transport RF signals between the base station hotel and the various cell sites that it serves, typically using signal converters 250, network interface equipment 260, and a broadband communication network 220. When broadband fiber optic cables are used, RF signals from the base stations are converted to optical format and communicated over the fiber optic cable and then converted back to analog RF signals at the remote sites. After the optical/RF conversion, the signal is sent to one of several sector transmitters 230 and radiated over the air via the antenna to provide cellular coverage. The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. ***In these types of areas it is getting increasingly more difficult to deploy new cell sites*** due to a variety of factors including regulatory and ***space constraint issues***.

Ex. 1009 at 1:44-65.

382. Based on Stratford, for those deployments of Ericsson's system in which the base station had to be located a long distance from cell sites (i.e., metropolitan areas as discussed in Stratford), the well-known benefit of including a DAS host unit and DAS links to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate

DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

383. For such deployments, Stratford's teaches to use a digital hub or host unit (e.g. "Digital Hub 310") as an interface between one or more base stations (i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units.

> A block diagram of a wireless communication system implementing the techniques of a preferred embodiment of the present invention is shown in FIG. 3. A series of base stations (BTS) reside in a BTS hotel 300. The base stations are connected to a digital hub 310 that also resides in the BTS hotel. The digital hub 310 is connected via a digital network 320 to one or more remote sites 330.

Ex. 1009 at 6:29-35, Figs. 3.

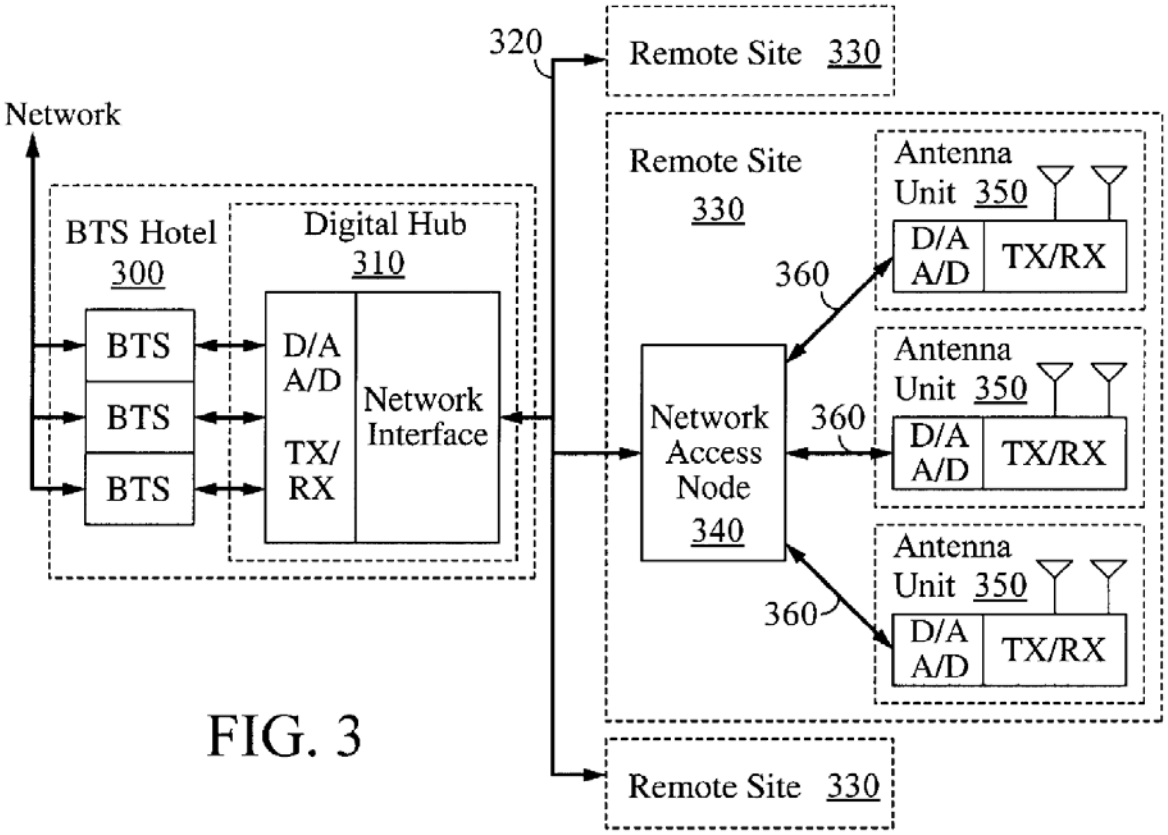


FIG. 3

As in the background of the ‘358 patent, Stratford teaches that the DAS host or hub can be employed at the base station hotel.

> In one aspect of the invention, a method of downlink wireless communication is implemented by a system comprising a base station hotel, at least one remote site, and a digital data network (e.g., a fiber optic network) connecting the hotel to the remote site. The base station hotel houses a plurality of base stations and a digital hub which connects the base stations to the digital network.

Ex. 1009 at 3:9-15, Figs 3 and 6.

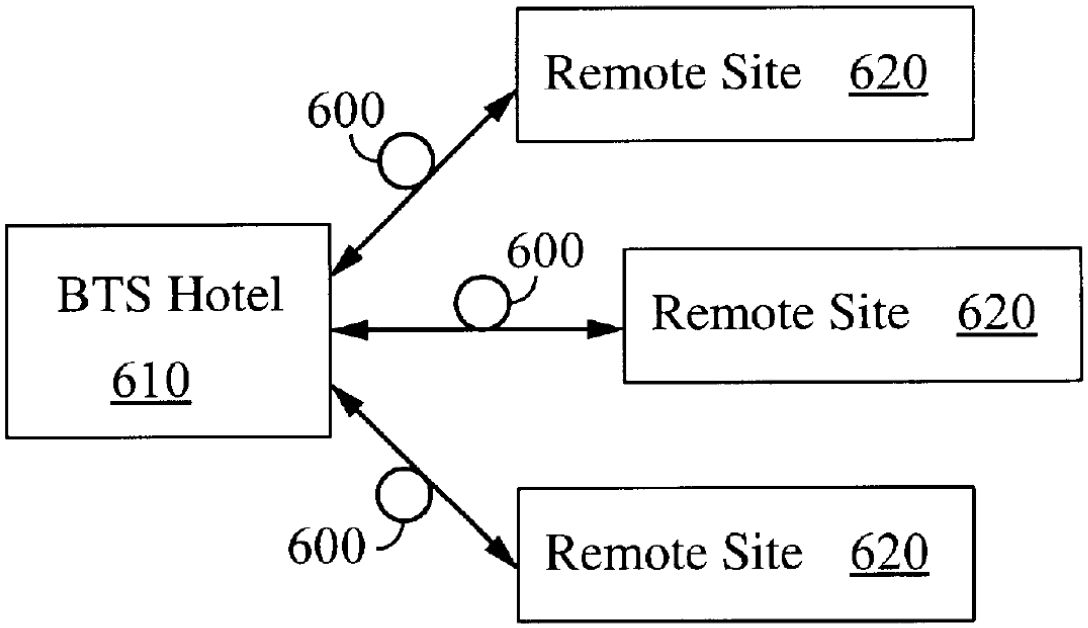


FIG. 6

384. Stratford explains the purpose of including a digital hub at the base station hotel.

> The digital hub acts as the interface between the base stations and the digital network. Its main purpose is to convert downlink analog RF signals into a digital format that is compatible with the network, and to extract uplink digital signals from the network and convert them back to analog RF signals.

Ex. 1009 at 13:10-15.

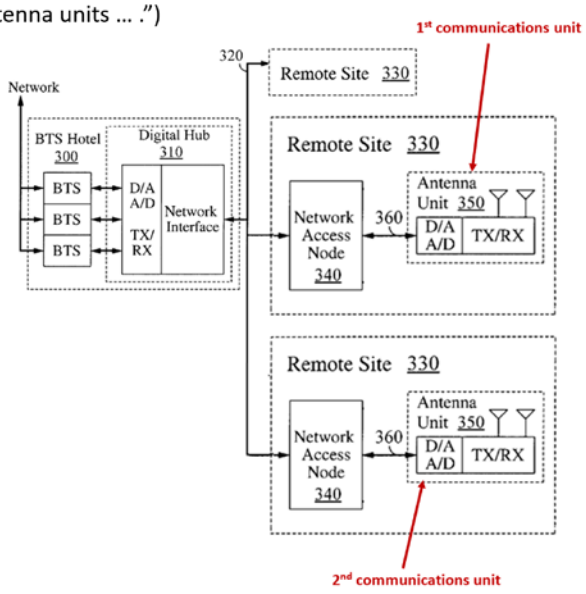
385. I have illustrated this combination of Ericsson and Stratford below. Further, one of skill would be motivated to use a host unit or hub as taught by Stratford that is not integral with one base station so that the host unit could serve

and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

386. I have illustrated this combination of Ericsson and Stratford below.

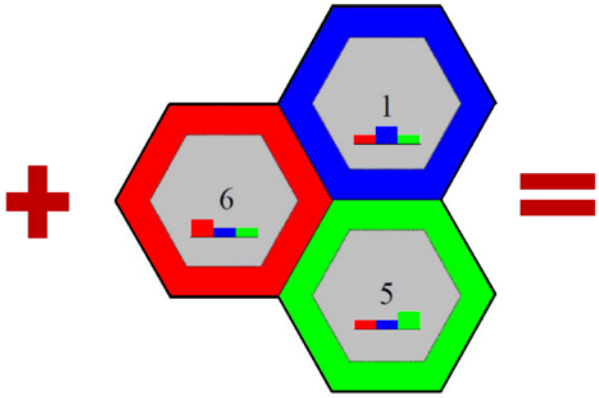
Stratford

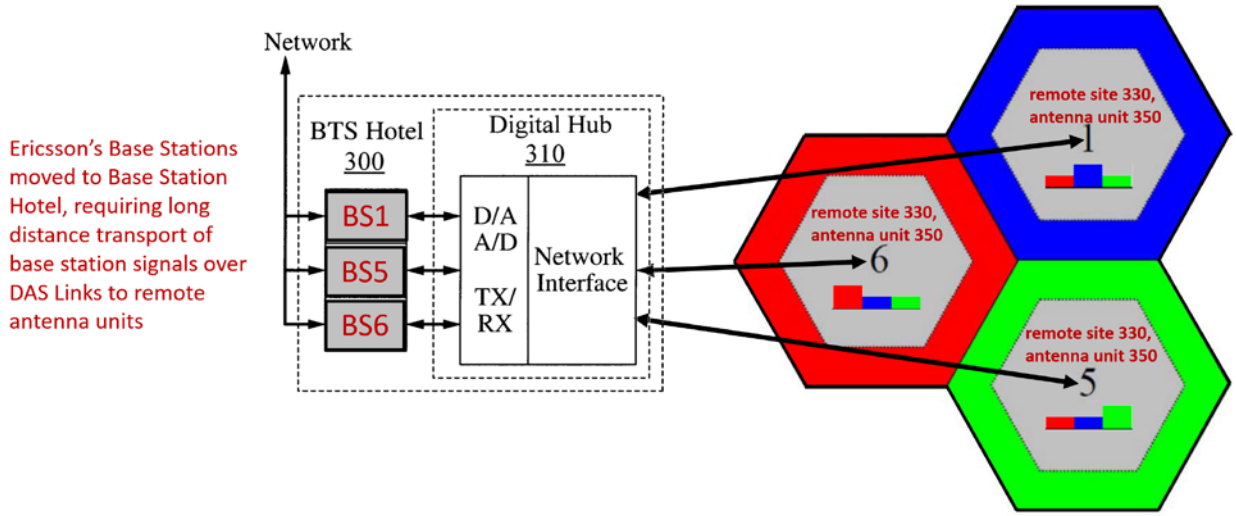
(illustrated to show each remote site 330 having one antenna unit, e.g., col. 8:45-51 stating: "At each remote site 330, the NAN 340 branches out to **one** or more sector antenna units … .")



Ericsson

(Cells 1, 5 and 6 of Ericsson Figure 2)



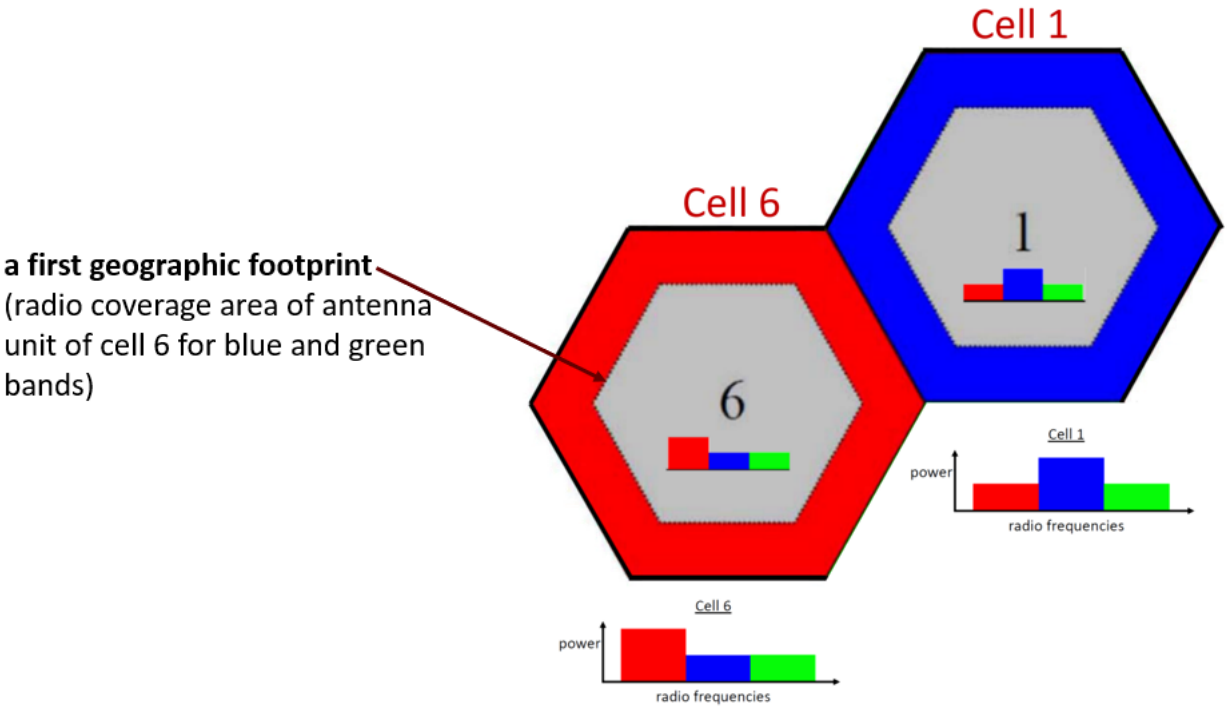


387. Reasonable expectation of success of the proposed combination. A POSA would have a reasonable expectation that such a combination would be successful. That DAS host units and corresponding transport links have been so long used in the art of DAS (Stratford filed in 2002 and Schwartz filed in 2000) would lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that DAS host units are "typical" in DAS deployments and commonly employed at base station hotel. Ex. 1001 at 1:14-26. One of the most common reasons to employ a DAS, including DAS host unit and DAS links, is to prepare the signals for successful transport over longer distances to remote cell sites without degradation of the data carried on the signals.

3. Claim 9

"the first geographic footprint includes a location of the first communications unit"

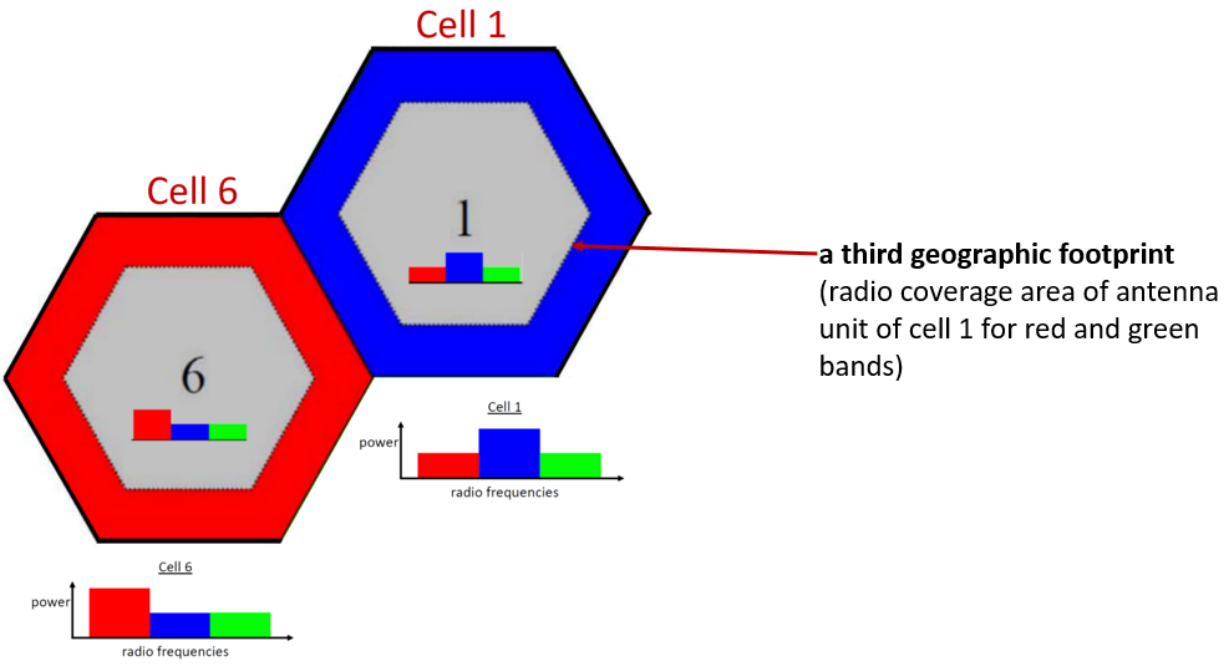
388. Since the first geographic footprint of Ericsson's cell 6 includes a location of cell 6's antenna unit, the limitation added by claim 9 is satisfied.



4. Claim 11

"the third geographical footprint includes a location of the second communications unit"

389. Since the third geographic footprint of Ericsson's cell 1 includes a location of cell 1's antenna unit, the limitation added by claim 11 is satisfied.



5. Claim 15

390. The claimed communication system of Claim 15 is similar to the claimed method of distributing communications frequencies of claim 7. Both require "a first communications unit" and "a second communications unit" and frequency reuse in Elements 15C and 15D. Claim 15 further requires "a host unit" that is coupled to the first and second communications units.

391. As discussed for claim 8, in Ericsson's discussion of fractional reuse (Ex. 1007 at 2 (Section 3), Fig. 2), Ericsson does not show or describe the use of a DAS or a DAS host unit to distribute radio resources from a remote location such as a base station hotel to cell's respective antenna units.

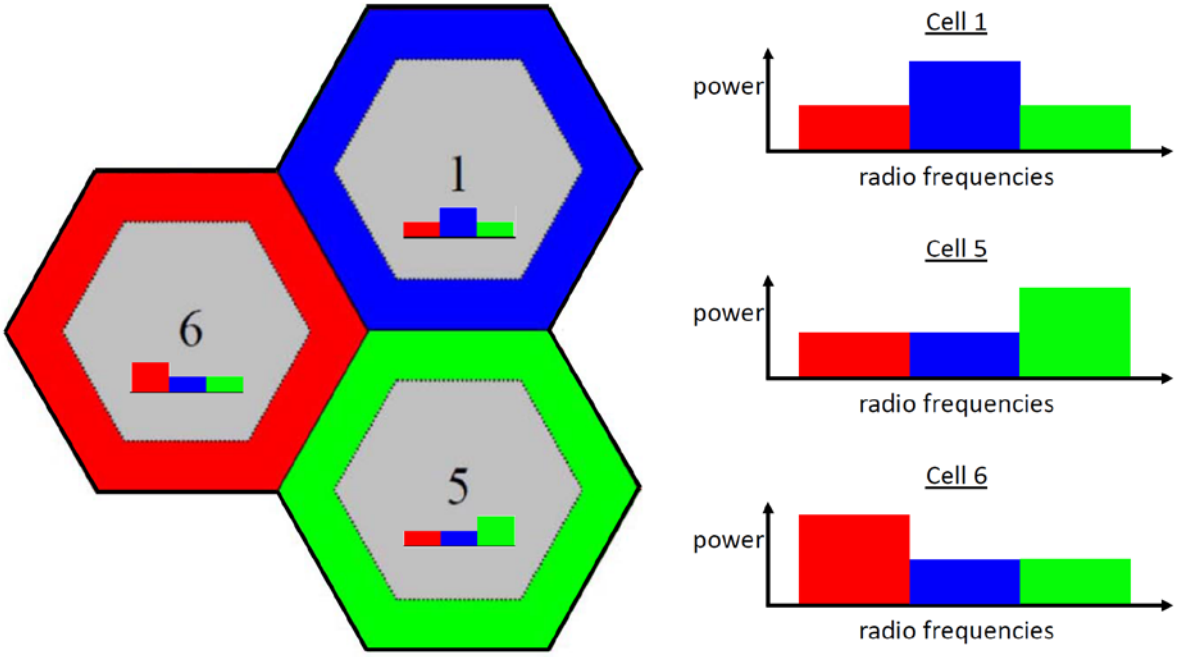
392. With the exception the "host unit," Ericsson discloses all the limitations of claim 15.

a. Element 15A

"a communication system"

393. Ericsson discloses this element because it discloses a multi-cell wireless communication system for transporting wireless communications. Ericsson's proposed a cellular communication system distributes communications frequencies in a way that implements a frequency reuse technique for "reducing the interference experienced by these users … ." Ex. 1007 at 2 (Section 3).

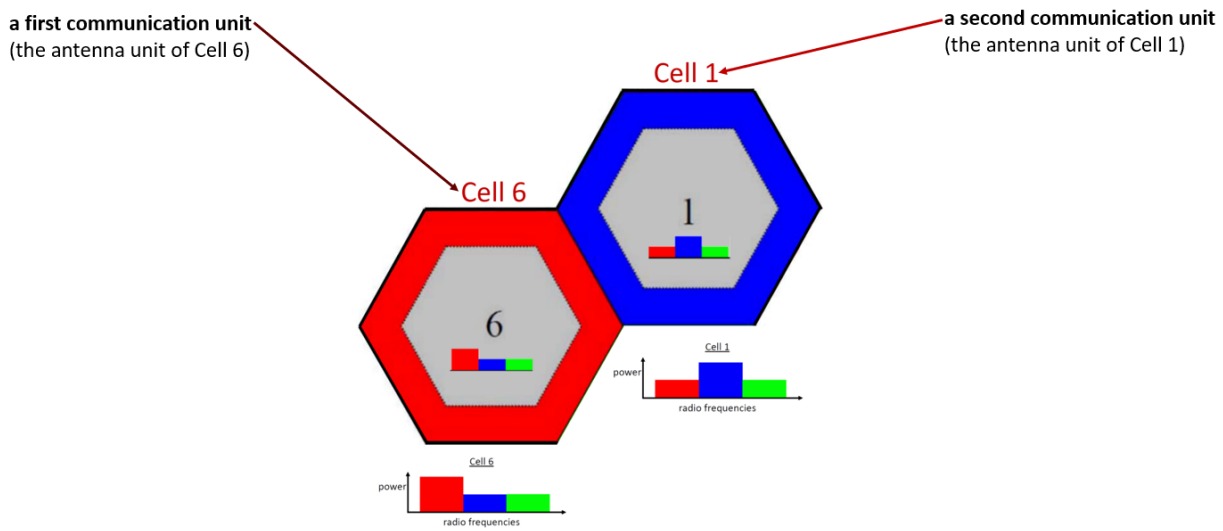
394. Cells 1, 5 and 6 of Ericsson's Figure 2 are isolated below with annotations to illustrate Ericsson's implementation of a frequency reuse scheme. Ericsson's system implements soft frequency reuse (SFR) in the same way as Figs. 1C & 1F of the '358 patent. To mitigate inter-cell interference cell-edge areas, each cell's centrally located antenna transmits a different RF band at a higher power to cover a cell-edge area, e.g., Cell 1 (blue), Cell 5 (green), and Cell 6 (red). Ericsson at 2 (e.g., "only cell 1 is allowed to transmit with ***full power*** using the 'blue' part of the spectrum").



b. Element 15B ("a host unit") and first / second communications units "coupled to the host unit" (from Elements 15C and 15D)

395. Cell 1 and Cell 6 from Ericsson's system are reproduced below (annotated) for comparing to the limitations of claim 15.

396. In Ericsson, the antenna unit that serves cell 6 is a "first communications unit" (below, left), and the antenna unit that serves cell 1 is a "second communications unit" (below, right).



397. Ericsson does not show or describe the use of host unit to distribute radio resources from a remote location such as a base station hotel to cell's respective antenna units.

398. Based on Ericsson alone, it would have been obvious to modify Ericsson's system for deployments in densely populated areas by housing the base stations at a remote location and employing a DAS that includes a DAS host and transport links for distributing radio resources to the antenna units of Ericsson's cell sites (e.g., for Ericsson's system above, cell 1's antenna unit, cell 5's antenna unit, and cell 6's antenna unit).

399. Particularly in densely populated areas, a POSA would have known that, for cost and efficiency reasons as well as lack of access to cell site property, POSA in reviewing Ericsson would have understood (a) that it was common to locate the base station equipment remote from the cell sites (commonly known as a

base station hotel) and (b) that a host unit would have been commonly employed at the base station hotel to facilitate the transport of the base station's RF signals long distances over DAS links to the remote antenna cites. This background is reinforced in the background section of the '358 patent.

> BACKGROUND OF THE INVENTION
>
> Wireless communication systems employing Distributed Antenna Systems (DAS) are available. A DAS typically includes one or more host units, optical fiber cable or other suitable transport infrastructure, and multiple remote antenna units. A radio base station is often employed at the host unit location commonly known as a base station hotel, and the DAS provides a means for distribution of the base stations downlink and uplink signals among multiple remote antenna units. The DAS architecture with routing of signals to and from remote antenna units can be either fixed or reconfigurable.

Ex. 1001 at 1:14-26.

400. That a POSA would have known that it was common in densely populated areas to house the base station equipment at a site remote from the cells and employ a DAS host and DAS links to transport the RF signal to the cell sites is also reinforced by the background DAS prior art. *See* Sabat (Ex. 1014); Schwartz (Ex. 1008); Stratford (Ex. 1009); Stapleton (Ex. 1010) discussed above at Section VII.B.1.

401. For a deployment of an Ericsson system in which the base station had to be located a long distance from the remote antenna units, the well-known benefit

of including a DAS host unit and DAS links (i.e., to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites) would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

402. Alternatively, it would have been obvious in view of Stratford combine Ericsson with a DAS.

403. Based on Stratford (and reinforced by the background in the '358 patent) a POSA would have known that that distributed antenna systems "***typically***" included "one or more host units" (Ex. 1001 at 1:17-18) that together with the DAS links would provide the "means for distribution of the base stations downlink and uplink signals among multiple remote antenna units." Ex. 1001 at 1:20-24.

404. Based on Stratford, a POSA would have understood that, for cost and efficiency reasons as well as lack of access to cell site property, in deploying cellular communication systems such as Ericsson's system: (a) the base station equipment often must be located remote from the cell sites (commonly referred to as a Base Station Hotel as noted in the background of the '358 patent) and (b) for such deployments, a DAS host unit (e.g., "Digital Hub 310" of Stratford Fig. 3) as

taught by Stratford would facilitate more efficient transport of radio resources to Ericsson's cells. Stratford explains the problem:

> Traditionally, a cellular communications system includes multiple remote sites, each providing wireless service to a geographic service area, or cell. As shown in FIG. 1, a cellular base station (BTS) is normally located in each remote site 100 together with an antenna tower, antennas, an equipment room, and a number of other relevant components. This traditional approach of deploying all the cell site equipment locally at each remote site has several drawbacks that contribute to the expense of the infrastructure, and upgrades to the infrastructure. At each remote site, a BTS room or cabinet to host the large base station equipment is required, as well as additional electric power supplies for the base station. This increases both the costs of the equipment at each site, as well as the costs of acquiring and renting the physical location for the equipment. The remote cell site equipment must be designed for future coverage and capacity growth, and upgrades to the equipment require physical access to the remote site.

Ex. 1009 at 1:26-43.

405. To mitigate these problems, Stratford teaches to house the base stations at a remote location (i.e., a base station hotel) and employ a DAS that includes a DAS hub or host unit and DAS transport links for distributing radio resources to the antenna units of the remote cell sites.

> To mitigate these problems, some cellular systems have been designed with a different architecture, as shown in FIG. 2. The base stations 240 for multiple remote sites 200 are centralized in a base station hotel 210, while the antenna towers and antennas remain located at various remote sites at a distance from the base station hotel.

> Separating the base stations 240 from the antennas, however, makes it necessary to transport RF signals between the base station hotel and the various cell sites that it serves, typically using signal converters 250, network interface equipment 260, and a broadband communication network 220. When broadband fiber optic cables are used, RF signals from the base stations are converted to optical format and communicated over the fiber optic cable and then converted back to analog RF signals at the remote sites. After the optical/RF conversion, the signal is sent to one of several sector transmitters 230 and radiated over the air via the antenna to provide cellular coverage. The BTS hotel concept is especially valuable in metropolitan areas where fiber is abundant but equipment space comes at a premium. ***In these types of areas it is getting increasingly more difficult to deploy new cell sites*** due to a variety of factors including regulatory and ***space constraint issues***.

Ex. 1009 at 1:44-65.

406. Based on Stratford, for those deployments of Ericsson's system in which the base station had to be located a long distance from cell sites (i.e., metropolitan areas as discussed in Stratford), the well-known benefit of including a DAS host unit and DAS links to facilitate the transport of the base station's RF signals over long distances to the remote antenna cites would have motivated a POSA to combine Ericsson with a DAS, including a DAS host and appropriate DAS links for more efficiently and reliably transporting the signals long distances to the cell sites (and respective antenna units) of Ericsson's system.

407. For such deployments, Stratford's teaches to use a digital hub or host unit (e.g. "Digital Hub 310") as an interface between one or more base stations

(i.e., a Base Station Hotel) to facilitate the transport of the base station signals over the DAS links to the remote antenna units.

> A block diagram of a wireless communication system implementing the techniques of a preferred embodiment of the present invention is shown in FIG. 3. A series of base stations (BTS) reside in a BTS hotel 300. The base stations are connected to a digital hub 310 that also resides in the BTS hotel. The digital hub 310 is connected via a digital network 320 to one or more remote sites 330.

Ex. 1009 at 6:29-35, Figs. 3.

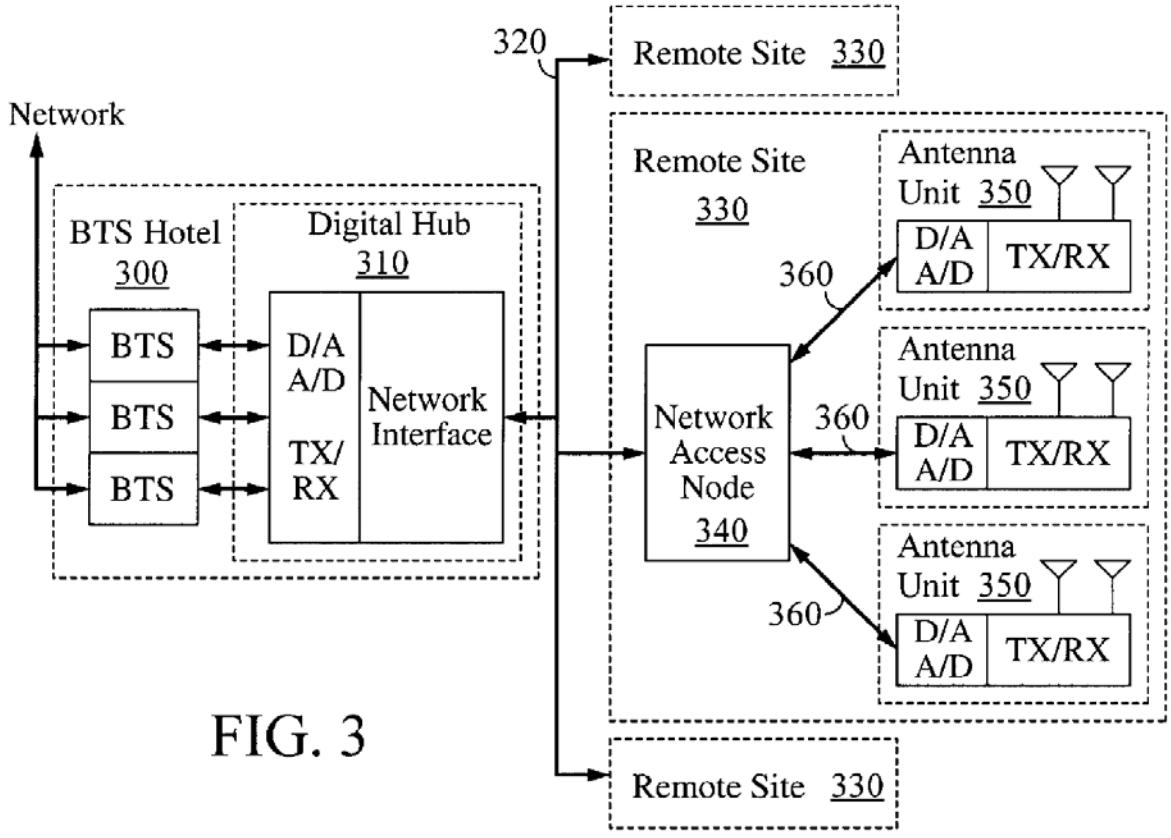


FIG. 3

As in the background of the '358 patent, Stratford teaches that the DAS host or hub can be employed at the base station hotel.

> In one aspect of the invention, a method of downlink wireless communication is implemented by a system comprising a base station hotel, at least one remote site, and a digital data network (e.g., a fiber optic network) connecting the hotel to the remote site. The base station hotel houses a plurality of base stations and a digital hub which connects the base stations to the digital network.

Ex. 1009 at 3:9-15, Figs 3 and 6.

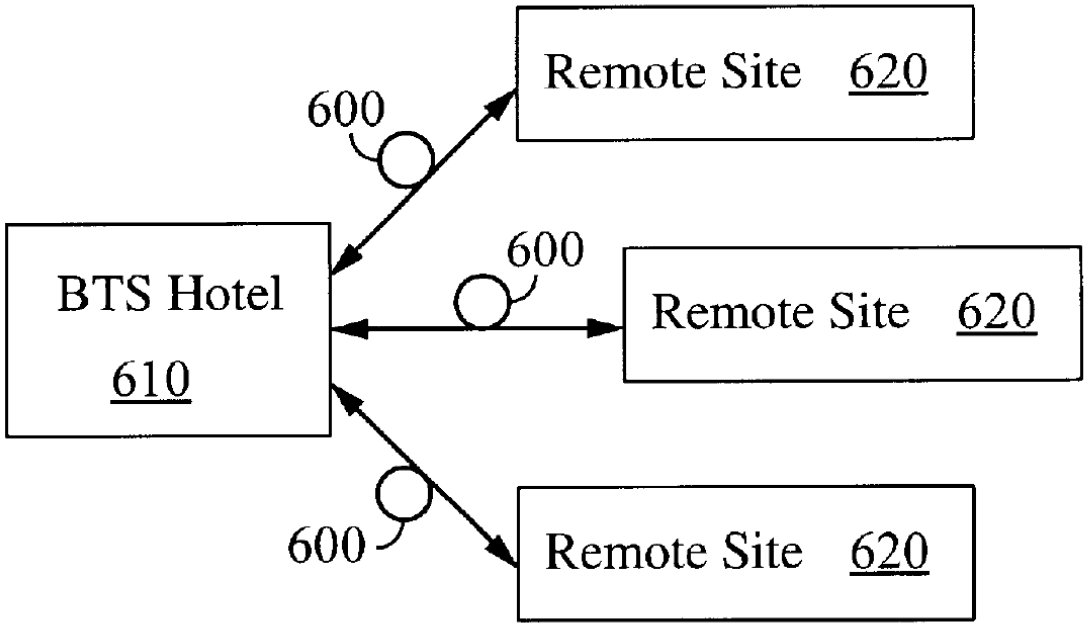


FIG. 6

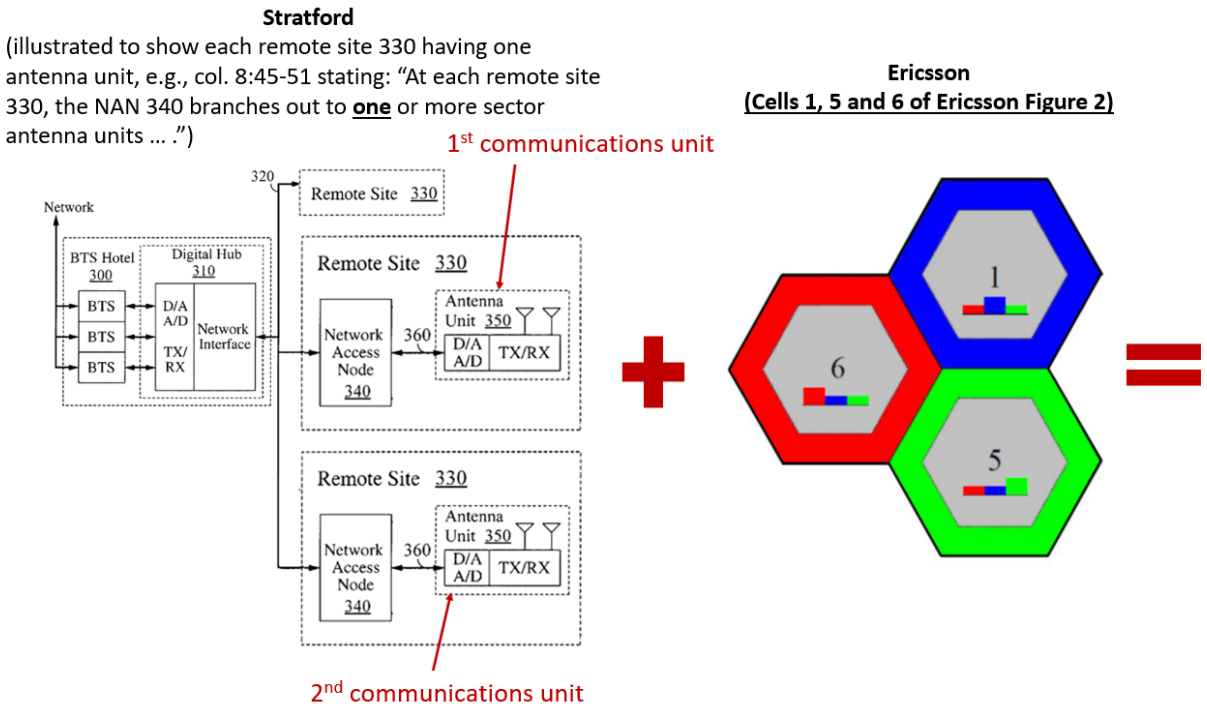
408. Stratford explains the purpose of including a digital hub at the base station hotel.

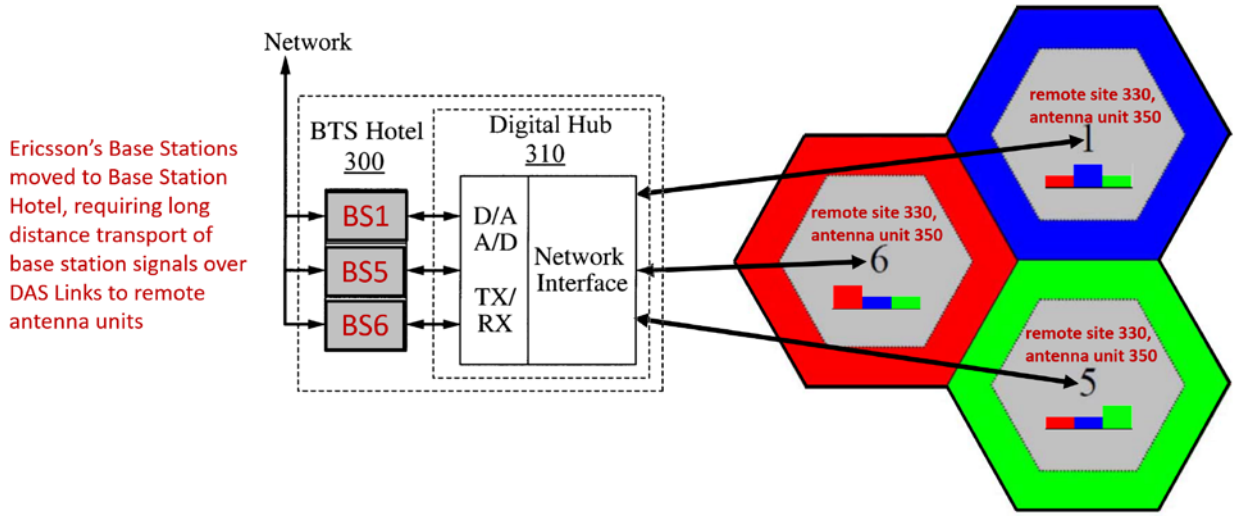
> The digital hub acts as the interface between the base stations and the digital network. Its main purpose is to convert downlink analog RF signals into a digital format that is compatible with the network, and to extract uplink digital signals from the network and convert them back to analog RF signals.

Ex. 1009 at 13:10-15.

409. I have illustrated this combination of Ericsson and Stratford below. Further, one of skill would be motivated to use a host unit or hub as taught by Stratford that is not integral with one base station so that the host unit could serve and manage signals from multiple base stations, not just one base station, which produces significant cost savings (only one host required, not multiple, i.e., one within each base station).

410. I have illustrated this combination of Ericsson and Stratford below.

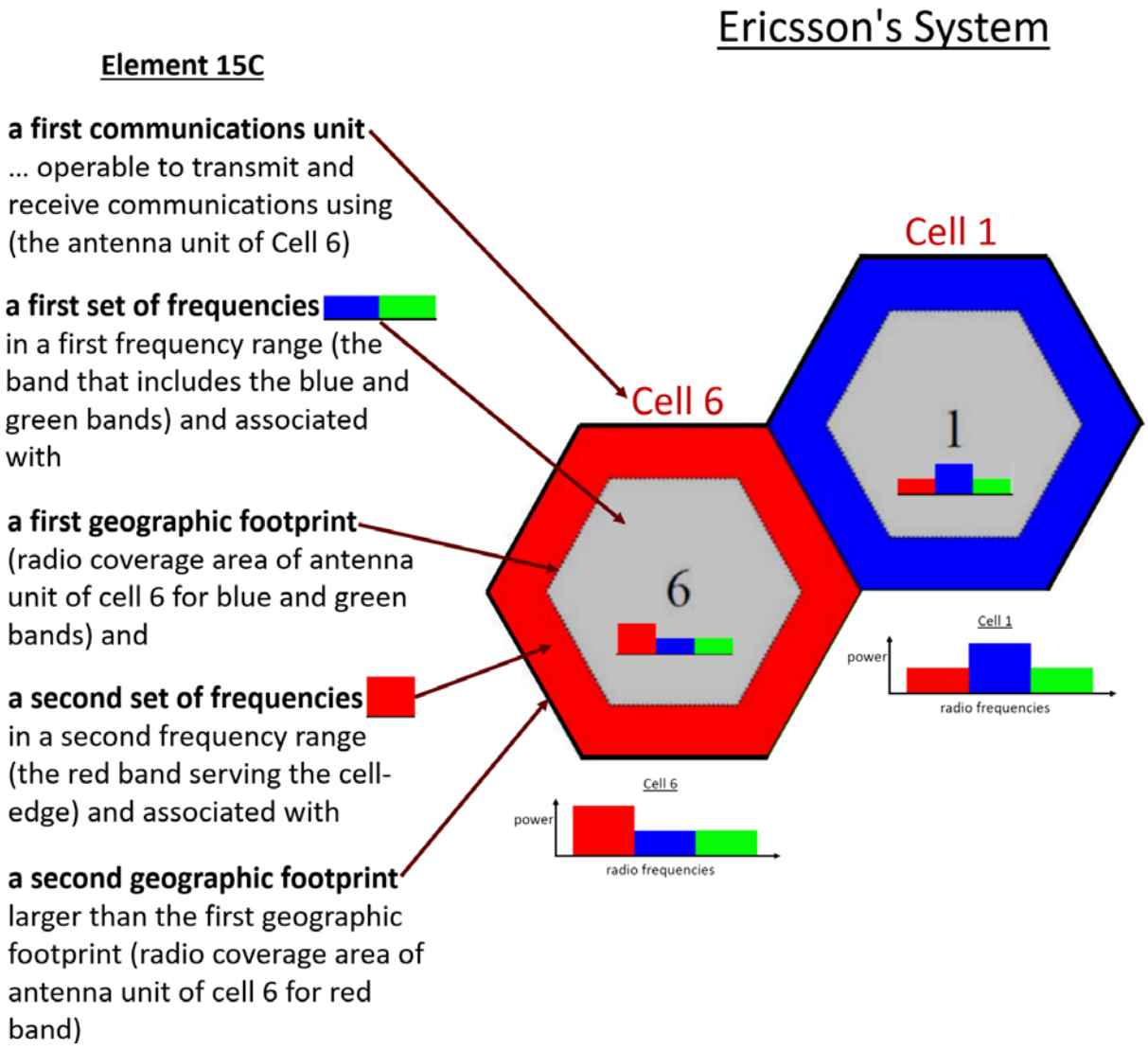




411. Reasonable expectation of success of the proposed combination. A POSA would have a reasonable expectation that such a combination would be successful. That DAS host units and corresponding transport links have been so long used in the art of DAS (Stratford filed in 2002 and Schwartz filed in 2000) would lead a POSA to have a reasonable expectation of success, a fact that is confirmed by the '358 patent itself which recognizes that DAS host units are "typical" in DAS deployments and commonly employed at base station hotel. Ex. 1001 at 1:14-26. One of the most common reasons to employ a DAS, including DAS host unit and DAS links, is to prepare the signals for successful transport over longer distances to remote cell sites without degradation of the data carried on the signals.

c. Element 15C

412. Below I have illustrated how Element 15C reads on Ericsson's system.



413. That Ericsson discloses Element 15C is consistent with the same logic and reason under which Element 15C reads on the second embodiment of the '358 patent.

414. The first communications unit: The antenna unit that serves Ericsson's cell 6 (above), is "a first communications unit".

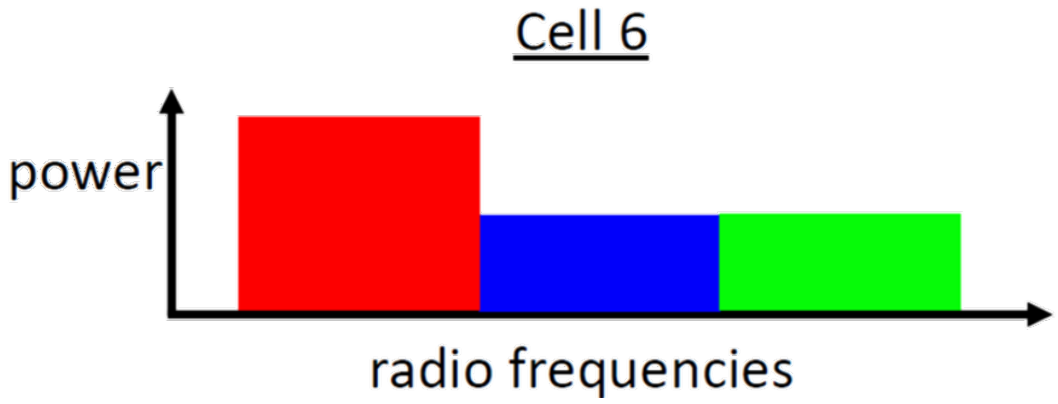
415. The first communications unit … operable to transmit and receive communications using **a first set of frequencies** in a first frequency range: In Ericsson's system, cell 6's antenna unit transmits a first set of frequencies in a first frequency range that includes blue and green bands. Ex. 1007 at 2, Fig. 2.

416. The first communications unit … operable to transmit and receive communications using a first set of frequencies in a first frequency range and associated with **a first geographic footprint**: In Ericsson's cell 6, the radio coverage area of cell 6's antenna unit for the blue and green bands is the "a first geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 6 (gray area) corresponds to the first geographic footprint.

417. The first communications unit … operable to transmit and receive communications using … **a second set of frequencies** in a second frequency range: In Ericsson's system, cell 6's antenna unit transmits a second set of frequencies in a second frequency range that includes the red band. Ex. 1007 at 2, Fig. 2.

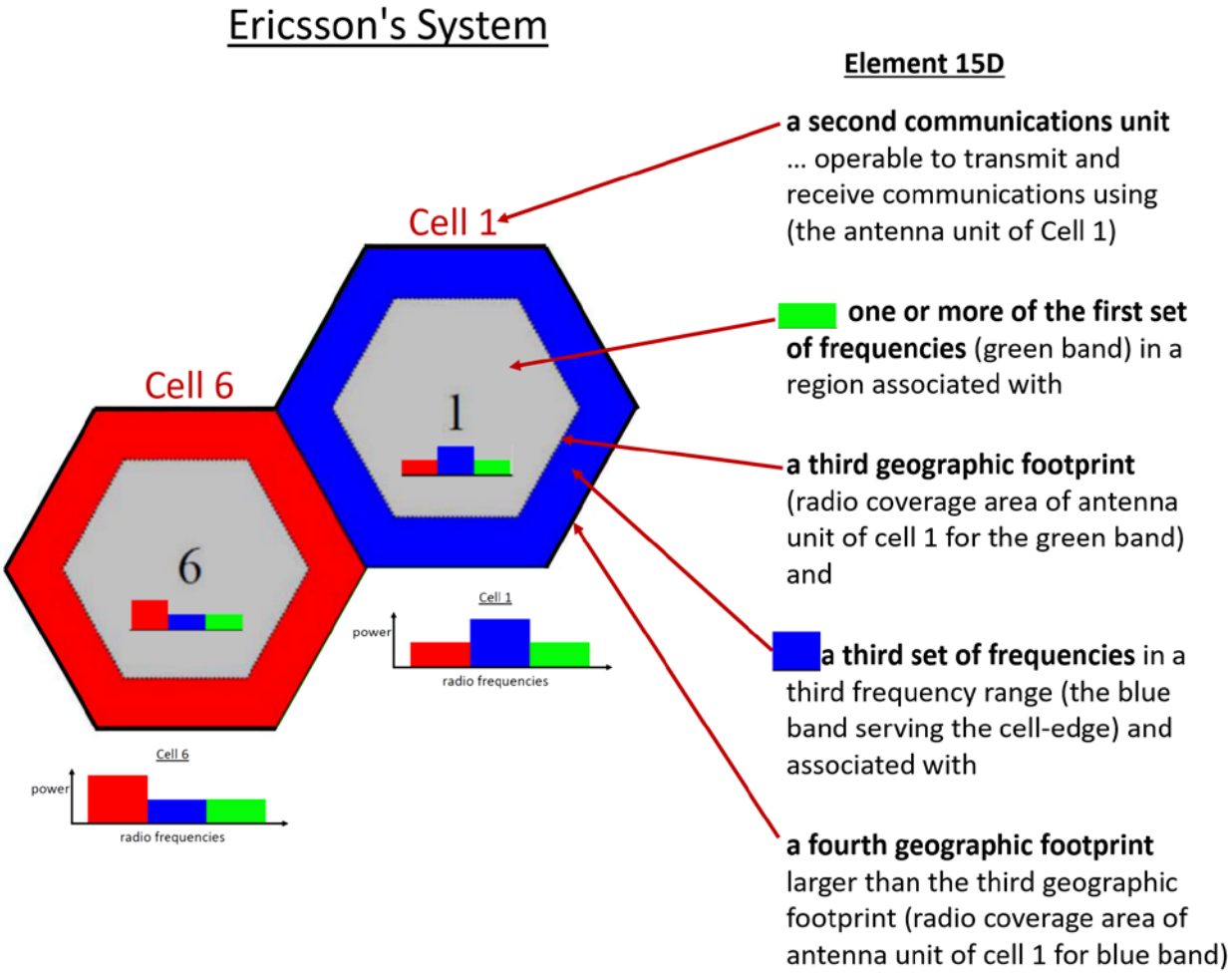
418. The first communications unit … operable to transmit and receive communications using … a second set of frequencies in a second frequency range and associated with **a second geographic footprint**: In Ericsson's cell 6, the radio

coverage area of cell 6's antenna unit for the red band is "a second geographic footprint". As illustrated below, cell 6's antenna unit transmits the red band at a higher power resulting in resulting in larger coverage area for the second geographic footprint. Ex. 1007 at 2, Fig. 2.



d. Element 15D

419. Below I have illustrated how Element 15D reads on Ericsson's system.



420. That Ericsson discloses Element 15D is consistent with the same logic and reason under which Element 15 reads on the second embodiment of the '358 patent.

421. The second communications unit: The antenna unit that serves Ericsson's cell 1 (above), is "a second communications unit".

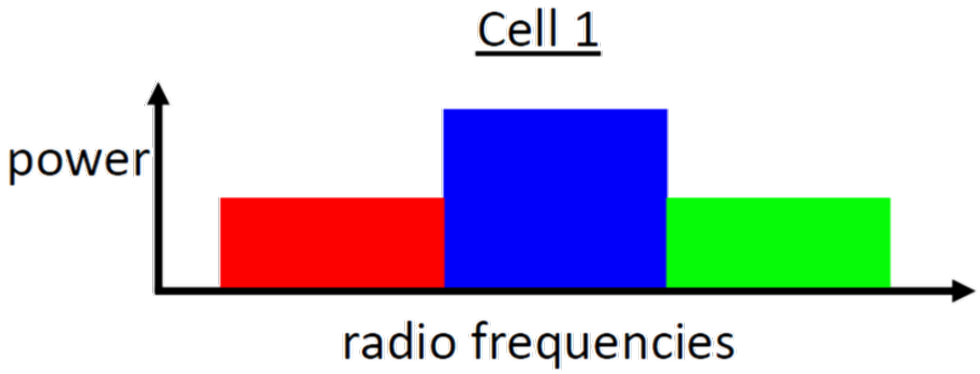
422. The second communications unit … operable to transmit and receive communications using **one or more of the first set of frequencies**: In Ericsson's

system, cell 1's antenna unit transmits one or more of the first set of frequencies (the green band). Ex. 1007 at 2, Fig. 2.

423. The second communications unit … operable to transmit and receive communications using one or more of the first set of frequencies in a region associated with **a third geographic footprint**: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the green band is "a third geographic footprint". Ex. 1007 at 2, Fig. 2. The cell-center area of cell 1 (gray area) corresponds to the third geographic footprint.

424. The second communications unit … operable to transmit and receive communications using … **a fourth set of frequencies** including one or more frequencies in a third band: In Ericsson's system, cell 1's antenna unit transmits a fourth set of frequencies including one or more frequencies in a third band (blue band serving the cell-edge area). Ex. 1007 at 2, Fig. 2.

425. The second communications unit … operable to transmit and receive communications using … a fourth set of frequencies … and associated with **a fourth geographic footprint**: In Ericsson's cell 1, the radio coverage area of cell 1's antenna unit for the blue band is "a fourth geographic footprint". As illustrated below, cell 1's antenna unit transmits the blue band at a higher power resulting in resulting in larger coverage area for the fourth geographic footprint. Ex. 1007 at 2, Fig. 2.



6. Claim 17

17. The communications system of claim 15 wherein the communications using the first set of frequencies in the first frequency range are associated with a first power level and the communications using the second set of frequencies in the second frequency range are associated with a second power level greater than the first power level.

426. Ericsson discloses the limitations of claim 17 because cell 6's antenna unit transmits the red band at a power level that is higher than the power level used to transmit the blue and green bands. This results in the antenna unit having a larger radio coverage for the red band. Ex. 1007 at section 3. Ericsson therefore discloses the limitations of claim 17.

7. Claim 18

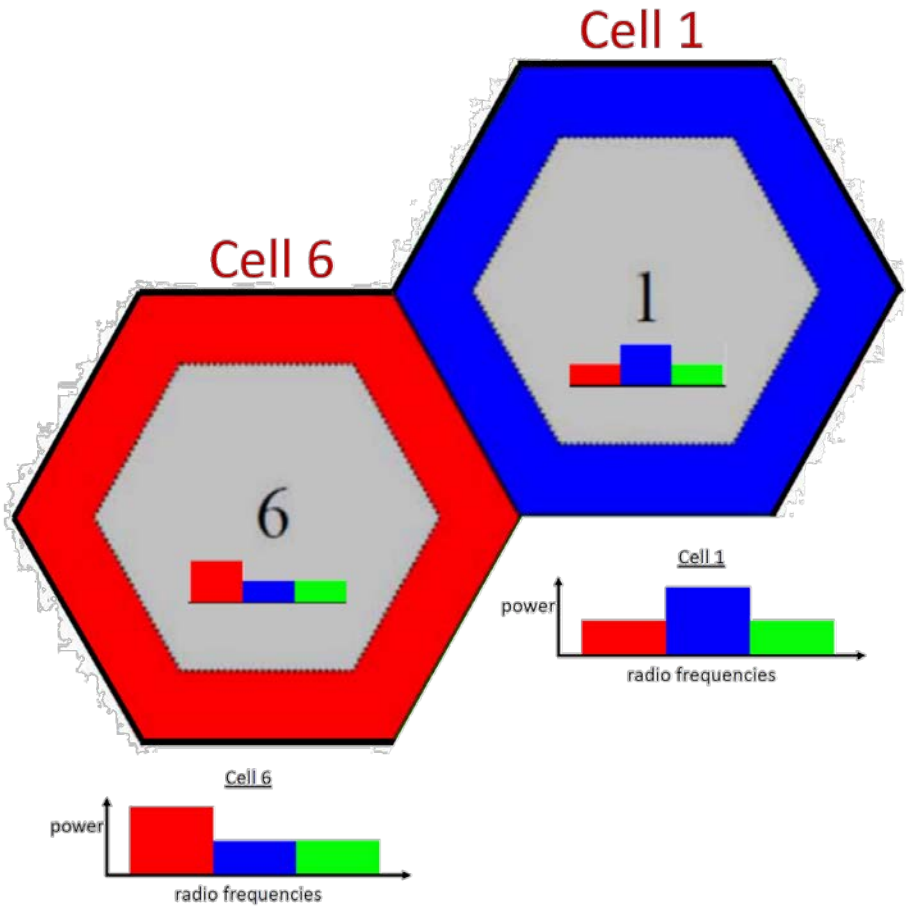
18. The communications system of claim 15 wherein the communications using one or more of the first set of frequencies in the region associated with a third geographical footprint are associated with a first power level and the communications using the third set of frequencies in the third frequency range are associated with a second power level greater than the first power level.

427. Ericsson discloses the limitations of claim 18 because cell 1's antenna unit transmits the blue band at a power level that is higher than the power level used to transmit the green band. This results in the antenna unit having a larger radio coverage for the blue band. Ex. 1007 at 2 (Section 3). Ericsson therefore discloses the limitations of claim 18.

8. Claim 20

The communications system of claim 15 wherein the first frequency band and the second frequency band are contiguous frequency bands.

428. Here it is unclear what claim 20 is referring to as "the first frequency band" and "the second frequency band." There is no prior recitation of frequency bands in claim 15 or claim 20. If these are construed to be referring to the first and second frequency ranges introduced in claim 15, then this limitation is disclosed by Ericsson. Ericsson discloses the limitations of claim 20 because, looking at the bands transmitted and received by cell 6's antenna unit, the first frequency band (the blue and green bands) and the second frequency band (the red band bands are contiguous frequency bands. *See* Ex. 1007 at 2, Fig. 2.



9. Claim 21

The communications system of claim 15 wherein the first frequency range, the second frequency range, and the third frequency range include distinct frequencies.

429. Ericsson discloses the limitations of claim 21 because the first frequency band/range (blue and green bands), the second frequency band/range (red band), and the third frequency band/range (blue band) include distinct frequencies, i.e., green, red and blue respectively. *See* Ex. 1007 at 2, Fig. 2.

G. Ground 7: Stratford in combination with Ericsson renders claims 7, 8, 9, 11, 15, 17, 18, 20 and 21 obvious

430. U.S. Patent No. 6,785,558 (Ex. 1009) ("Stratford") discloses a distributed antenna system for distributing wireless cellular communication signals between a base station hotel and remote cell sites with digitized RF carrier signals. Ex. 1009 at Abstract, Fig. 3, 2:37-44, 3:9-20, 6:29-51. As shown, for example, in Figure 3, the system operates to distribute RF signals digitally from base stations located in a base station "hotel" to multiple remote cell sites. Ex. 1009 at Fig. 3, 1:26-65; 3:9-20; 6:29-51. Figure 3 is reproduced below.

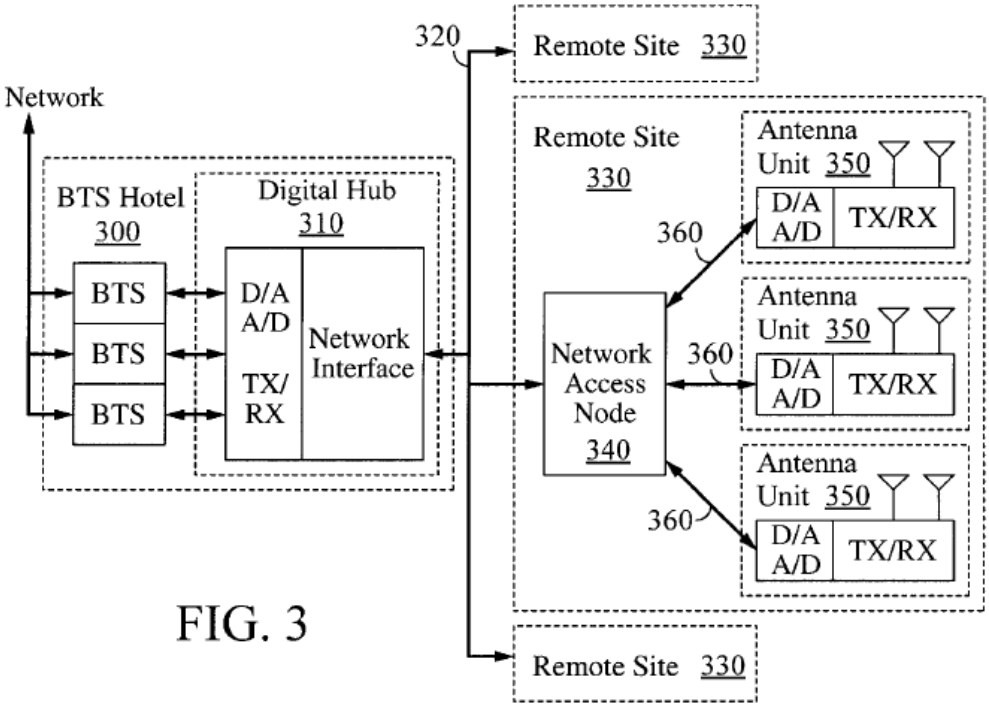


FIG. 3

Ex. 1009 at Fig. 3. The system includes a digital hub 310 (a host unit) that distributes RF signals from multiple base stations over digital fiber links to remote cell sites where antenna units convert the digital signals back into analog RF

signals for wireless transmission into each cell's coverage area. *See* Ex. 1009 at Fig. 3, 3:9-47.

431. Although Stratford describes and illustrates distributing communication frequencies to communication units in adjacent cell sites, Stratford does not teach how to address inter-cell interference that may result from adjacent cell sites. Ericssson (Ex. 1007), however, taught that using fractional frequency reuse improves the performance for cell edge users while also obtaining the spectral efficiency improvements of frequency reuse. Ex. 1007 at 2, Figure 2:

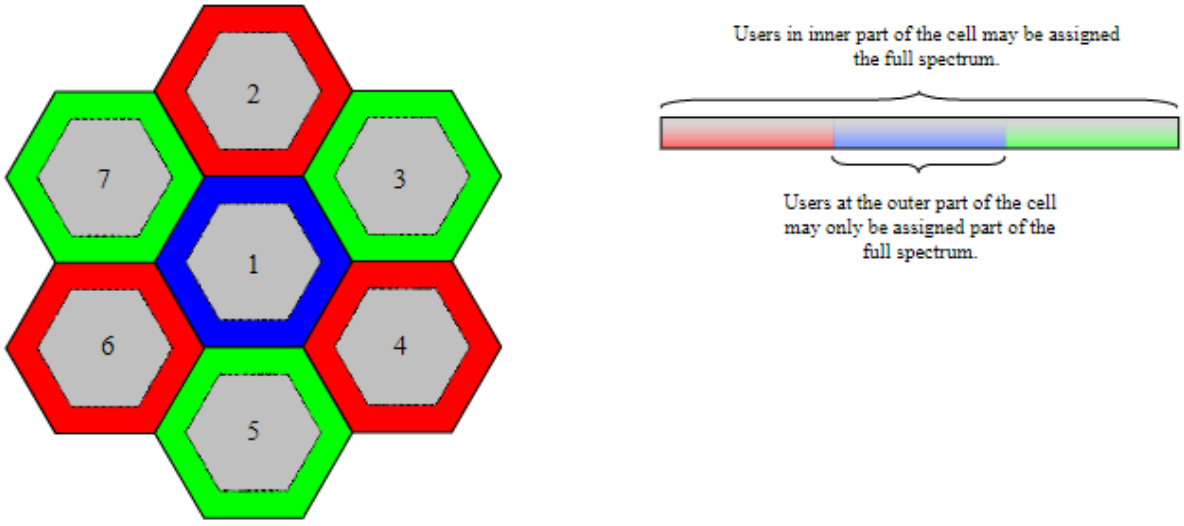


Figure 2: Example illustrating fractional reuse for cell-edge users (a continuous spectrum for the fractional reuse is assumed for illustrative purposes, distributed approaches could equally well be used).

> Fractional reuse, also known as soft frequency reuse or interference coordination, has been proposed as a means to increase the performance for cell-edge users [2][3][4]. With fractional reuse, only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users (at

> the cost of a reduced bandwidth). Typically, fractional reuse is implemented as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, only cell 1 is allowed to transmit with full power using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a reduced power. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2.

432. It would have been obvious to use fractional frequency reuse as taught by Ericsson in Stratford's cellular communication system to increase spectral efficiency through frequency reuse while mitigating inter cell interference. The combination of these two references render all of the challenged claims obvious. As set out below.

1. Claim 7

a. Element 7A

"A method of distributing communications frequencies"

433. Stratford discloses a method of distributing communications frequencies. *See, e.g.*, Ex. 1009 Title ("System and Method for Distributing

Wireless Communication Signals over Metropolitan Telecommunications Networks"); Abstract ("A method for transporting wireless communication signals between a base station hotel and remote cell sites with separately digitized RF carrier signals is provided."); Fig. 3; 2:50-54 ("digitized carrier signals…are distributed within the remote site to the various antenna units of the remote site"), 3:9-47; 4:22-27 ("…the method is implemented in a cellular system using a digital hub at the base station hotel for performing the required A/D and D/A conversions, signal processing, and interfacing with the switched data network. A similar network access node is used at each remote site."); 4:40-44 ("After being distributed to the appropriate antenna radio units, the digital signals are converted to analog RF signals and broadcast over the air to the mobile users using an amplifier and suitable antennas."); 6:29-51. "RF" stands for radio frequency. Therefore, Stratford discloses a distributed antenna system that digitally distributes radio frequency communication signals from a base station hotel to antenna units in remote cell sites. *Id.*

b. Element 7B

"providing a set of communications units;" that includes "a first communications unit" (from element 7C) and "a second communications unit" (from element 7D)

434. In Stratford's method and system, each of multiple remote cell sites 330 includes at least one "antenna unit 350" which are illustrated in Figure 3. Ex. 1009 at 8:45-53 ("At each remote site 330, the NAN 340 branches out to one or more sector antenna units 350, e.g. using composite fiber cable 360."). The antenna units wirelessly communicate with wireless subscribers (such as cell phones) within their respective coverage areas. Ex. 1009 at 6:41-44 ("The NANs remove the network formatting and send the digital signals to the antenna units 350 *where they are converted back to RF analog signals which are then transmitted to wireless subscribers*."). The antenna unit 350 within a first remote cell site is a first communication unit of claim 7. The antenna unit 350 within a second remote cell site is a second communication unit according to claim 7. Together they are an example of "providing a set of communications units" according to claim 7.

435. I have annotated Figure 3 from Stratford below to identify the communications units. Note that for simplicity, I have assumed there is one antenna unit in each of two remote sites as taught by Stratford where he teaches "one or more" antenna units at each remote cell site. Ex. 1009 at 8:45-53. However, the claims are obvious whether applied to Stratford's teaching of one antenna unit at the cell site or multiple antenna units at the cell site. In other words, the first communications unit can be a single antenna unit 350 at the cell site or can be a collection of multiple antenna units 350 at the cell site.

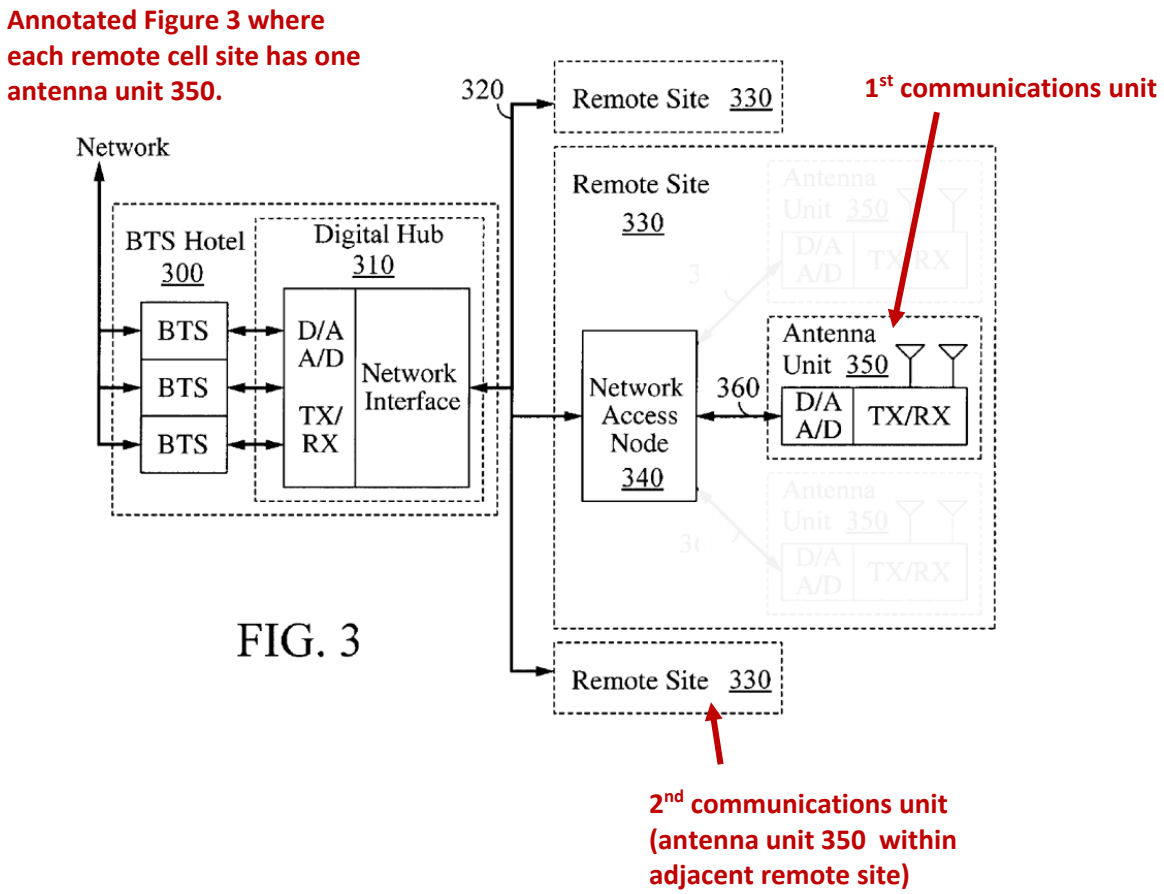
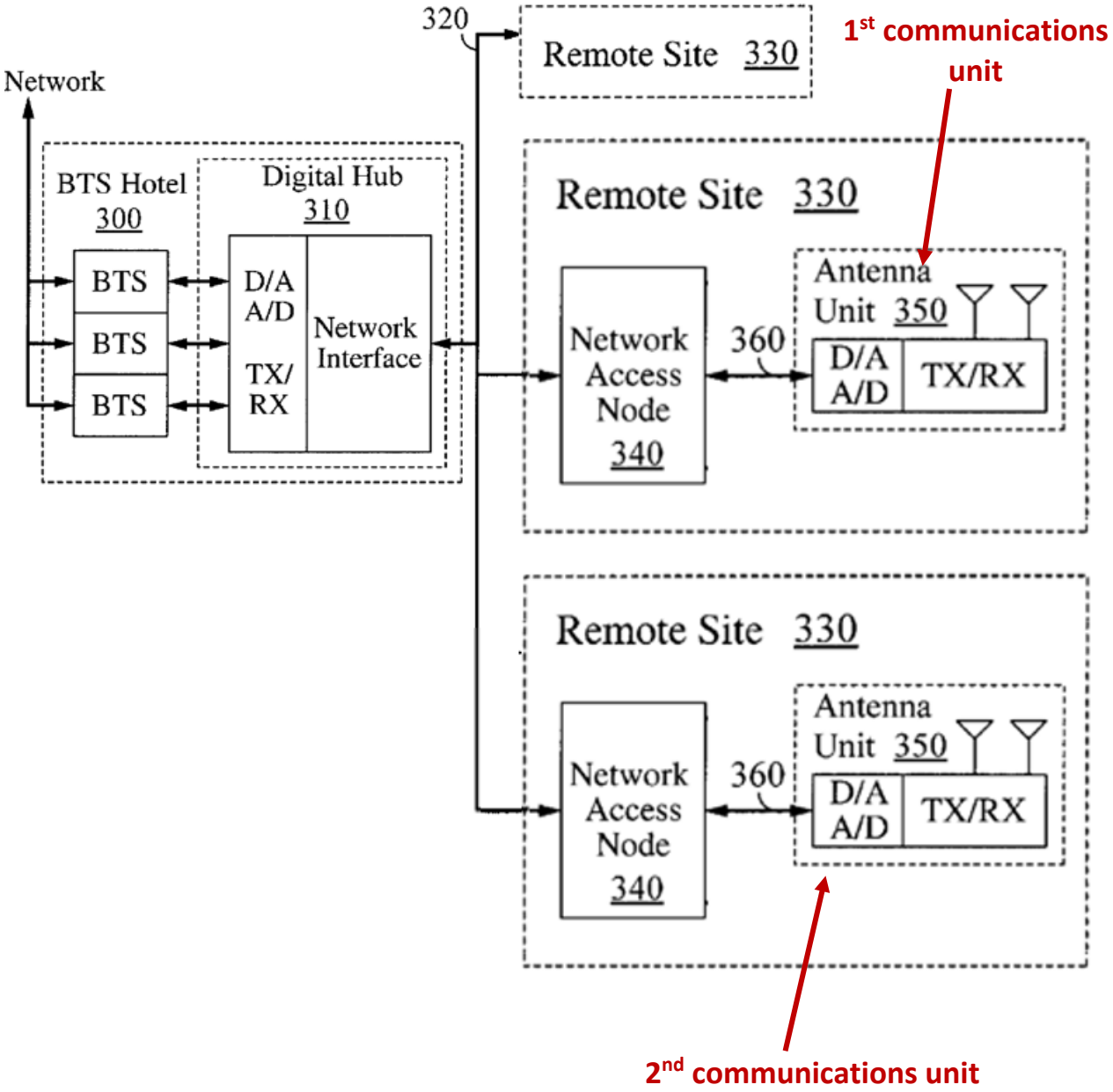


FIG. 3

436. The same set of communications units can be illustrated by simply repeating the details given for the first remote site inside the second remote site as I have illustrated below.



437. Together the first and second antenna units identified above constitute a set of communications units according to claim element 7B.

c. Element 7C

"transmitting and receiving, from a first communications unit of the set of communications units:

a first set of frequencies characterized by a first frequency band and a first geographic footprint; and

a second set of frequencies characterized by a second frequency band different from the first frequency band and a second geographic footprint larger than and at least partially surrounding the first geographic footprint; and"

438. Stratford teaches that the antenna units 350 (communications units) transmit and receive RF analog signals to wireless subscribers. Ex. 1009 at 6:41-44 ("The NANs remove the network formatting and send the digital signals to the antenna units 350 where they are converted back to RF analog signals which are then transmitted to wireless subscribers."). Stratford teaches that multiple different carrier signals ("first and second sets of frequencies") even from different base stations can be transmitted to a particular antenna unit at a remote cellular site and wirelessly transmitted by the antenna unit to subscribers. *See, e.g.*, Ex. 1009 at 3:21-47 ("In some cases, however, a base station can multicast to multiple remote sites, or various base stations can provide carrier signals to the same remote site."); 6:52-7:4 ("In contrast, FIG. 5 illustrates the method used in a preferred embodiment of the present invention, where narrowband A/D converters are used to digitize separately the distinct narrowband carriers 410 to obtain digitized

narrowband carriers 440. Both performance benefits and flexibility stem from this separate conversion of carrier signals."); 4:22-44 ("At the remote cell site a remote version of the digital hub, the network access node (NAN), is then used to recover the digital RF carrier signals from the network. After being distributed to the appropriate antenna radio units, the digital signals are converted to analog RF signals and broadcast over the air to the mobile users using an amplifier and suitable antennas."); 6:29-44. Stratford's first narrowband carrier or carrier signal transmitted/received by the first antenna unit is an example of a first set of frequencies of claim 7C. Stratford's second narrowband carrier or carrier signal (when multiple carrier signals are delivered to the same remote cell site as taught by Stratford) is an example of a second set of frequencies of claim 7C.

439. Stratford also teaches that reciprocal functions exist in the upstream direction allowing the carrier signals to be received by the antenna units at the remote site and received upstream from the antenna unit by the relevant base stations at the base station hotel (via the NAN and digital hub). Ex. 1009 at 3:48-60; 4:45-63, 6:44-50:

> In the uplink direction, similar reciprocal functions exist. At the remote site the antenna units receive analog RF signals over the air…digitized and sent over a local data link to the remote site's NAN where the digital carrier signal is formatted into a standard telecommunication protocol, multiplexed onto the digital network, and sent over the digital network to the base Station hotel. At the

> base station hotel, the digital hub is used to extract the data from the telecom network, and convert the digitized RF carrier signals from the network data format back into their native analog RF format. Finally, the RF analog signals are provided to the appropriate base stations for processing. In most instances, the same telecommunication protocol will be used in both the downlink and uplink directions. There may be situations, however, (especially with asymmetric services and applications) where different protocols can be used in each direction.

Ex. 1009 at 4:45-63.

440. One of skill in the art would understand that each narrowband carrier or carrier signal (set of frequencies) will inherently be associated with a coverage area or geographic footprint depending on the amplification used for transmitting that carrier signal at the remote antenna units. One of skill in the art would understand that the geographic footprint or coverage area for a first carrier signal transmitted or received by the first antenna unit will be larger if the power of the amplifier is increased.

441. Stratford discloses that each carrier signal can be associated with a different power level. *See, e.g.*, Ex. 1009 at 7:18-23, 7:45-67. However the specific relationship between the geographic footprints recited in claim elements 7C and 7D would not necessarily be inherent in Stratford's system.

442. Ericssson (Ex. 1007), however, taught that employing fractional frequency reuse by transmitting/receiving different frequencies at different power

levels, improves the performance for cell edge users while also obtaining the spectral efficiency improvements of frequency reuse. Ex. 1007 at 2, Figure 2:

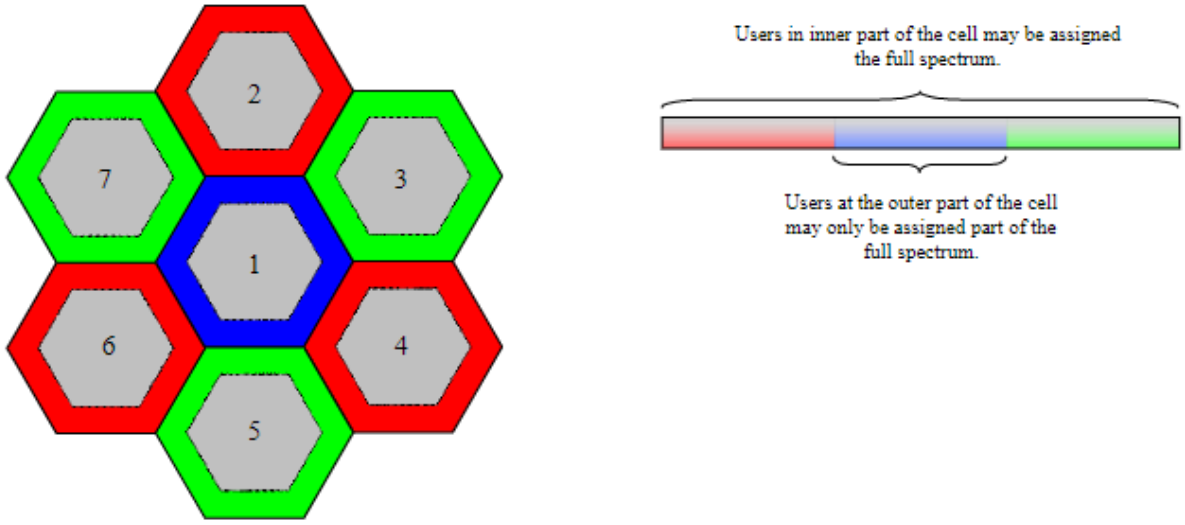


Figure 2: Example illustrating fractional reuse for cell-edge users (a continuous spectrum for the fractional reuse is assumed for illustrative purposes, distributed approaches could equally well be used).

> Fractional reuse, also known as soft frequency reuse or interference coordination, has been proposed as a means to increase the performance for cell-edge users [2][3][4]. With fractional reuse, only a part of the total resources is used for transmission to/from cell-edge users, thereby reducing the interference experienced by these users (at the cost of a reduced bandwidth). Typically, fractional reuse is implemented as fractional frequency reuse, although other possibilities may exist as well. Figure 2 illustrates the principle of fractional frequency reuse. In the figure, only cell 1 is allowed to transmit with full power using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a reduced power. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to

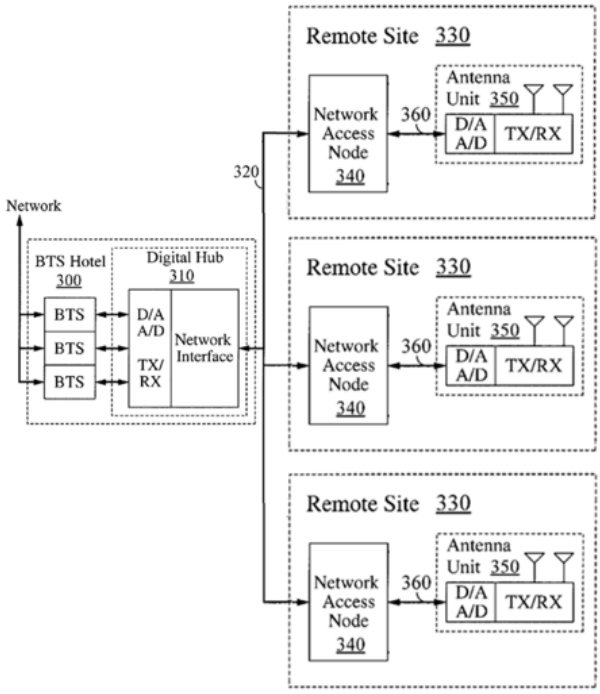
> cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2.

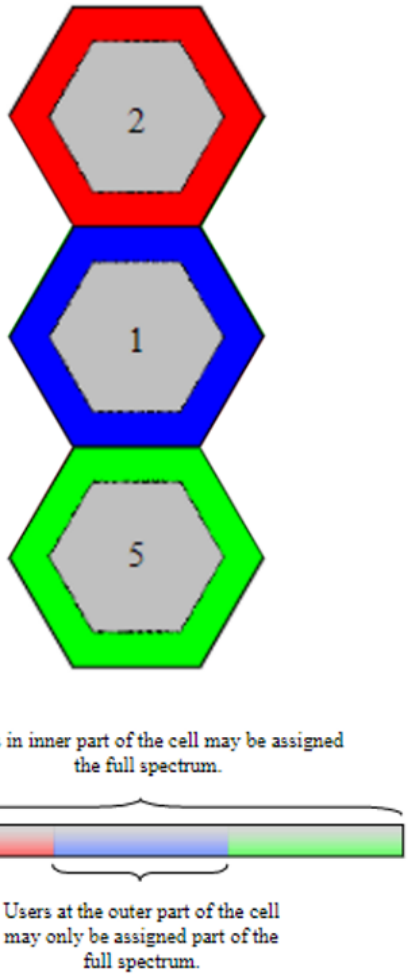
443. It would have been obvious to use fractional frequency reuse as taught by Ericsson in Stratford's cellular communication system to increase spectral efficiency through frequency reuse in the inner areas of each cell while mitigating inter cell interference at the cell edges.

444. Applying Ericsson's fractional frequency reuse in Stratford's system would have been straight forward for a person of ordinary skill in the art. As shown in the figure below, Stratford already disclosed a distributed antenna system that fed multiple carrier signals to each of multiple remote adjacent cell sites. One of skill in the art would apply Ericsson to Stratford as shown in the illustrations below:

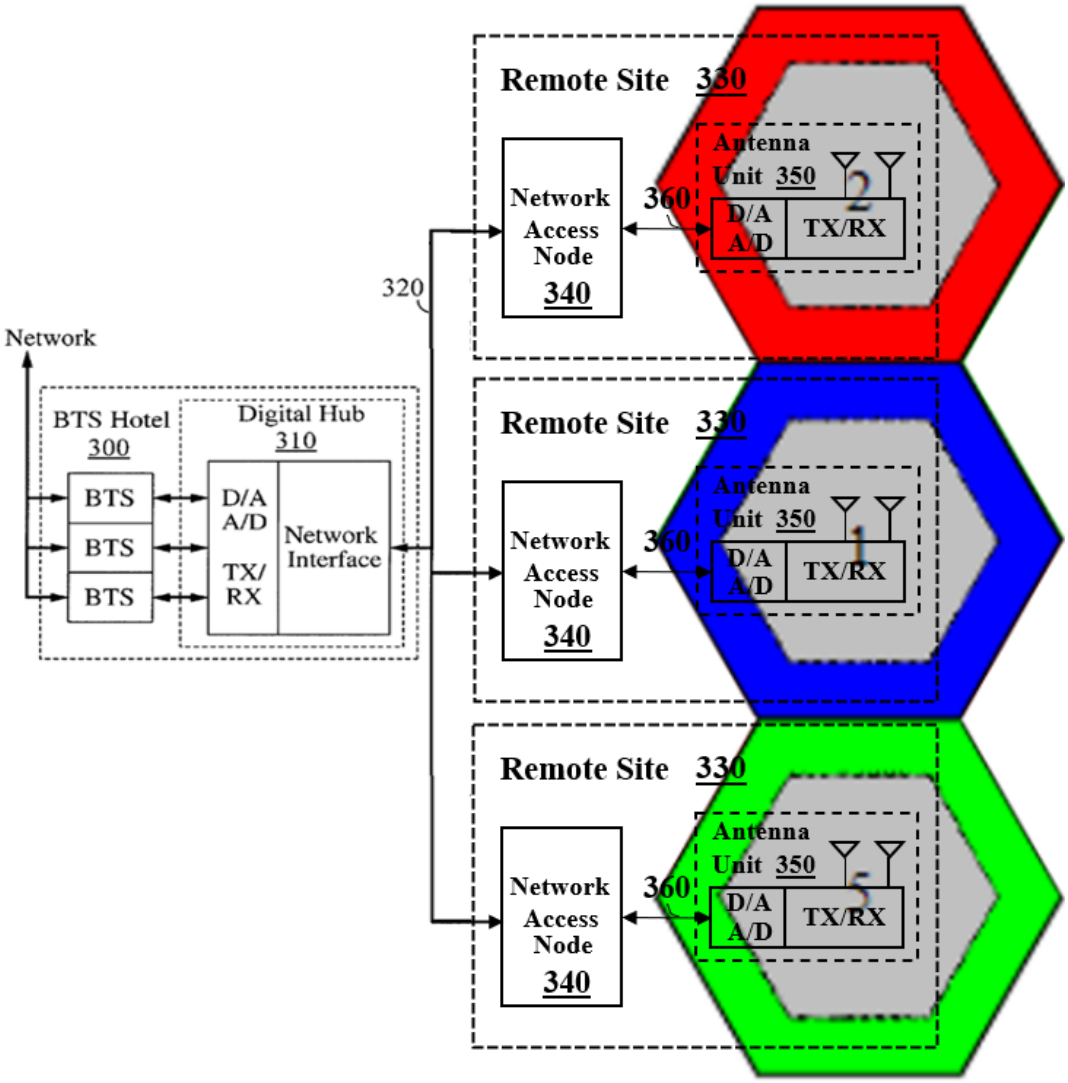
From Stratford
(see, e.g., description of Fig. 3)



From Ercisson
(see, e.g., p. 2, Figure 2)



Combination of Stratford and Ericsson:



445. As I have illustrated above, each remote cell site 330 in Stratford would correspond to one of the cells taught by Ericsson. Using Ericsson's frequency reuse technique in Stratford would result in using, for example, the red

portion of the frequency spectrum in the inner portions (grey areas) of two each of Stratford's remote cell sites by using "reduced power" for those transmissions as taught by Ericsson. Reusing at least a portion of the frequency spectrum increases the bandwidth capacity available in each cell. The edge region of each remote cell would use only a part of the frequency spectrum (only the red, blue, or green portion of the spectrum depending on the cell) but at normal or full power as taught by Ericsson. This reduces inter cell interference between cells for users in the edge regions.

446. Motivations to Combine: One of skill in the art would be motivated to combine Ericsson's fractional frequency reuse technique with Stratford's system for multiple reasons. Ericsson teaches a technique that is useful for cellular wireless systems (Ex. 1007 at 1-2 ("Inter-cell Interference Handling"), and Stratford discloses a cellular wireless system (Ex. 1009 Abstract, 1:15-43 ("a cellular communications system includes multiple remote sites, each providing wireless service to a geographic service area, or cell."), Fig. 3, Fig. 6).

447. One of skill in the art would have been motivated to use frequency reuse in Stratford to increase the bandwidth capacity in each cell (by reusing some bandwidth in the inner portion of each cell), and would have been motivated to use Ericsson's specific fractional frequency reuse technique in order to minimize potential inter cell interference caused by that frequency reuse.

448. Using Ericsson's frequency reuse technique in Stratford's cellular system would be an example of combining prior art elements according to known methods to yield predictable results and use of known technique to improve similar systems in the same way. The benefits of using frequency reuse techniques were known, e.g., increasing bandwidth or spectral efficiency in a cellular system (reusing frequencies in adjacent cells) and mitigating inter cell interference in the edge regions of adjacent cells. *See, e.g.*, Ex. 1005 at 1 ("The classic unity frequency reuse (UFR) pattern may be applied by wireless systems to maximize the attainable area spectral efficiency at the cost of increasing the co-channel interference (CCI) level; hence, the UFR typically exhibits low throughput at the cell edge. As a remedy, the fractional frequency reuse (FFR) philosophy may be invoked"). The application of Ericsson's known method to Stratford's cells would yield the same predictable results: partial frequency reuse with reduced cell edge interference.

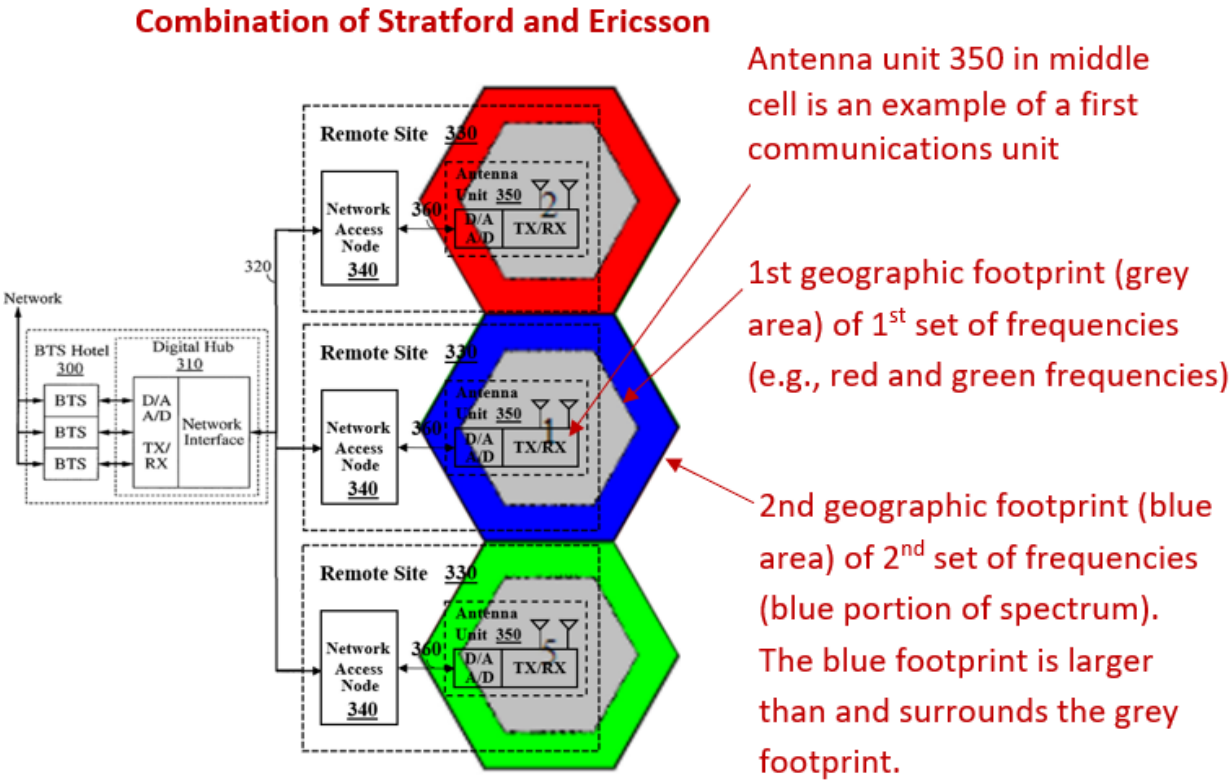
449. A person of skill in the art would have a reasonable expectation of success because the technique can be employed using simple modifications or duplication of components already present in Stratford's system. The technique is accomplished using different power amplification/gain on different portions of the spectrum. Stratford's system already includes power amplifiers (Ex. 1009 at 4:41-48 ("amplifiers")), and one of ordinary skill in the art would have a reasonable

expectation of success of including separate power amplifiers for separate portions of the spectrum (separate carrier signals) so that different power/gain levels can be applied to different portions of the spectrum as taught by Ericsson.

450. One of skill in the art would also have a reasonable expectation of success in combining these references because Stratford already discloses the need to manage and accommodate different carrier signals having different transmit and receive power levels. Ex. 1009 at 7:15-38 ("different power levels of the various carriers"). In addition, Stratford discloses the use of auxiliary channels such as the "power control sub-channel" to send power control information from the digital hub to the remote cell sites for each carrier signal. Ex. 1009 at 7:45-67 ("power control scaling bits…power control sub-channel…the transmit power level of each separately digitized RF carrier is sent to the remote site where it is extracted and used to set the transmit power levels.").

451. The combination of Stratford's system with Ericsson's soft frequency reuse technique would result in satisfying claim element 7C. The remote antenna unit in a first cell would transmit a first carrier signal (a first set of frequencies characterized by a first band, e.g., the red band) at reduced power, therefore, inherently defining a smaller geographical footprint as taught by Ericsson (shown as the grey inner coverage areas). In the middle remote cell site shown below, for example, the frequencies and band associated with the red portions of the RF

spectrum (first set of frequencies characterized by a first band) are only transmitted at reduced power and will have a geographical footprint that extends only to the edge of the grey area in the middle of the cell. The same remote antenna unit would also transmit a second carrier signal (second set of frequencies characterized by a second, different band shown in blue) at normal power to the cell-edge region and, therefore, define a second geographical footprint larger than and surrounding the first geographical footprint as shown in Ericsson (for example, the coverage area extending from the center out to the edge of the blue colored geographical footprint).



d. Element 7D

"transmitting, and receiving, from a second communications unit of the set of communications units:

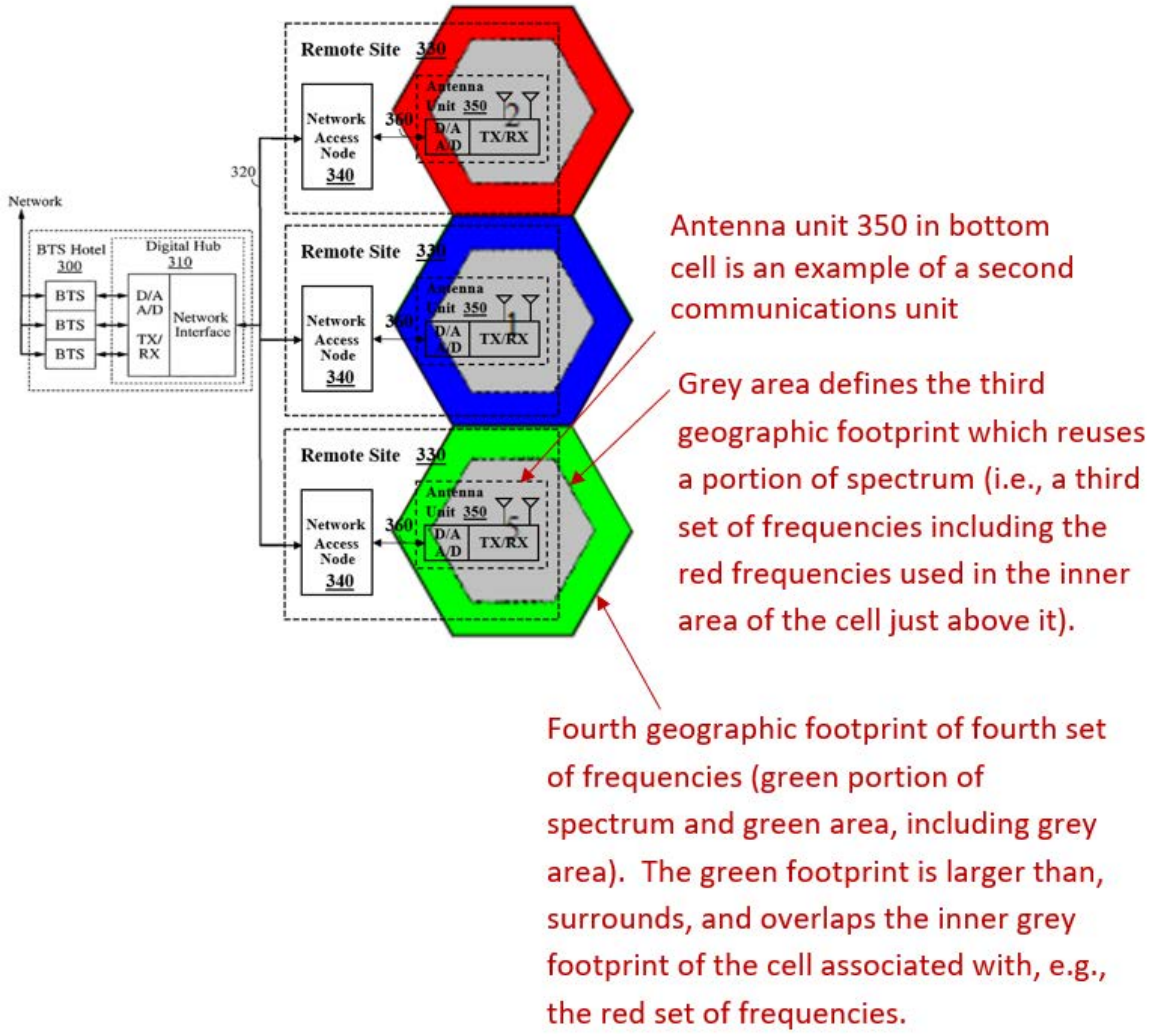
a third set of frequencies including one or more frequencies in the first frequency band and a third geographical footprint; and

a fourth set of frequencies including one or more frequencies in a third frequency band and a fourth geographical footprint larger than and at least partially surrounding the third geographical footprint."

2nd geographic footprint (blue area) of 2nd set of frequencies (blue portion of spectrum). The blue footprint is larger than and surrounds the grey footprint.

452. The combination of Stratford and Ericsson also renders obvious claim element 7D for the same reasons discussed above with respect to element 7C except that the frequencies and footprints associated with the antenna unit of a second remote site is used to satisfy the claim language as shown below.

Combination of Stratford and Ericsson



2. Claim 8

"8. The method of claim 7 wherein the set of communications units includes a plurality of remote units in communication with a host unit."

453. The combination of Stratford and Ericsson also renders obvious claim 8. The elements of claim 7, from which claim 8 depends, are obvious in light of Stratford and Ericsson for the reasons discussed above with respect to claim 7. Claim 8 adds the set of communications units includes a plurality of remote units

in communication with a host unit. The antenna units 350 of Stratford are a plurality of remote units in communication with a host unit. The antenna unit 350 at each remote cell site 330 are examples of remote communications units that are in communication with the digital hub which is a host unit. Ex. 1009 at Fig. 3, 6:34-38 ("The digital hub 310 is connected via a digital network 320 to one or more remote sites 330. Each remote site has a network access node (NAN) 340 and several remote antenna units 350 connected to the NAN 340 by digital communication links 360.").

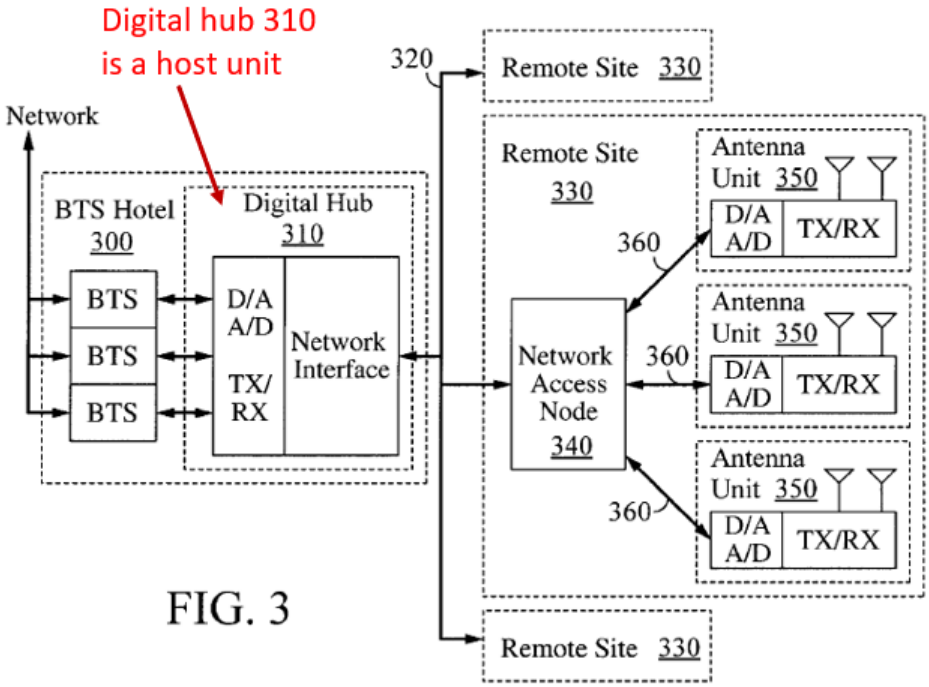
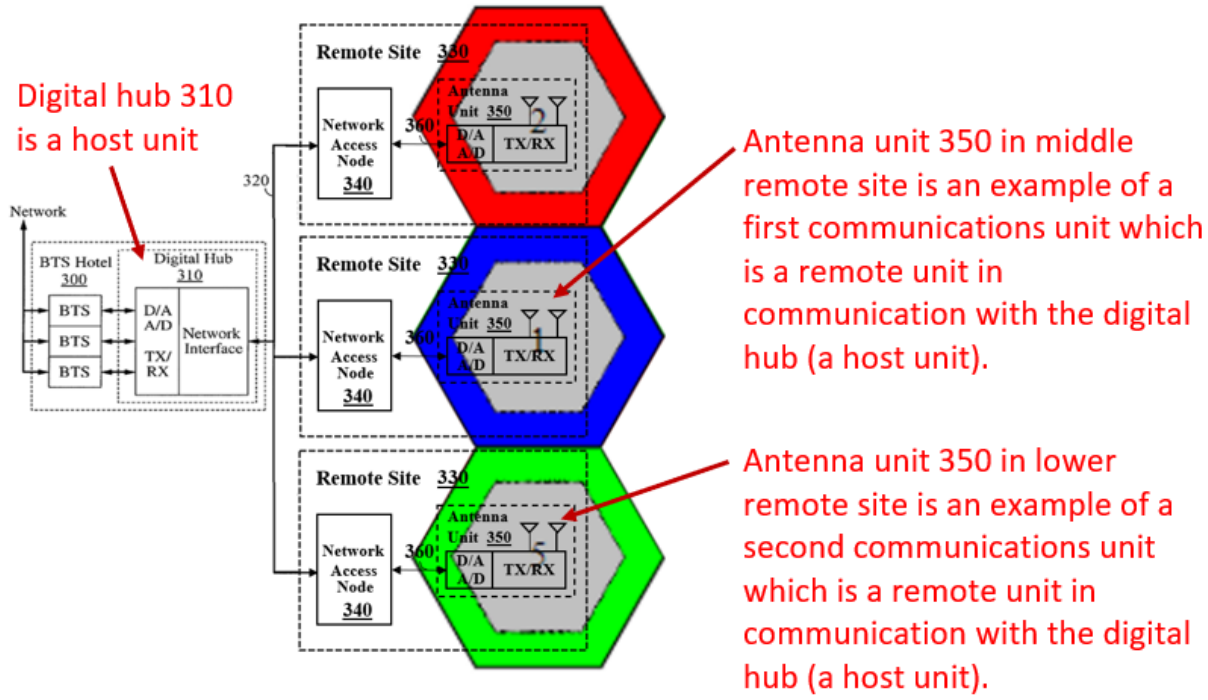


FIG. 3

Combination of Stratford and Ericsson



454. Stratford's digital hub 310 is a host unit. It receives and manages signals from base stations at the base station hotel 300. The hub digitizes and formats the base station signals for transmission to the remote antenna units via the network links and access nodes 340. Ex. 1009 at 6:38-50 ("Downlink cellular signals from a base station are digitized at the digital hub 310 and sent as standard formatted data over the digital network 320 to the NANs 340. …The digital hub converts the uplink data back to analog RF signals which then get passed on to the appropriate base stations (BTS)."), 6:51-7:38 ("RF/Digital Conversion"). It performs the reciprocal functions in the upstream direction.

3. Claim 9

"9. The method of claim 7 wherein the first geographic footprint includes a location of the first communications unit."

455. The combination of Stratford and Ericsson also renders obvious claim 9. The elements of claim 7, from which claim 9 depends, are obvious in light of Stratford and Ericsson for the reasons discussed above with respect to claim 7. Claim 9 adds that the first geographic footprint includes a location of the first communications unit. This is disclosed by Stratford (and inherently by Ericsson).

456. Stratford's remote antenna units 350 are located within the remote cellular site (*see, e.g.*, Ex. 1009 at Fig. 3) and within the geographic footprint of the grey inner area associated with the first carrier signals (first set of frequencies) in the combination of Stratford with Ericsson.

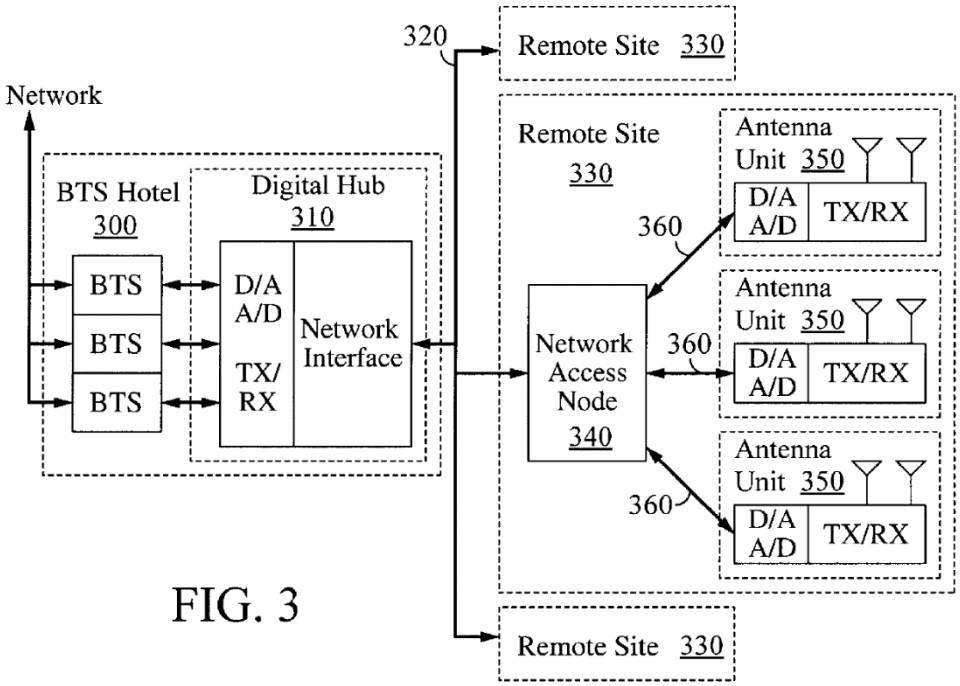
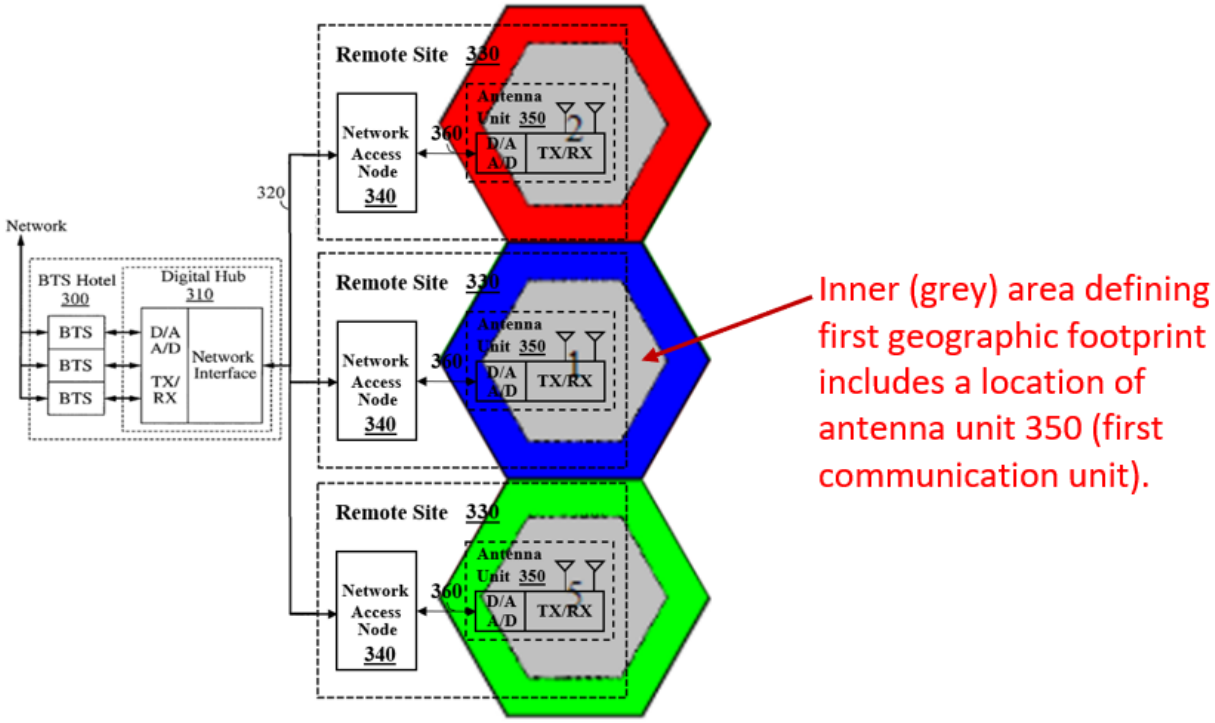


FIG. 3

Combination of Stratford with Ericsson



457. Further, one of skill in the art reading Ericsson would inherently conclude that the communication units were centrally located within each cell site in order to create the different geographic footprints using different power levels.

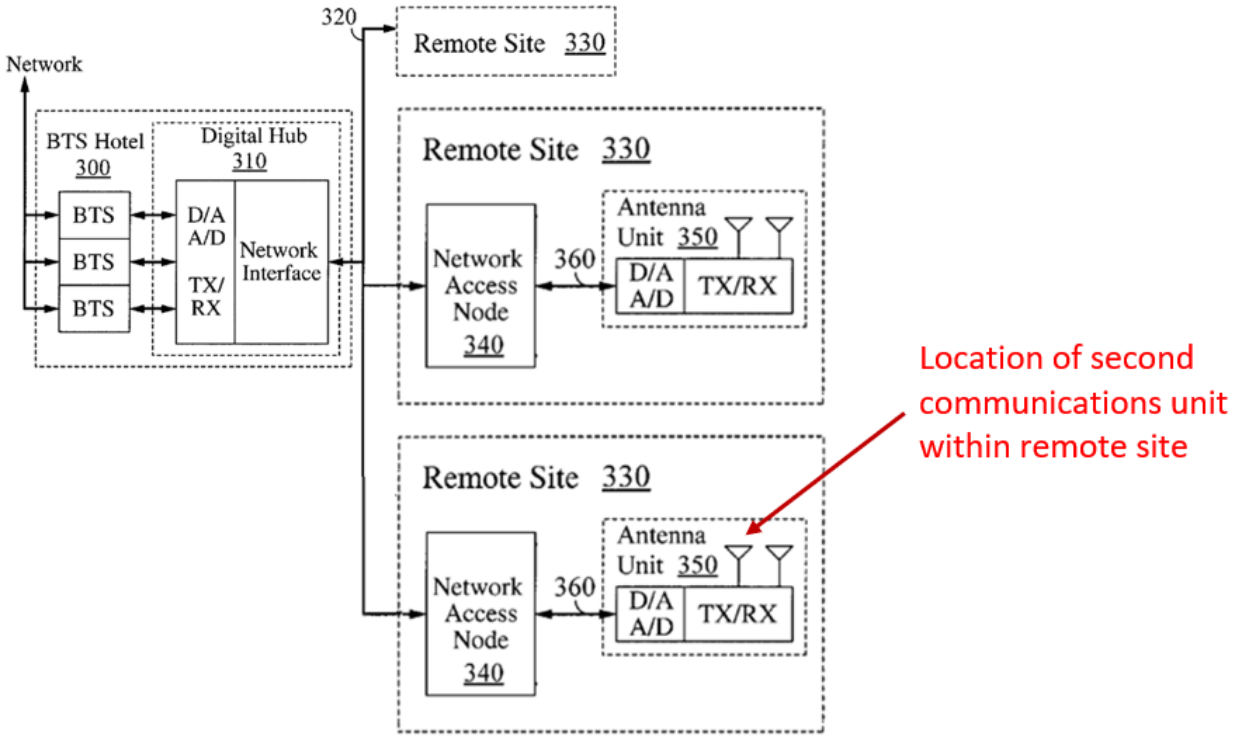
4. Claim 11

"11. The method of claim 7 wherein the third geographical footprint includes a location of the second communications unit."

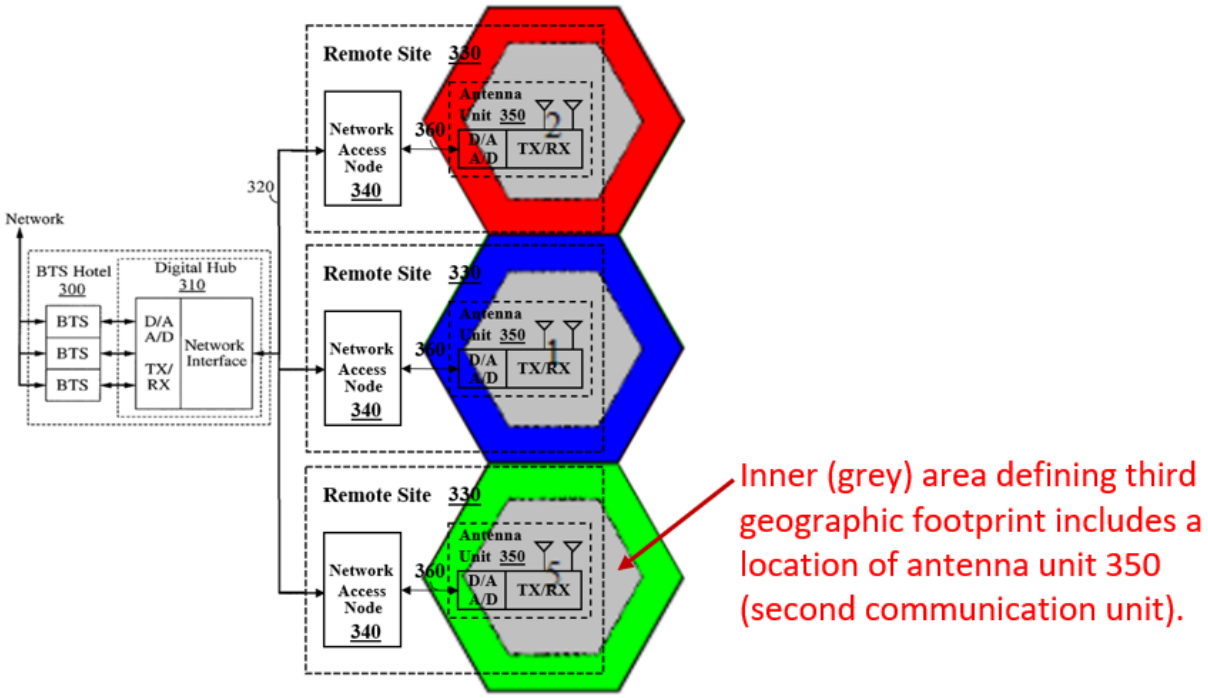
458. The combination of Stratford and Ericsson also renders obvious claim 11. The elements of claim 7, from which claim 11 depends, are obvious in light of Stratford and Ericsson for the reasons discussed above with respect to claim 7.

Claim 11 adds that the third geographic footprint includes a location of the second communications unit. This is disclosed by Stratford (and inherently by Ericsson).

459. In the combination of Stratford with Ericsson, Stratford's second remote antenna unit 350 is located within the second remote cellular site (*see* description of, *e.g.*, Fig. 3) and within the geographic footprint of the grey inner area associated with the reused frequencies in Stratford's combination with Ericsson.



Combination of Stratford with Ericsson



460. Further, one of skill in the art reading Ericsson would inherently conclude that the communication units were centrally located within each cell site and within its geographic footprints in order to create the different geographic footprints merely using different power levels for transmission/reception as shown in Ericsson's Figure 2.

5. Claim 15

461. The same combination of Stratford and Ericsson discussed above with respect to claim 7 and 8 also renders obvious claim 15 for the same reasons as claim 7 and 8 are obvious. I incorporate my discussion of claim 7 and 8 into my analysis of claim 15.

a. Element 15A

"A communications system, comprising"

462. Stratford discloses a communications system. Ex. 1009 at Title, 1:15-16 ("Wireless communication systems, and cellular system in particular"); 3:9-20 ("In one aspect of the invention, a method of downlink wireless communication is implemented by a system comprising…"). Figure 3 of Stratford, for example, discloses a communications system, including base stations, a digital hub, digital fiber communications links, network access nodes and antenna units for providing wireless cellular communications coverage. *See* Ex. 1009 at Fig. 3, 6:29-51.

b. Element 15B

"a host unit"

463. Stratford's digital hub 310 is a host unit. It receives and manages signals from base stations at the base station hotel 300 and digitizes, formats and distributes those signals to appropriate remote cell sites using optical fiber communication links leading to distributed antenna units via network access nodes. *See*, *e.g.*, Ex. 1009 at 6:38-50 ("Downlink cellular signals from a base station are digitized at the digital hub 310 and sent as standard formatted data over the digital network 320 to the NANs 340. …The digital hub converts the uplink data back to analog RF signals which then get passed on to the appropriate base stations (BTS)."); 6:51-7:38 ("RF/Digital Conversion"); Fig. 3; 6:34-38 ("The digital hub

310 is connected via a digital network 320 to one or more remote sites 330. Each remote site has a network access node (NAN) 340 and several remote antenna units 350 connected to the NAN 340 by digital communication links 360."). It performs the reciprocal functions in the upstream direction. Ex. 1009 at 3:48-60; 4:45-63, 6:44-50.

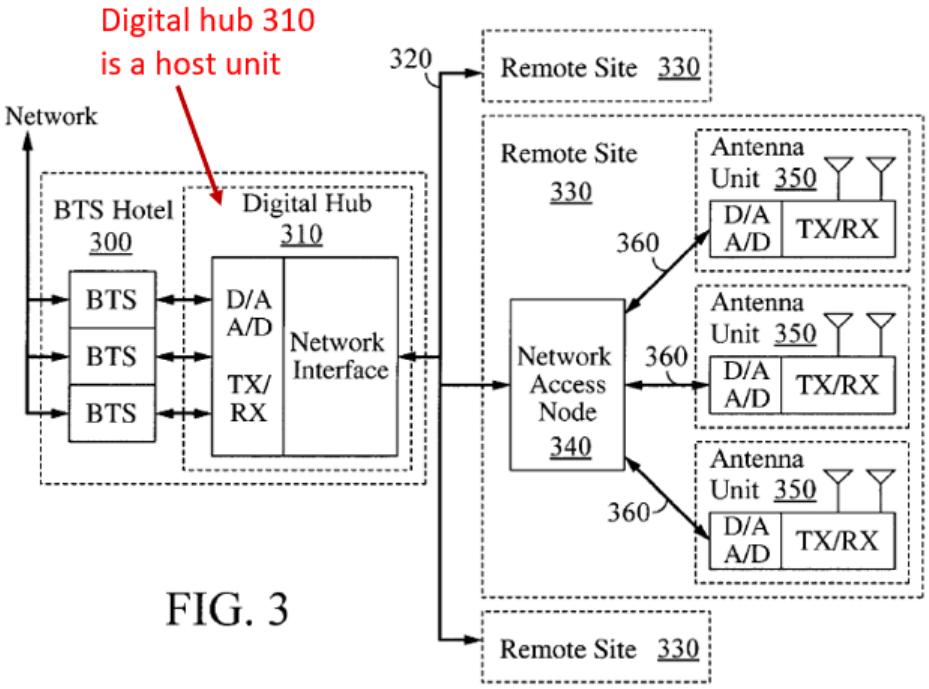
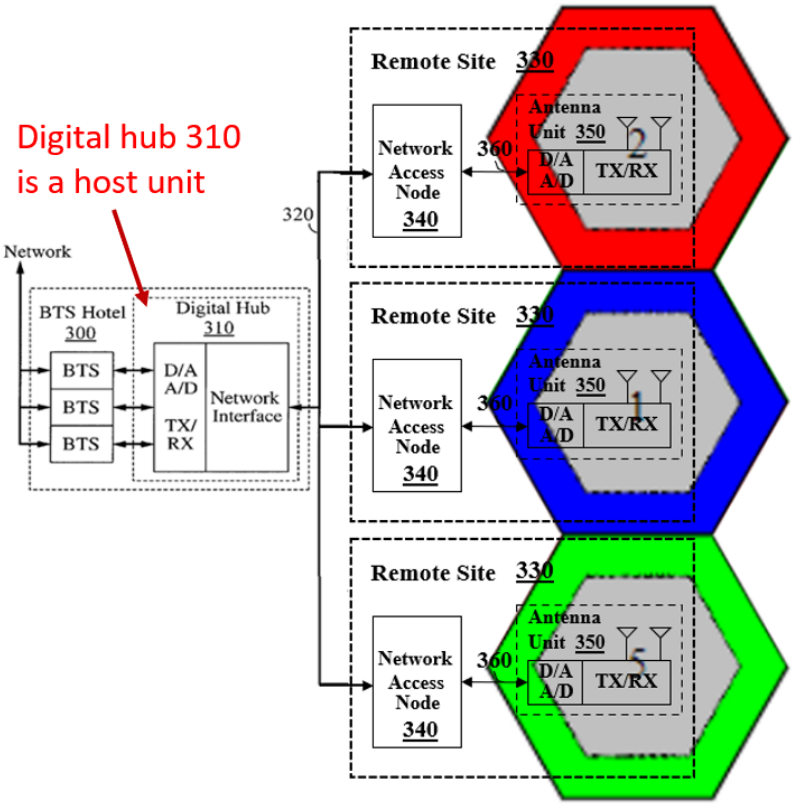


FIG. 3

464. The combination of Stratford and Ericsson discussed above for claim 7 includes a host unit in communication with multiple antenna units (via network access nodes) as shown below.

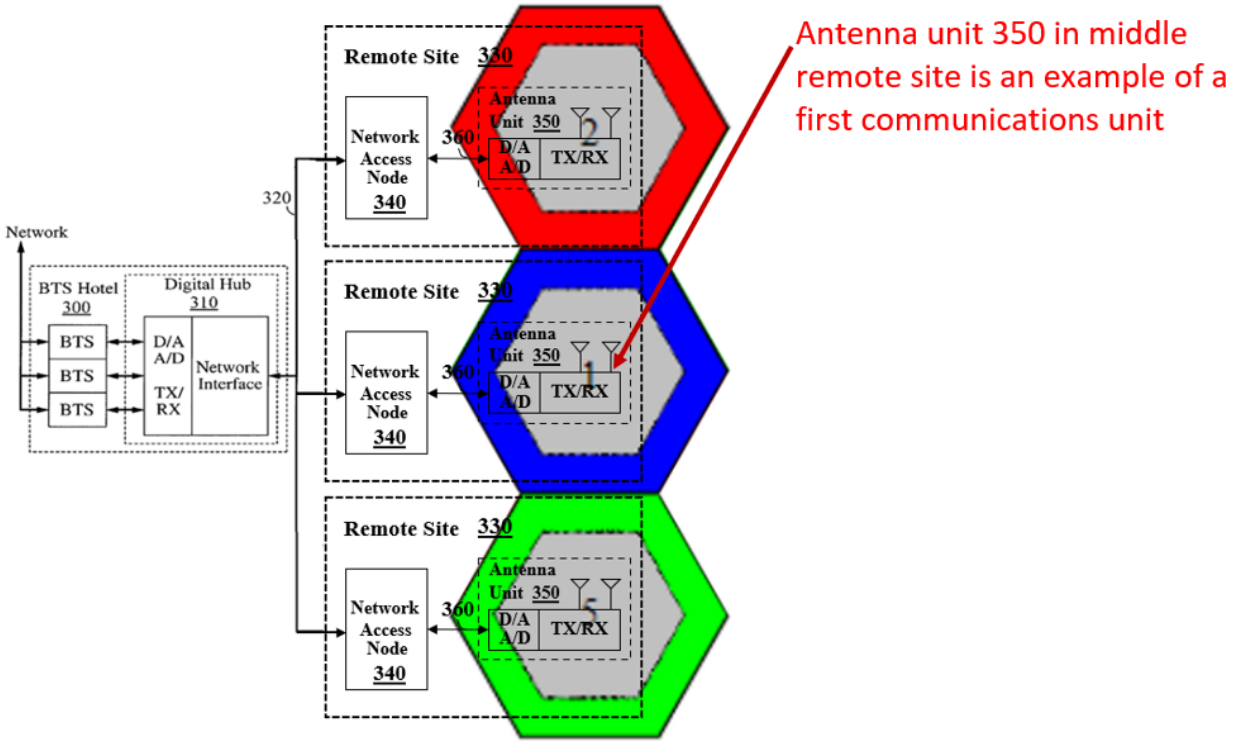


c. Element 15C

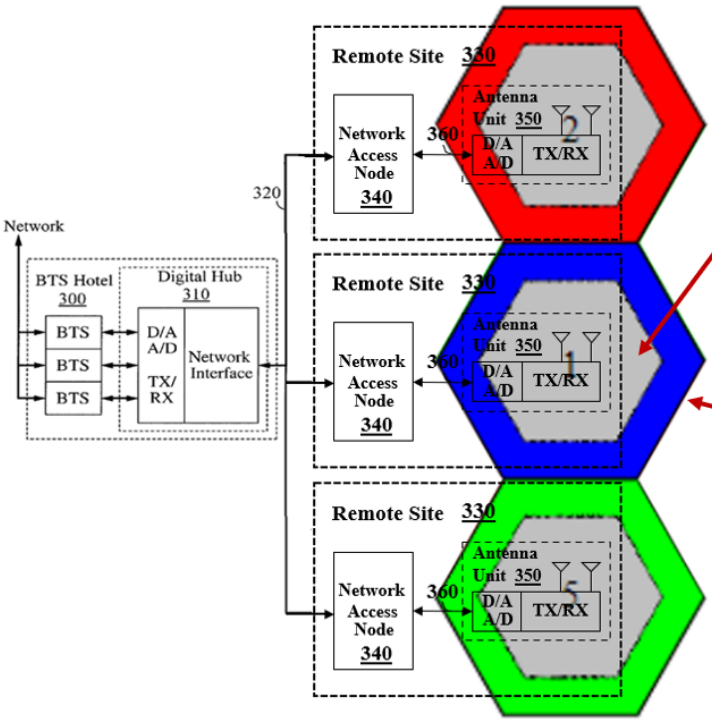
"a first communications unit coupled to the host unit and operable to transmit and receive communications using a first set of frequencies in a first frequency range and associated with a first geographical footprint and a second set of frequencies in a second frequency range and associated with a second geographical footprint larger than the first geographical footprint; and"

465. Element 15C is satisfied in the combination of Stratford and Ericsson for the same reasons as element 7C is satisfied. Stratford's antenna unit at one of its remote cell sites is a first communications unit.

466. When combined with Ericsson for the reasons discussed above regarding claim 7, the antenna unit (first communications unit) is coupled to the digital hub ("host unit") via optical fiber and the network access node.



467. When combined with Ericsson for the reasons discussed above regarding claim 7, the antenna unit (first communications unit) is operable to transmit and receive communications using a both (a) a first set of frequencies in a first frequency range in a region associated with a first geographic footprint, and (b) a second set of frequencies in a second frequency range and associated with a second geographical footprint, as shown below.



The first communications unit transmits and receives a first set of frequencies in a first frequency range (including e.g., the red portion of the spectrum) in the region shown in grey having a first geographic footprint.

The first communications unit also transmits and receives a second set of frequencies in a second frequency range (only the blue part of the spectrum). The geographical footprint of the blue frequencies is larger than and surrounds the geographic footprint (shown in grey) of the red and green set of frequencies used in the inner region.

Users in inner part of the cell may be assigned the full spectrum.



Users at the outer part of the cell may only be assigned part of the full spectrum.

468. As shown above, for the middle remote cell site, the geographical footprint or coverage area of the blue set of frequencies is larger than and surrounds the geographical footprint of the red (and green) set of frequencies shown in grey area. Ericsson teaches that this is achieved by using reduced power for the red (and green) portions of the frequency spectrum as compared to the power used for the blue portion of the frequency spectrum at the middle cell site.

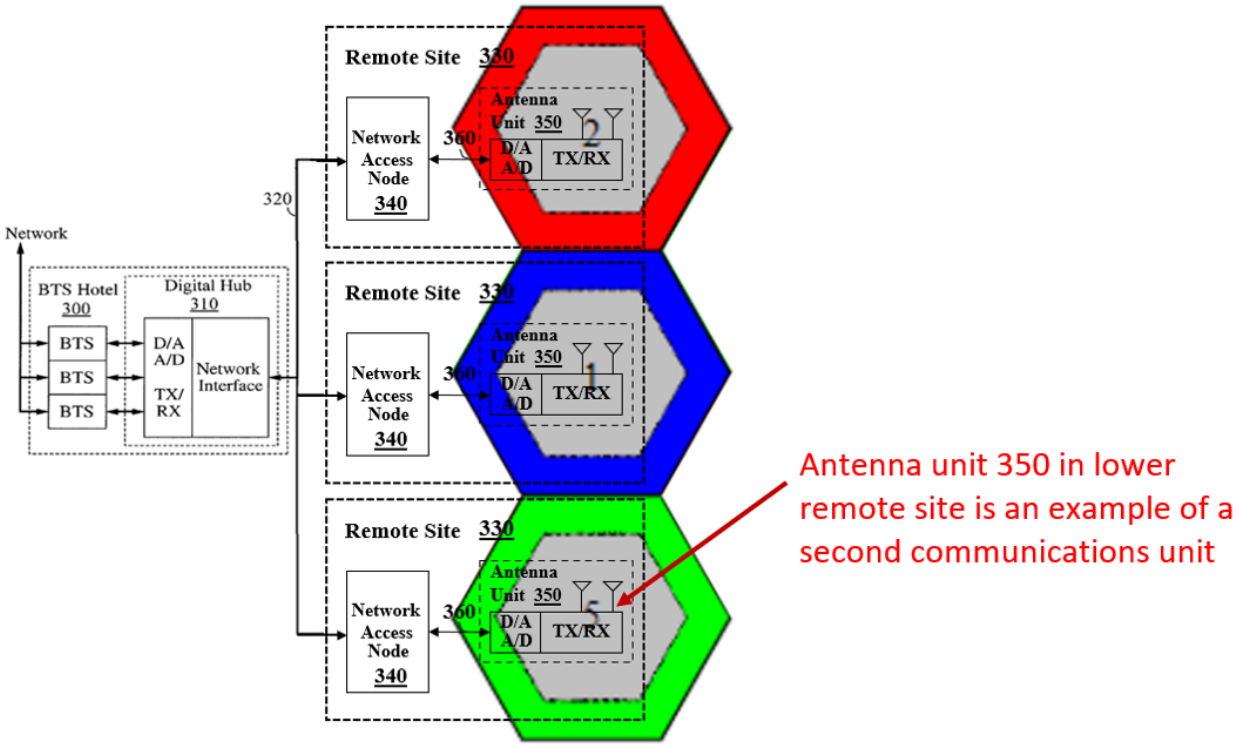
c. Element 15D

"a second communications unit coupled to the host unit and operable to transmit and receive communications using one or more of the first set of frequencies in a region associated with a third geographical footprint and a third set of frequencies in a third frequency range and associated with a fourth geographical footprint larger than the third geographical footprint."

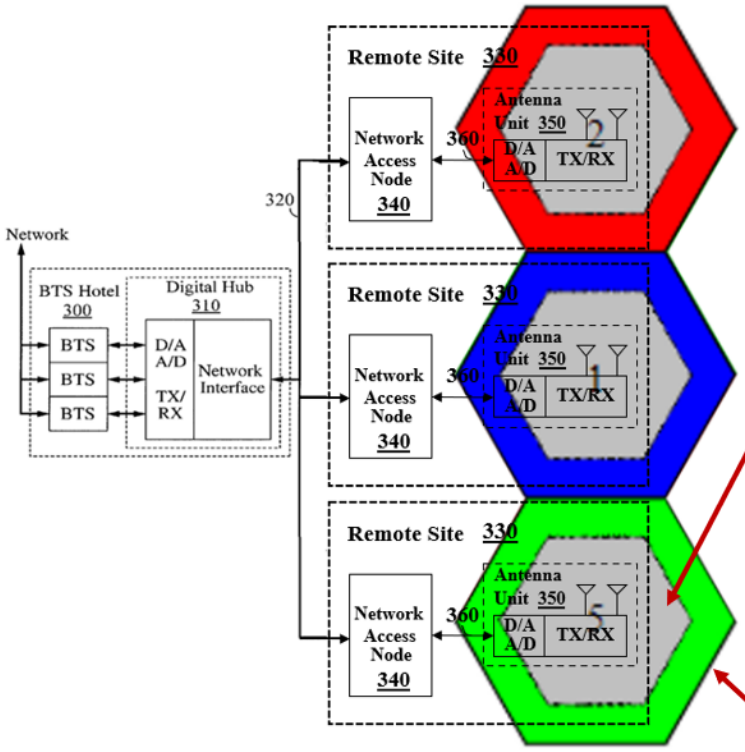
469. Element 15D is satisfied in the combination of Stratford and Ericsson for the same reasons as element 7D is satisfied. A second of Stratford's antenna units at an adjacent remote cell site is a second communications unit.

470. When combined with Ericsson for the reasons discussed above regarding claim 7, the antenna unit (second communications unit) is coupled to the

digital hub ("host unit") via optical fiber and the network access node.

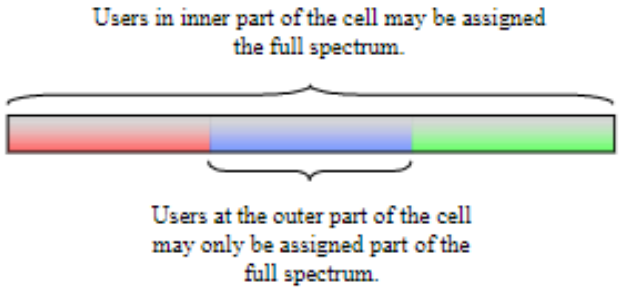


471. When combined with Ericsson for the reasons discussed above regarding claim 7, the antenna unit at the second remote cell site (second communications unit) is operable to transmit and receive communications using a one or more of the first set of frequencies in a region associated with a third geographic footprint as shown below. For example, it uses the red portion of the frequency spectrum at reduced power having a third geographical footprint (shown as the inner grey area) in the lower cell site.



The second communications unit transmits and receives one or more of the frequencies in the first set (e.g. the red frequencies) in the region shown in grey (third geographical footprint).

The second communications unit also transmits and receives a third set of frequencies in a third frequency range (including only the green part of the frequency spectrum). The geographical footprint of the green frequencies is larger than and surrounds the footprint of the red frequencies used in the inner grey areas of both remote sites.



472. As shown above, for the lower remote cell site, the geographical footprint or coverage area of the green set of frequencies is larger than and surrounds the geographical footprint of the red and blue set of frequencies shown in grey area. Ericsson teaches that this is achieved by using reduced power for the red and blue portions of the frequency spectrum as compared to the power used for the green portion of the frequency spectrum at the bottom cell site.

473. For the foregoing reasons (including the reasons given in my discussion of claims 7 and 8) claim 15 would have been obvious to one of ordinary skill in the art based on the combination of Stratford and Ericsson.

6. Claim 17

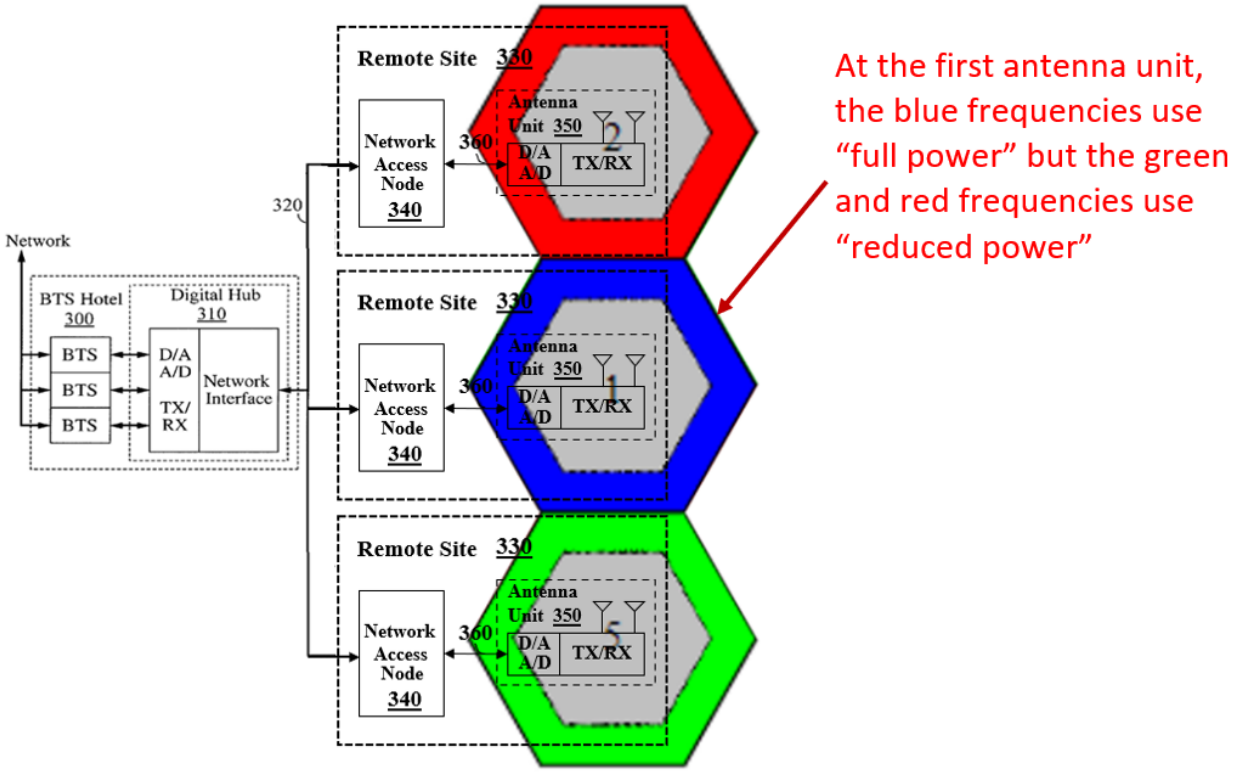
"17. The communications system of claim 15 wherein the communications using the first set of frequencies in the first frequency range are associated with a first power level and the communications using the second set of frequencies in the second frequency range are associated with a second power level greater than the first power level."

474. The combination of Stratford and Ericsson also renders obvious claim 17. The elements of claim 15, from which claim 17 depends, are obvious in light of Stratford and Ericsson for the reasons discussed above with respect to claim 15 (and 7 and 8). Claim 17 merely adds that the communications using the second set of frequencies are associated with a different, higher power level than the second set of frequencies. This is exactly what is taught in Ericsson:

> Figure 2 illustrates the principle of fractional frequency reuse. In the figure, only cell 1 is allowed to transmit with **full power** using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a **reduced power**. This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2.

475. This teaching is illustrated in the figure below:



476. At the middle cell site, the blue frequencies are the second set of frequencies that convey communications using a greater power level than the power level used to convey communications in the red and green set of frequencies.

7. Claim 18

"18. The communications system of claim 15 wherein the communications using one or more of the first set of frequencies in the region associated with a third geographical footprint are associated with a first power level and the communications using the third set of frequencies in the third frequency range are associated with a second power level greater than the first power level."

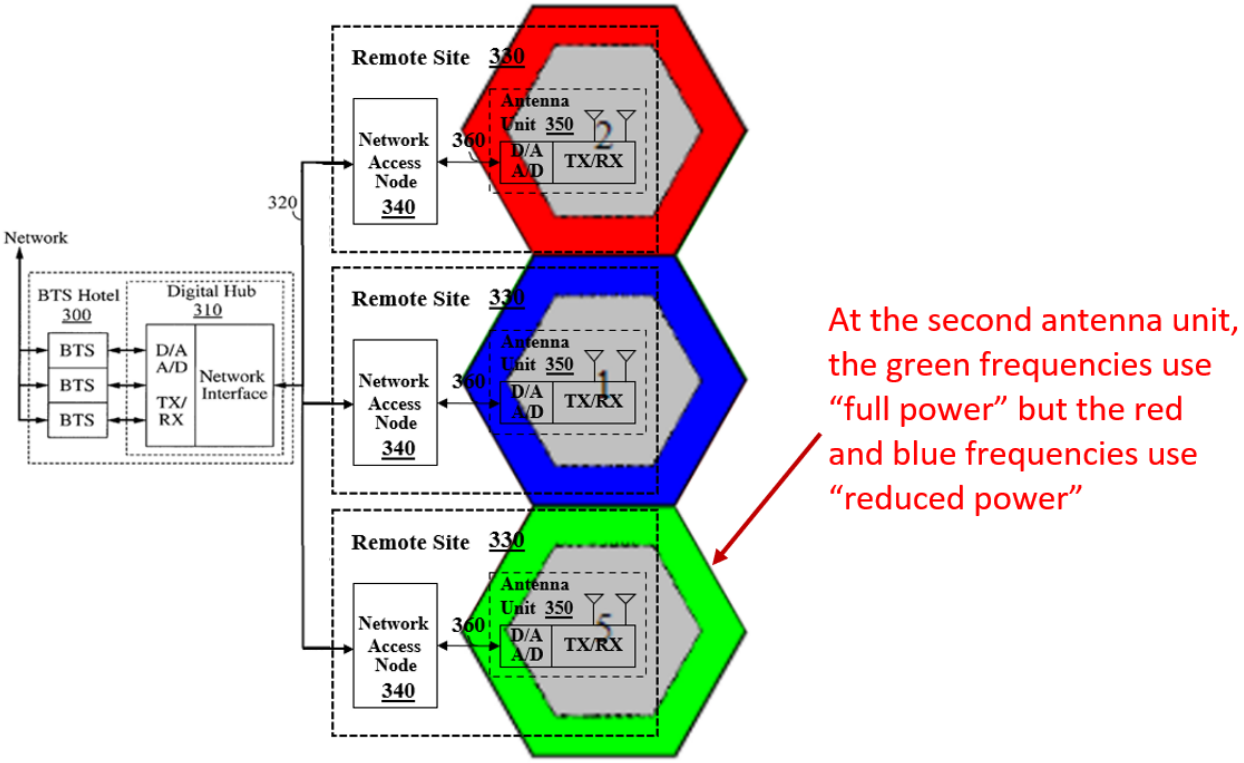
477. The combination of Stratford and Ericsson also renders obvious claim 18. The elements of claim 15, from which claim 18 depends, are obvious in light of Stratford and Ericsson for the reasons discussed above with respect to claim 15 (and 7 and 8). Claim 18 merely adds that the communications using the third frequency range (associated with the fourth geographical footprint) use a different, higher power level than the communications conveyed by the set of frequencies associated with the third geographical footprint. This is exactly what is taught in Ericsson:

> Figure 2 illustrates the principle of fractional frequency reuse. In the figure, only cell 1 is allowed to transmit with **full power** using the "blue" part of the spectrum while cells 2-7 only are allowed to transmit in the blue part of the spectrum using a **reduced power**.

> This will reduce the downlink interference seen by cell-edge users served by cell 1. Similarly, cell-edge UEs received by cell 1 will only transmit in the uplink using the blue part of the spectrum in order not to cause excessive interference in cells 2-7. UEs located in the inner parts of cell 1 may use the full part of the spectrum as the attenuation to the other cells keeps the interference at a reasonable level, assuming slow power control combating and log-normal fading path loss.

Ex. 1007 at 2.

478. This teaching is illustrated in the figure below:



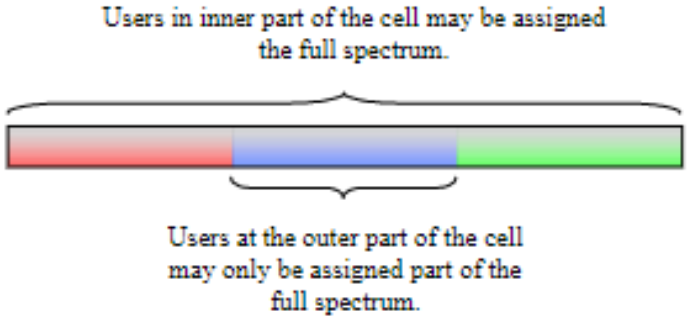
479. At the bottom cell site, the green frequencies are the third set of frequencies that convey communications using a greater power level than the power level used to convey communications in the red and blue set of frequencies.

8. Claim 20

"20. The communications system of claim 15 wherein the first frequency band and the second frequency band are contiguous frequency bands."

480. Here it is unclear what claim 20 is referring to as "the first frequency band" and "the second frequency band." There is no prior recitation of frequency bands in claim 15 or claim 20. If these are construed to be referring to the first and second frequency ranges introduced in claim 15, then this limitation is disclosed by the combination of Stratford and Ericsson.

481. The elements of claim 15, from which claim 20 depends, are obvious in light of Stratford and Ericsson for the reasons discussed above with respect to claim 15 (and 7 and 8). Claim 20 merely adds that the first frequency band and the second frequency band are contiguous frequency bands. In the combination of Stratford and Ericsson discussed above for claim 15, the first and second frequency bands (e.g., the green portion of spectrum and the blue portion of spectrum respectively) are contiguous frequency bands. Likewise the blue portion and the red portion of the spectrum are contiguous.

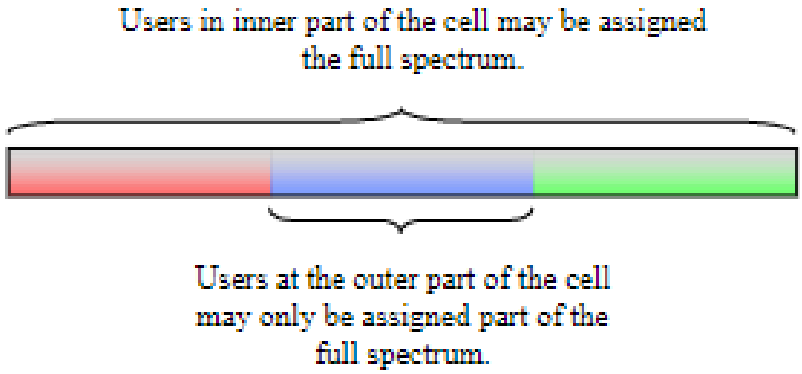


Ex. 1007 at 2, Fig. 2.

8. Claim 21

"21. The communications system of claim 15 wherein the first frequency range, the second frequency range, and the third frequency range include distinct frequencies."

482. The combination of Stratford and Ericsson also renders obvious claim 21. The elements of claim 15, from which claim 21 depends, are obvious in light of Stratford and Ericsson for the reasons discussed above with respect to claim 15 (and 7 and 8). Claim 21 merely adds that the first frequency range, the second frequency range, and the third frequency range include distinct frequencies. This is disclosed in Ericsson. As shown in the figure of Ericsson these ranges include distinct frequencies. For example, the red frequency range (first set of frequencies with a first footprint) includes frequencies that are distinct from the blue frequency range (second set of frequencies with a second footprint), and frequencies which are distinct from the green frequency range (third set of frequencies).



Ex. 1007 at 2, Fig. 2.

Executed on: January 12, 2023

Dr. Anthony Acampora

Claims Listing Appendix

U.S. Patent No. 9,197,358

Challenged Claims

Designation	Claim 7
Element 7A	7. A method of distributing communications frequencies, the method providing:
Element 7B	providing a set of communications units;
Element 7C	transmitting and receiving, from a first communications unit of the set of communications units: a first set of frequencies characterized by a first frequency band and a first geographic footprint; and a second set of frequencies characterized by a second frequency band different from the first frequency band and a second geographic footprint larger than and at least partially surrounding the first geographic footprint; and
Element 7D	transmitting, and receiving, from a second communications unit of the set of communications units: a third set of frequencies including one or more frequencies in the first frequency band and a third geographical footprint; and a fourth set of frequencies including one or more frequencies in a third frequency band and a fourth geographical footprint larger than and at least partially surrounding the third geographical footprint.
Claim 8	8. The method of claim 7 wherein the set of communications units includes a plurality of remote units in communication with a host unit.

Claim 9	9. The method of claim 7 wherein the first geographic footprint includes a location of the first communications unit.
Claim 11	11. The method of claim 7 wherein the third geographical footprint includes a location of the second communications unit.

Designation	Claim 15
Element 15A	15. A communications system comprising:
Element 15B	a host unit;
Element 15C	a first communications unit coupled to the host unit and operable to transmit and receive communications using a first set of frequencies in a first frequency range and associated with a first geographical footprint and a second set of frequencies in a second frequency range and associated with a second geographical footprint larger than the first geographical footprint; and
Element 15D	a second communications unit coupled to the host unit and operable to transmit and receive communications using one or more of the first set of frequencies in a region associated with a third geographical footprint and a third set of frequencies in a third frequency range and associated with a fourth geographical footprint larger than the third geographical footprint.
Claim 17	17. The communications system of claim 15 wherein the communications using the first set of frequencies in the first frequency range are associated with a first power level and the communications using the second set of frequencies in the second

	frequency range are associated with a second power level greater than the first power level.
Claim 18	18. The communications system of claim 15 wherein the communications using one or more of the first set of frequencies in the region associated with a third geographical footprint are associated with a first power level and the communications using the third set of frequencies in the third frequency range are associated with a second power level greater than the first power level.
Claim 20	20. The communications system of claim 15 wherein the first frequency band and the second frequency band are contiguous frequency bands.
Claim 21	21. The communications system of claim 15 wherein the first frequency range, the second frequency range, and the third frequency range include distinct frequencies.