

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS INC.,

Petitioner

IPR2025-01569

U.S. Patent No. 7,894,385

**DECLARATION OF CHRISTOPHER HANSEN, PH.D.,
UNDER 37 C.F.R. § 1.68 IN SUPPORT OF PETITION
FOR *INTER PARTES* REVIEW**

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I, Christopher Hansen, Ph.D., do hereby declare as follows:

I. INTRODUCTION

1. I am making this declaration at the request of Cisco Systems, Inc. in the matter of the *Inter Partes* Review of U.S. Patent No. 7,894,385 (“the ’385 patent”) to daCosta and Dayanandan.

2. I am being compensated for my work in this matter at my standard hourly rate. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this proceeding. My compensation is not contingent on the outcome of this matter or the specifics of my testimony.

3. I have been asked to provide my opinions regarding whether the subject matter of claims 1-3 (“the Challenged Claims”) of the ’385 patent would have been obvious to a person having ordinary skill in the art (“POSITA”) at the time of the alleged invention, in light of the prior art. It is my opinion that the Challenged Claims would have been obvious to a POSITA.

4. In the preparation of this declaration, I have studied:

- a. the ’385 patent, Ex.1001;
- b. the prosecution history of the ’385 patent (“’385 File History”), Ex.1002;
- c. U.S. Patent Publication No. 2006/0215583 to Castagnoli (“Castagnoli”), Ex.1005;

d. U.S. Patent No. 5,982,780 to Bohm et al. (“Bohm”), Ex.1006;
and

e. U.S. Patent Publication No. 2006/0198346 to Liu et al. (“Liu”),
Ex.1007.

5. In forming the opinions expressed below, I have considered: the documents listed above; the relevant legal standards, including the standard for obviousness; and my own knowledge and experience based upon my work in the field of wireless network communications as described below, as well as portions of the following additional materials:

a. U.S. Patent Publication No. 2002/0136170 to Struhsaker,
Ex.1008;

b. U.S. Patent Publication No. 2003/0224750 to Sampath, Ex.1009;

c. U.S. Patent Publication No. 2009/0049199 to Kuik et al.,
Ex.1010;

d. IEEE Standard 802.11-1999, Ex.1011;

e. U.S. Patent No. 5,535,338 to Krause et al., Ex.1013;

f. A. S. Tanenbaum, Computer Networks, 4th ed. (Prentice Hall PTR), Ex.1014;

g. J. Henry, 802.11s Mesh Networking (White paper) (The Certified Wireless Network Professional (CWNP) Program), Ex.1015;

- h. A. S. Tanenbaum, *Modern Operating Systems*, 2nd ed. (Prentice Hall PTR), Ex.1016;
- i. H. Newton, *Newton's Telecom Dictionary*, 17th ed. (CMP Books), Ex.1018;
- j. U.S. Patent No. 5,027,431 to Tanaka et al., Ex.1019;
- k. U.S. Patent No. 6,912,215 to Lin et al., Ex.1020;
- l. U.S. Patent No. 7,333,800 to Gopinath, Ex.1021;
- m. U.S. Patent No. 7,630,332 to Elliott, Ex.1022;
- n. U.S. Patent Publication No. 2004/0100929 to Garcia-Luna-Aceves, Ex.1023;
- o. U.S. Patent Publication No. 2006/0003764 to Saglam et al., Ex.1024;
- p. U.S. Patent Publication No. 2006/0117174 to Lee, Ex.1025;
- q. U.S. Patent Publication No. 2007/0100396 to Freeberg, Ex.1026;
- r. U.S. Patent No. 6,807,163 to Shi, Ex.1027;
- s. U.S. Patent Publication No. 2006/0114851 to Gupta et al., Ex. 1028;
- t. U.S. Patent Publication No. 2005/0058149 to Howe, Ex.1029;
- u. U.S. Patent No. 7,058,027 to Alessi, Ex.1030;
- v. U.S. Patent Publication No. 2006/0009244 to Schacht, Ex.1031;

- w. U.S. Patent Publication No. 2004/0218562 to Orava et al., Ex.1032;
- x. U.S. Patent No. 5,081,623 to Ainscow, Ex.1033;
- y. U.S. Patent No. 4,747,100 to Roach et al., Ex.1034;
- z. U.S. Patent No. 4,803,485 to Rypinski, Ex.1035; and
- aa. Infringement Contentions for the '385 patent, *Dynamic Mesh Networks, Inc. d/b/a MeshDynamics v. Cisco Systems, Inc.*, No. 2:25-cv-00472 (E.D. Tex.), Ex.1036.

6. Unless otherwise noted, all **emphasis** in any quoted material has been added. Claim terms are *italicized*.

II. QUALIFICATIONS AND PROFESSIONAL EXPERIENCE

7. My complete qualifications and professional experience are described in my *Curriculum Vitae*, a copy of which can be found in Exhibit 1004. The following is a brief summary of my relevant qualifications and professional experience.

8. I am currently an independent technical consultant based in Los Altos, California. I work at Covariant Corporation, which is a consulting company that I own. My primary areas of expertise are in the fields of wireless networking, wireless standards development, and signal processing for wireless communications. I received a Bachelor of Science (B.S.) degree in Electrical

Engineering from Rensselaer Polytechnic Institute in 1987, a Master of Science (M.S.) in Electrical Engineering from the University of Massachusetts, Amherst in 1989, and a Ph.D. in Electrical Engineering from the University of California, Los Angeles (“UCLA”) in 1997.

9. I was employed by Broadcom Corporation (“Broadcom”) in Sunnyvale, California from January 2000 to May 2012. From January 2000 to February 2011, I held several titles, including Sr. Staff Scientist, Engineering Manager, and Sr. Principal Scientist. My duties in these roles included, among other things, Institute of Electrical and Electronics Engineers (“IEEE”) 802.11 (i.e., Wi-Fi) physical layer (“PHY”) application-specific integrated circuit (“ASIC”) development. I also participated in Bluetooth standard development during this timeframe. From March 2011 to May 2012, I served as an Associate Technical Director and my duties included, among other things, performing wireless communications technology research and development (“R&D”) as well as standards and intellectual property development.

10. While employed at Broadcom, I regularly attended meetings for the IEEE 802.11 Working Group. I submitted technical contributions to Task Group E (“TGe”), Task Group H (“TGh”), and Task Group N (“TGn”).

11. I served on the Board of Directors of the Wireless Gigabit Alliance (“WiGig Alliance”) from March 2010 to March 2012. Specifically, I served as the

Board's Secretary. The WiGig Alliance was a trade association focused on the development and promotion of high-speed wireless communications technology. The WiGig Alliance collaborated for multiple years with the Wi-Fi Alliance (an industry organization that owns the "Wi-Fi" brand and certifies devices for interoperability and security), and the two organizations eventually merged in 2013.

12. I served as the Vice Chair of the IEEE 802.11ad Task Group ("TGad") from May 2011 to March 2012. TGad developed an amendment to the IEEE 802.11 wireless networking standard focused on directional multi-gigabit (i.e., DMG) technology. In this role, I assisted the task group Chair, Eldad Perahia, and Technical Editor, Carlos Cordeiro, with the operation of the task group meetings and developing the 802.11ad draft standards amendment documents.

13. I was employed as a Senior Wireless System Architect by Apple Inc. ("Apple") in Cupertino, California from June 2012 to July 2013. During my tenure at Apple, I was responsible for, among other things, performing systems engineering for iPhone Operating System ("iOS") Wi-Fi functionality. During this time, I participated in multiple IEEE 802.11 groups, including Task Group AF ("TGaf") and the HEW Study Group, on behalf of Apple. I also regularly accessed and reviewed documents submitted by members of the IEEE 802.11 Working Group, including through the IEEE Mentor server.

14. Since August 2013, I have been employed as President of Covariant Corporation in Los Altos, California. In this role, I provide technical consulting services related to wireless communications, IEEE 802.11/Wi-Fi, signal processing technology, integrated circuits technology, and intellectual property. During the time I have been employed by Covariant, I have submitted multiple technical contributions to Task Group AY (“TG_{AY}”) (responsible for 802.11ay) which led to new mmWave features, Task Group M (“TG_M”) (responsible for the 802.11-2020 standard), and the Integrated mmWave Study Group (“IMW SG”) (the precursor for TG_{bq}). I received awards from the IEEE for my contributions to TG_{AY} and TG_M.

15. I served as a member of the Board of Directors for the Professional and Technical Consultants Association (“PATCA”) in Silicon Valley, California from March 2017 to March 2024. I was President of the Board of Directors from June 2019 to March 2024. PATCA is a non-profit corporation that supports technical consultants in Silicon Valley and elsewhere.

16. Since June 2020, I have been employed as a Guest Instructor for the UCLA Department of Electrical and Computer Engineering. I teach classes on wireless communications for upper-level undergraduate students and graduate students in electrical engineering. In these classes, I use examples from the IEEE 802.11 standards.

17. I am a named inventor on over 100 issued United States patents related to wireless communications, signal processing, and integrated circuits.

18. I have been a member of the Institute of Electrical and Electronics Engineers (“IEEE”) since 1983 (42 years) and am currently a Senior member. I have participated in the activities of the IEEE Standards Association (“IEEE-SA”) continuously since 2000. I have participated in the IEEE 802.11 Wireless Local Area Networks (“WLAN”) Working Group as a voting member since 2000.

III. LEVEL OF ORDINARY SKILL IN THE ART

19. I understand there are multiple factors relevant to determining the level of ordinary skill in the pertinent art, including (1) the levels of education and experience of persons working in the field at the time of the invention; (2) the sophistication of the technology; (3) the types of problems encountered in the field; and (4) the prior art solutions to those problems.

20. A POSITA in the field of the ’385 patent, as of its claimed priority date of June 19, 2006, would have been someone knowledgeable and familiar with wireless mesh networks and techniques for operating the same available in the mid-2000s. A POSITA would have had a working knowledge of the wireless networking art that is pertinent to the ’385 patent, including familiarity with standards such as IEEE 802.11. For example, the ’385 patent uses (without explanation) the acronyms AP and BSS (Ex.1001, 3:4-6), which a POSITA would

have understood to stand for “access point” and “basic service set,” respectively, from being familiar with the IEEE 802.11 standard. Ex.1011, 3 (defining “access point” and “basic service set”).

21. A POSITA would have a bachelor’s degree in computer science, computer engineering, electrical engineering, or equivalent training, and approximately two years of experience working in the field of network communications, or more particularly, wireless mesh networks. Additional work experience can substitute for specific educational background, and vice versa.

22. For purposes of this Declaration, in general, and unless otherwise noted, my statements and opinions, such as those regarding my own experience and what a POSITA would have understood or known generally (and specifically related to the references I consulted herein), reflect the knowledge that existed in the relevant field as of the priority date of the ’385 patent.

IV. RELEVANT LEGAL STANDARDS

23. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the ’385 patent, I am relying on certain basic legal principles that Cisco’s counsel has explained to me.

24. I understand that prior art to the ’385 patent includes patents and printed publications in the relevant art that predate the claimed priority date of the

'385 patent. For purposes of this Declaration, I am applying June 19, 2006, as the priority date of the '385 patent.

25. I have been informed by Cisco's counsel that a claimed invention is unpatentable under 35 U.S.C. § 103 if the differences between the claimed invention and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a POSITA. I have also been informed by Cisco's counsel that the obviousness analysis considers factual inquiries, including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed subject matter.

26. I have been further informed by Cisco's counsel that there are several recognized rationales for combining references or modifying a reference to show obviousness. These rationales include: (a) combining prior art elements according to known methods to yield predictable results; (b) simple substitution of one known element for another to obtain predictable results; (c) use of a known technique to improve a similar device (method, or product) in the same way; (d) applying a known technique to a known device (method, or product) ready for improvement to yield predictable results; (e) choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and (f) some teaching, suggestion, or motivation in the prior art that would have led a

POSITA to modify the prior art or to combine prior art teachings to arrive at the claimed invention.

V. BACKGROUND

27. As personal computers became more common in the 1980s, businesses found increasing advantages in networking computers together. Ex.1014, 6-9. By the late 1990s, the global network known as the internet evolved from its early military and research uses into a commercial juggernaut. Ex.1014, 50-59. Personal computers also continued to shrink in size and grow in capability, with “laptop” computers becoming increasingly common. With computers becoming more mobile, and network access becoming more important, the desire and interest for wireless networking grew. Ex.1014, 100. While several proprietary and niche wireless networking technologies were introduced in the 1990s, standardization efforts by the Institute of Electrical and Electronics Engineers (IEEE) produced an industry standard in 1997 known as IEEE 802.11, and often referred to as Wi-Fi. Ex.1014, 59-71. The standard was quickly extended in 1999 to standardize higher speed wireless networking technologies that operated in two radio frequency ranges: 802.11(a) operating around 5 GHz, and 802.11(b) operating around 2.4 GHz. Ex.1014, 292-295. Products implementing these standards quickly dominated the market for low-cost, high-speed wireless computer networking. Ex.1014, 301-302.

28. The IEEE 802.11 standards describe two operating modes or architectures. Ex.1014, 68-71. In infrastructure mode, a wireless access point has a wired network connection and provides wireless connectivity to client devices within its communication range. Ex.1014, 68-71. In ad hoc mode, a group of wireless peer nodes directly communicate among themselves (and there is no connectivity to a wired network). Ex.1014, 68-71.

29. Even before the IEEE standards published, there was interest in extending wireless networks to support communication between two nodes that are not close enough to one another to communicate via a single source-to-destination wireless transmission. Ex.1015, 3. To facilitate such communications, one or more intermediate wireless nodes retransmit packets between the source and destination. Ex.1015, 4. The use of packet retransmission was the subject of various projects, including an IEEE standardization effort that began in 2003 and resulted in the formally adopted IEEE 802.11s standard in 2011. Ex.1015, 3-5. Networks that support packet retransmission between wireless nodes are sometimes called “mesh” networks. Ex.1015, 3.

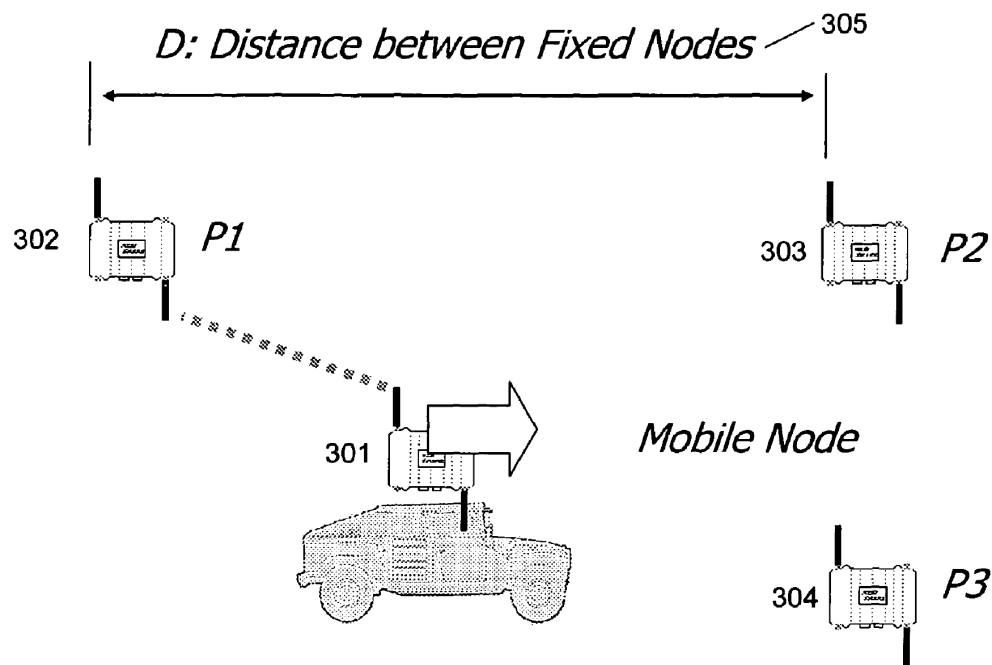
30. All of the features and functionality described in this section were well known in the mid-2000s, and a POSITA would have been familiar with them.

VI. OVERVIEW OF THE '385 PATENT

31. The '385 patent purports to address the issue of maintaining data throughput and low latency in wireless mesh networks with mobile nodes.

Ex.1001, 1:15-21. The patent acknowledges that “existing systems use multiple radio backhaul” and “sometimes use different non-interfering radio channels.”

Ex.1001, 1:21-25. When a node is mobile, however, the '385 patent states that the node “must sample downlink channels” from potential parent nodes and “decide whether to switch from its current parent node.” Ex.1001, 1:33-36. This scenario is illustrated in Fig. 3, below, where mobile node 301 is moving away from current parent node 302 and toward potential parent nodes 303 and 304.



Ex.1001, Fig. 3.

32. The '385 patent describes a technique in which a mobile node uses a dedicated scanning radio to identify potential parent nodes when they come into range. Ex.1001, 3:62-67. The mobile node then uses its uplink radio to evaluate the identified potential new parent nodes. Ex.1001, 4:15-22. While the mobile node is scanning potential parent nodes, both the mobile node and its current parent node buffer packets to be transmitted between them. Ex.1001, 4:15-22. Although Fig. 3 is depicted with only one mobile node, the '385 patent describes how a parent node may have multiple mobile nodes associated with it, with all of them needed to evaluate potential parent nodes. Ex.1001, 4:23-25. To control the amount of buffering the parent node must perform at one time, the parent node coordinates the times that multiple child nodes sample their potential parent nodes. Ex.1001, 4:25-33. For example, time slots may be assigned to the child nodes in round robin fashion. Ex.1001, 4:34-36.

33. In summary, the '385 patent merely combines known elements—multi-radio mesh networking, a dedicated scanning radio, and network coordination via time slots—into one system. This agglomeration of known ideas did not advance human knowledge or understanding, and the '385 patent claims should not have been allowed to issue.

34. As I will explain below, these concepts were well known as of the priority date of the '385 patent.

VII. CLAIM CONSTRUCTION

35. It is my understanding that in order to properly evaluate the '385 patent, the terms of the claims must first be interpreted. It is my understanding that for the purposes of this *inter partes* review, the claims are to be construed under the so-called *Phillips* standard, under which claim terms are given their ordinary and customary meaning as would have been understood by a POSITA in light of the specification and prosecution history, unless the inventor has set forth a special meaning for a term. I have also been informed that claim terms only need to be construed to the extent necessary to resolve the obviousness inquiry.

36. I have reviewed the entirety of the '385 patent, as well as its prosecution history. It is my opinion that for purposes of applying the prior art presented herein to evaluate the patentability of the Challenged Claims, no terms require formal construction. However, I note below one issue regarding claim interpretation.

A. “at a first point in time” (Claim 3)

37. Claim 3 recites “*at a first point in time*” three times. The first instance is in [3.3], which recites “*a first relay radio operating on a first RF channel **at a first point in time** and dedicated to uplink connections to a single current parent node.*” The second instance is in [3.4], which recites “*a second relay radio operating on a second RF channel **at a first point in time** and dedicated to*

downlink connections to zero or more child nodes.” And the third instance is in [3.5], which recites “*a dedicated scanning radio operating on a third RF channel at a first point in time and configured to scan a Radio Frequency (RF) environment*” From the specification and prosecution history, it is apparent that these three recitations are intended to refer to a **single** “*first point in time,*” not three separate and different points in time.

38. During prosecution of the '385 Patent, the patent Applicant identified paragraphs [0015]-[0018] of the specification, corresponding to 3:46-4:11 of the '385 Patent, as providing support for the above three limitations. Ex.1002, 89. The cited portion describes a problem that arises when a “mobile mesh node” “[a]ddress[es] [m]obility with [m]ultiple [r]adio [b]ackhaul (relay) nodes.” Ex.1001, 49-50. The '385 Patent explains that, in the event the mobile mesh node “is connected to [mesh node] P1 302 but moving towards [mesh nodes] P2 303 and P3 304[,] [i]t must sample throughput available from those potential parents.” Ex.1001, 51-53. But the mobile mesh node is unable to hear P2 and P3 because “P2 and P3 downlinks are operating on non-interfering channels than P1 and its uplink is connected to node P1's downlink.” Ex.1001, 58-61. The '385 Patent suggests the solution of “a separate, dedicated radio, referred to as the scanning radio” to “scan[] the RF environment and discover[] potential parent nodes” to enable the mobile mesh node to scan its RF environment while already connected

to other mesh nodes (such as parent node P1 or any child nodes) of the mesh network. Ex.1001, 3:62-64.

39. Accordingly, it is my opinion that each of [3.3], [3.4], and [3.5] refers to the same **single** point in time. Consistent with that understanding, my analysis below analyzes the second and third recitations (in [3.4] and [3.5]) as if they recited “*at the first point in time,*” that is, at the same point in time identified in limitation [3.3].

VIII. IDENTIFICATION OF HOW THE CLAIMS ARE UNPATENTABLE

40. The discussion in this Declaration provides a detailed analysis of how the asserted prior art references teach each limitation of the Challenged Claims.

41. As part of my analysis, I have considered, and discuss in detail, the scope and content of the prior art and any differences between the alleged invention and the prior art.

42. It is my opinion that the alleged invention recited in the Challenged Claims would have been obvious in view of the teachings of the asserted prior art and the knowledge of a POSITA.

A. Ground 1: Claims 2 and 3 would have been Obvious over Castagnoli in view of Bohm.

1. Summary of Castagnoli

43. U.S. Patent Publication No. 2006/0215583 to Castagnoli (Ex.1005, “Castagnoli”) was filed on August 26, 2005, and published on September 28, 2006.

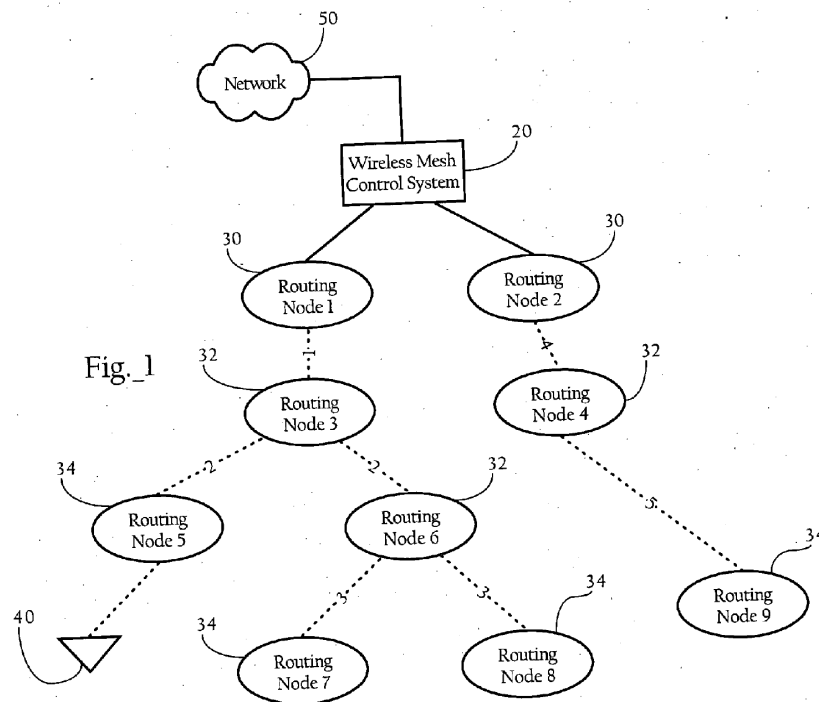
Ex.1005, 1(fields 22 (filing date) and 43 (publication date)). Castagnoli is titled “Slot-based Transmission Synchronization Mechanism in Wireless Mesh Networks.” Ex.1005, 1(field 54). Castagnoli was not before the Examiner during prosecution of the ’385 patent.

44. Castagnoli is analogous art to the ’385 patent for two reasons. First, it is directed to the same field of endeavor as the ’385 patent. The ’385 patent is directed to “Wireless Multiple Radio Mesh” networks. Ex.1001, Title, Abstract. Likewise, Castagnoli is directed to “wireless mesh communication networks,” where “wireless mesh routing nodes can be ... multiple radio systems.” Ex.1005, [0006]-[0007].

45. Second, Castagnoli is analogous art to the ’385 patent because it is reasonably pertinent to a problem the inventors of the ’385 patent attempted to solve. In the ’385 patent, “the main task at hand” is “the transfer of packets” in the wireless mesh, where a parent node “coordinate[s] all the[] sampling times” of its child nodes using a “timing chart”. Ex.1001, 7:28-30, 2:3-5, 4:25-28. Likewise, Castagnoli describes techniques for mobile mesh network communications. For example, Castagnoli describes “synchronizing transmissions among parent and child routing nodes in a hierarchical wireless mesh network” via “a time slot scheduling algorithm.” Ex.1005, Abstract. Castagnoli and the ’385 patent therefore

both recognize a need to synchronize communications to avoid collisions and interference. Thus, Castagnoli is analogous art to the '385 patent.

46. Castagnoli further describes “facilitat[ing] data transfer between routing nodes in a wireless mesh network.” Ex.1005, Abstract. Castagnoli depicts, in Figure 1, a wireless mesh network that includes parent routing nodes 30, 32, child routing nodes 32, 34, and channels 1, 2, 3, 4, and 5 for enabling wireless transmissions between the parent and the child routing nodes. Ex.1005, [0032], Fig. 1. The wireless mesh network allows a wireless client 40 to communicate with the network 50 and/or another wireless client 40. Ex.1005, [0032].

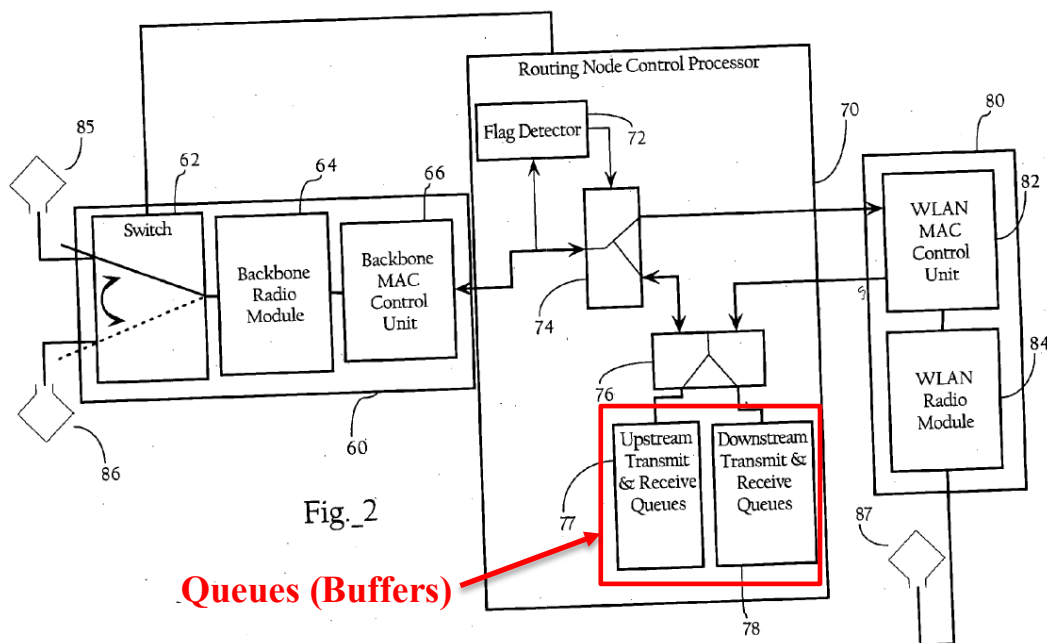


Ex.1005, Fig. 1.

47. Figure 2 of Castagnoli depicts a schematic illustration of a routing node including a wireless backbone interface unit 60, a routing node control processor 70, a WLAN interface unit 80, and antennas 85-87. Ex.1005, [0040]. The routing node control processor maintains “upstream transmit and receive queues 77” for transmission to a parent routing node and “downstream transmit and receive queues 78” for transmission to a child routing node. Ex.1005, [0040]. Castagnoli discloses that:

wireless frames received from a parent routing node during the parent slot are buffered in the downstream transmit/receive queues 78 for transmission to a child routing node for transmission in the appropriate child slot. Oppositely, wireless frames received from a child routing node during the downstream phase are buffered in the parent slot queue 77 for transmission to the parent routing node during the upstream phase.

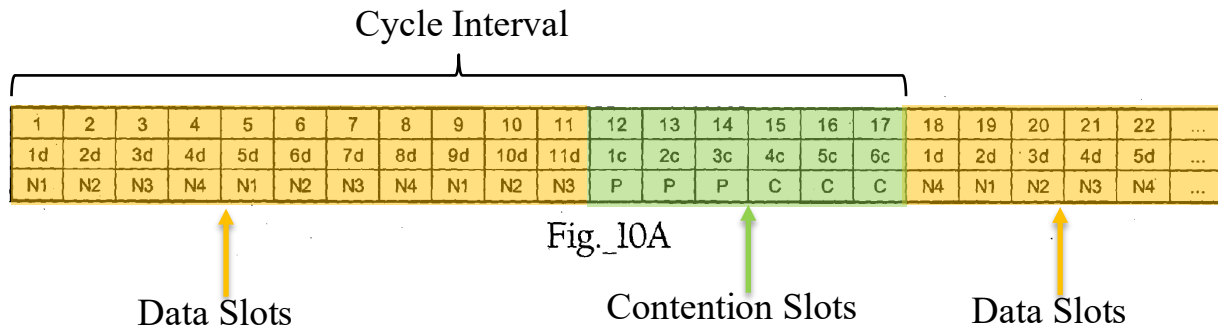
Ex.1005, [0040].



Ex.1005, Fig. 2 (annotated).

48. Castagnoli also discloses a “slot-based synchronization mechanism” for synchronizing transmissions among parent and child routing nodes in the wireless mesh network. Ex.1005, [0006], Abstract. The slot-based synchronization mechanism utilizes “a time slot scheduling algorithm” where “slot scheduling information propagates throughout the mesh[, so that] individual nodes [] compute their respective time slot schedules based on this information and the current state of the network.” Ex.1005, [0031]. A parent routing node sends a child routing node a slot scheduling information to indicate “when the parent has scheduled communications with it.” Ex.1005, [0107]. That is, the slot scheduling information includes the parent’s slot schedule. Ex.1005, [0111].

49. The slot schedules of the parent and child routing nodes are based on cycle intervals comprising fixed, uniform numbers of data slots and contention slots, shown below in Figure 10 of Castagnoli. Ex.1005, [0107]. A parent node “cycl[es] through its child nodes” when allocating available data slots (e.g., 1-11) among its child routing nodes (e.g., N1-N4). Ex.1005, [0111]. “[C]ontention slots are optional,” so an “implementation need not include contention slots.” Ex.1005, [0108].



Ex.1005, Fig. 10A (annotated).

50. Each routing node has a “neighbor state machine” for discovering neighboring routing nodes to “identify a potential parent routing node with which to synchronize.” Ex.1005, [0045], [0049]. This neighbor state machine includes a SEEK state in which a routing node “scans all available operating channels, broadcasting neighbor request packets and listening for neighbor response packets.” Ex.1005, [0049]. Castagnoli discloses that “typically,” a routing node has a dedicated radio that performs the scanning step by “monitoring the RF

environment and other conditions on multiple radio frequencies.” Ex.1005, [0007]. Routing nodes also have another radio dedicated “for access,” and “one or more” radios dedicated “to service the backhaul.” Ex.1005, [0007].

2. Summary of Bohm

51. U.S. Patent No. 5,982,780 to Bohm et al. (“Bohm”) was filed on Dec. 26, 1996, and issued on Nov. 9, 1999. Ex.1006, 1 (fields 22 (filing date) and 45 (issue date)). Bohm is titled “Resource management scheme and arrangement.” Ex.1006, 1 (field 54). Bohm was not before the Examiner during prosecution of the ’385 patent.

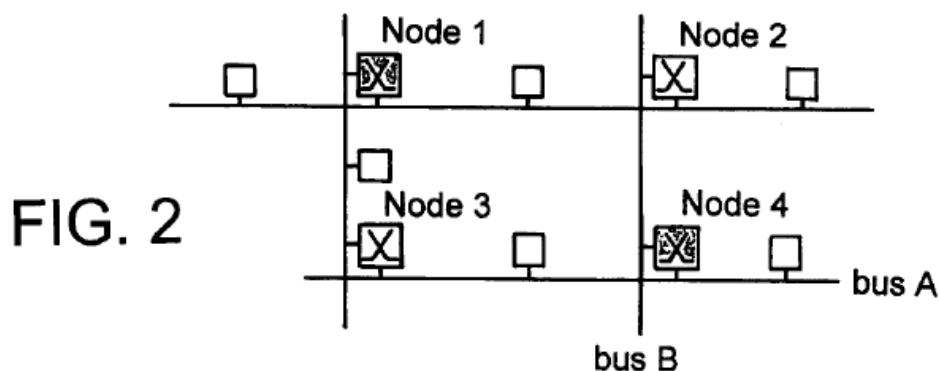
52. Bohm is analogous art to the ’385 patent for two reasons. First, it is directed to the same field of endeavor as the ’385 patent. The ’385 patent is directed to “Wireless Multiple Radio Mesh” networks. Ex.1001, Title, Abstract. Likewise, Bohm is directed to a network of “nodes interconnected in a mesh structure.” Ex.1006, 5:4-5, 7:20-21.

53. Second, Bohm is analogous art to the ’385 patent because it is reasonably pertinent to a problem the inventors of the ’385 patent attempted to solve. The ’385 patent attempts to address the problem of “coordinat[ing] all these sampling times,” i.e., the times that child nodes “sample other candidate parents,” “by having the parent node (P1 FIG. 3) send a token ... to each of its children.” Ex.1001, 4:23-28. Likewise, Bohm describes transferring tokens associated with

data time slots to nodes so that only the nodes with the token can transmit during that data time slot, thereby coordinating data transmission among the nodes.

Ex.1006, 12:9-13, 4:56-63, 13:12-13, 36-40. Thus, Bohm is analogous art to the '385 patent.

54. Bohm describes “a method and arrangement for centralized and distributed management of capacity (communication resources) in a circuit switched network with shared medium topology such as bus or ring topology.” Ex.1006, 4:49-52. Multiple buses can be interconnected to form a network of nodes in a mesh structure, as shown in FIG. 2 of Bohm below. Ex.1006, 5:4-5, 7:20-21. The capacity is “divided into cycles which in turn are divided into control time slots for signaling and data time slots for data transmission. Each data time slot is associated with a token.” Ex.1006, 4:54-57. A controller of a node “may write data into a slot only if it owns the corresponding token.” Ex.1006, 12:9-11.



Ex.1006, Fig. 2.

55. Bohm discloses a “centralized server [token management] mechanism” or scheme where “a single node controller manage[s] all free tokens.” Ex.1006, 13:11-13. In this mechanism, “a first node, called server node, [] is assigned tokens corresponding to the unidirectionally flowing data time slots on the communication link.” Ex.1006, 4:57-60. The server node “reserves and transfers tokens” to nodes that “lock[] them throughout the channel life-time” while “transmitting data using the reserved slots,” i.e., slots that are associated with the reserved tokens. Ex.1006, 4:62-63, 13:20-21, 36-40. Once the reservation expires, “the tokens are immediately returned to the manager” node. Ex.1006, 13:21-23; *see also* Ex.1006, 22:40-43.

3. Reasons to Combine Castagnoli with Bohm

56. It would have been obvious to a POSITA to combine Castagnoli and Bohm because the combination is nothing more than a simple substitution of one known, equivalent element for another to obtain predictable results. Specifically, the combination is a simple substitution of the use of tokens to coordinate data transmissions by nodes so as to avoid interference between the transmissions, as taught by Bohm, for a packet collision avoidance mechanism to avoid radio interference between routing nodes, as taught by Castagnoli, to obtain the predictable result of avoiding nodes interfering with one another.

57. As discussed at [2.5], it would have been obvious to a POSITA that, when there are no contention slots, the assignment of time slots to child nodes for performing neighbor discovery would correspond to Castagnoli's assignment of time slots to child nodes for performing data transmission. A parent node assigns time slots to child nodes for performing data transmission according to Castagnoli's "slot-based transmission scheduling mechanism," i.e., "a time slot scheduling algorithm [that] coordinate[s] communications between wireless nodes of a hierarchical tree." Ex.1005, [0107], [0031]. The algorithm includes a parent node performing "clock synchronization across routing nodes," such as across its child nodes, and "each routing node ... generally employ[ing] a packet collision avoidance mechanism as part of the wireless communications protocol." Ex.1005, [0118], [0008]. A POSITA would have understood that a parent node performs the clock synchronization process and each child node employs the "packet collision avoidance mechanism" so that each child node can perform data transmission (corresponding to performing neighbor discovery, as discussed above) without interference from another child node performing its own neighbor discovery.

58. Before the '385 patent's priority date, a well-known network communication technique for avoiding interference between nodes of a network was the use of tokens to provide transmission permission to nodes, where only a holder of a token in a network has permission to perform data transmission.

Ex.1033, 1:17-20 (“In a token-passing network each node in the network may **only transmit information** to other nodes **when it is in possession of a ‘token’**”); Ex.1034, 4:54-62 (“**Token** passing logical rings **are well known in the art as a means for implementing an orderly discipline for control of a shared broadcast communications media**. In a token passing logical ring, **only one station has control over the media at any one time**. Control over the media can **include transmitting messages** and commanding other stations to transmit a response. **That station** having control over the media is said to **possess the ‘token’ at that time**”); Ex.1035, 1:63-2:1 (“**presently recognized standard[]** of the Institute of Electrical and Electronics Engineers (IEEE) ... **IEEE 802.4: Bus Token passing**”), 11:37-40 (“To assure accurate communication, several bus control protocols may be used ... including **token passing** (e.g. **IEEE 802.4**) which **avoids simultaneous transmission**”).

59. As discussed below at [2.7] in Ground 1, Bohm discloses an example implementation of the use of tokens to coordinate data time slot access by nodes, thereby avoiding interferences therebetween during data transmission or neighbor discovery. Because “[e]ach data time slot is associated with a token” and a node can use a data time slot “only if it owns the corresponding token,” a POSITA would have understood that interference between child nodes performing data transmission (corresponding to performing neighbor discovery, as discussed

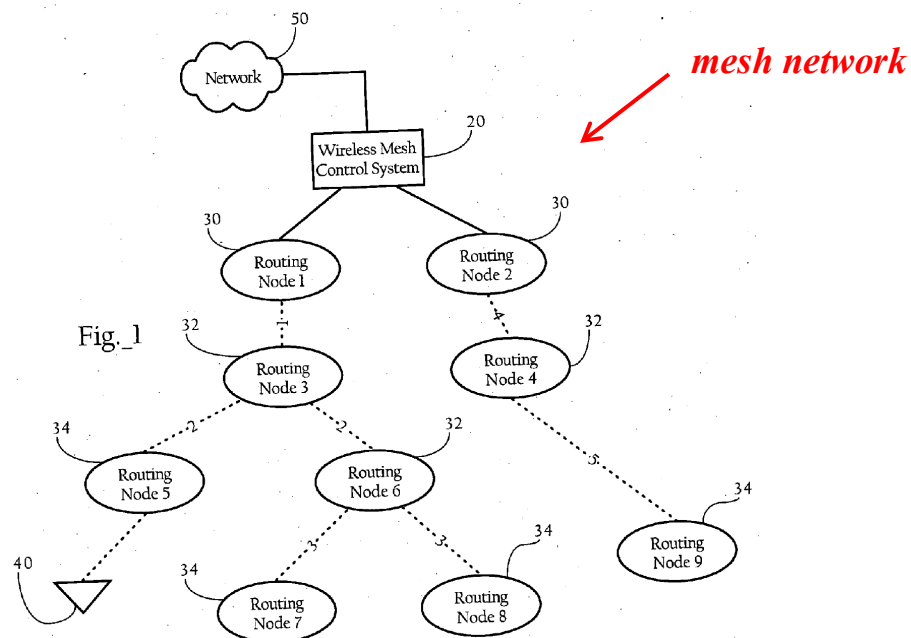
above) can be avoided by using tokens to coordinate neighbor discovery by the child nodes, as taught by Bohm. Ex.1006, 4:56-57; 12:10-11. The results would have been predictable because Bohm teaches that its “token protocol guarantees the slot access to be conflict free, which means that at most one node writes data into the same slot.” Ex.1006, 12:11-13.

4. Claim 2

a. [2.0] A mesh network comprising:

60. To the extent that the preamble is limiting, Castagnoli discloses it or renders it obvious.

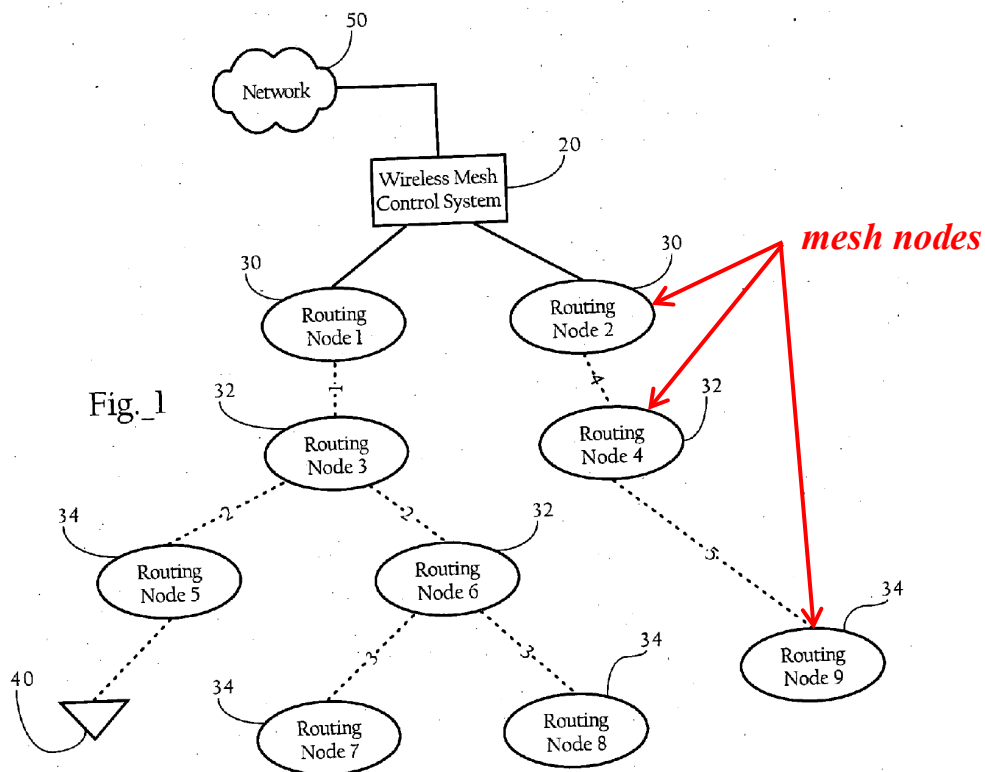
61. Castagnoli discloses a “wireless mesh network,” shown in Figure 1 below, teaching “a mesh network.”



Ex.1005, Fig. 1 (annotated).

b. [2.1] *a plurality of mesh nodes;*

62. Castagnoli's wireless mesh network includes "a plurality of routing nodes," also known as "mesh routing nodes." Ex.1005, [0032], [0036]. For example, Castagnoli discloses "root routing nodes 30," "intermediary routing node[s] 32," and "leaf routing nodes 34," as indicated in Figure 1 of Castagnoli below. Ex.1005, [0032]; *see also, e.g.,* Ex.1005, [0033] (noting Fig. 1 below describes a "a hierarchical wireless mesh network"). The plurality of routing nodes of Castagnoli's wireless mesh network teaches "*a plurality of mesh nodes.*"



Ex.1005, Fig. 1 (annotated).

c. [2.2] *wherein at least one mesh node of the mesh network is configured to scan a Radio Frequency (RF)*

Ex.1003

environment using a dedicated scanning radio to determine a new potential parent mesh node for connecting with said at least one mesh node;

63. First, Castagnoli renders obvious “*a dedicated scanning radio [configured to scan a Radio Frequency (RF) environment]*” because it describes a radio dedicated to monitoring multiple radio frequencies. Ex.1005, [0007]. In its background section, Castagnoli explains that “typically,” nodes have a radio dedicated “for access,” “one or more” radios dedicated “to service the backhaul,” and a radio “**dedicate[d]** [] for the purposes of monitoring the RF environment and other conditions on multiple radio frequencies.” Ex.1005, [0007]. Accordingly, Castagnoli’s description of a radio dedicated to monitoring multiple radio frequencies renders obvious a “*dedicated scanning radio*” that is “*configured to scan a Radio Frequency (RF) environment.*”

64. Second, Castagnoli renders obvious “*new potential parent mesh node for connecting with said at least one mesh node*” because Castagnoli discloses neighbor routing nodes that a potential child routing node discovers to choose one as a parent routing node. Ex.1005, [0046], [0052]. Castagnoli explains that a routing node discovers neighbor routing nodes by “scan[ning] all available operating channels.” Ex.1005, [0049]. Castagnoli discloses that each routing node implements “a neighbor state machine” that allows the nodes “to automatically configure and maintain the hierarchical routing configuration across the mesh

network.” Ex.1005, [0046]. The “neighbor state machine” includes techniques for managing connections between routing nodes in its wireless mesh network, including the “dynamic discovery of routing nodes” as potential parent routing nodes:

In one implementation, the neighbor and route management functionality implemented on each node is responsible for one or more of the following tasks: 1) **discovering neighboring routing nodes**; 2) maintaining a list of attractive neighbor routing nodes **as tentative parent routing nodes**; 3)....

Ex.1005, [0046].

65. Accordingly, Castagnoli’s description of neighbor routing nodes, which a potential routing node discovers and considers as “tentative parent routing nodes,” renders obvious “*new potential parent mesh node for connecting with said at least one mesh node.*”

66. Third, although Castagnoli does not expressly state that the routing nodes of its wireless mesh network scan for neighbor routing nodes *using* the dedicated scanning radio, it would have been obvious to a POSITA for the nodes to incorporate such a dedicated scanning radio for multiple reasons. Ex.1005, [0007]. A first reason is Castagnoli’s express teaching that it was “typical[]” for routing nodes to have a “dedicate[d] [] radio for the purposes of monitoring the RF

environment.” Ex.1005, [0007]. It is my opinion, then, that a POSITA would have found it obvious for a routing node of Castagnoli’s wireless mesh network (“*at least one mesh node of the mesh network*”) to incorporate, as was done “typically,” a scanning radio dedicated for “monitoring the RF environment ... on multiple radio frequencies,” and use the dedicated scanning radio for the same purpose (“*is configured to scan a Radio Frequency (RF) environment using a dedicated scanning radio*”). Ex.1005, [0007].

67. A second reason for a POSITA to find it obvious to incorporate a dedicated scanning radio in a routing node for scanning potential parent nodes is to free up the other radio(s) of the routing node to be used for data communication. A radio is able to scan multiple channels by tuning to each channel, one at a time. Ex.1019, 4:43-50 (“[T]he **channels are scanned sequentially**.... [E]ach channel change is performed in response to the increment of the channel number....”); Ex.1027, 4:4-7 (“During each scan, the mobile station **tunes the receiver to the appropriate carrier**, detects the RF energy on that carrier during an appropriate time slot, demodulates and decodes the RF energy and determines activity on the channel.”); Ex.1021, 10:49-52 (“For example, a sensor device that **scans 20 radio channels in the round robin fashion and dwells on each channel for 200 ms** can tune to a given channel again only once every 4 seconds.”); Ex.1024, [0041], (“**For each channel of the scan list**, the net server needs to tell the lower logical

layers to what channel to tune to search for a signal broadcast thereon. The commands are routed through the logical layers and **the DSP programs the RF portion of the mobile node to the specified channel** to search for the signal broadcast thereon and reports the results back to the net server layer.”); Ex.1028, [0035] (“The main reason for this is that each IEEE 802.11 host is equipped with one half-duplex transceiver, so it can only transmit or listen on one channel at a time. So **when a host is listening on a particular channel, it cannot hear the communication taking place on a different channel.**”); Ex.1023, [0065] (“We assume that the radios used in the network are half-duplex and **can tune to only one channel at a time**”).

68. The radio’s receiver would pause on each channel to listen, during which time the radio’s transmitter would remain silent (and thus be unavailable to engage in data communication). Ex.1021, 10:49-52 (“For example, a sensor device that **scans 20 radio channels in the round robin fashion and dwells on each channel for 200 ms** can tune to a given channel again only once every 4 seconds.”); Ex.1022, 1:55-59 (“Typically, each node in a network has a single transceiver. Usually the single transceiver may transmit or receive, but **may not simultaneously transmit and receive** because the power used to transmit information may interfere with reception.”); Ex.1020, 2:41-55 (“In the multihop mobile wireless networks.... Half-duplex mode of operation is assumed.”);

Ex.1032, [0023] (“In all systems according to the IEEE 802.11 standards, **transmission and reception occur alternately** in the same frequency band, i.e. a half-duplex technique is concerned.”); Ex.1025, [0003] (“**Current wireless systems**, most notably 802.11 wireless local area network (‘WLAN’) systems, operate in half-duplex mode on a single frequency. That is, the mobile station in a wireless system **either transmits or receives at any given time, not both simultaneously.**”); Ex.1026, [0015] (“**Most wireless transceivers** operate in a half-duplex mode, however, and **cannot simultaneously transmit and listen for ongoing network activity.**”).

69. Then, to free up other radio(s) of a routing node to engage in data communication when the routing node “scans all available operating channels,” it would have been obvious to a POSITA to employ the described dedicated scanning radio in the routing node for the purpose of scanning the RF environment for potential parent nodes. Ex.1005, [0049]. This is consistent with Castagnoli’s disclosure of nodes “typically dedicat[ing] one radio for access” and “one or more to service the backhaul,” while dedicating a scanning radio for “monitoring the RF environment.” Ex.1005, [0007]. That is, when Castagnoli teaches “the use of a single radio dedicated to wireless backbone transmissions,” for example, it would have been obvious to a POSITA that the radio would not be used for scanning for potential parents. Ex.1005, [0031]. It is my opinion that, instead, a dedicated

scanning radio (“*a dedicated scanning radio*”) of the routing node (“*at least one mesh node*”) would be used for the purpose of “monitoring the RF environment” (“*configured to scan a Radio Frequency (RF) environment*”) and scanning for potential parents (“*to determine a new potential parent mesh node for connecting with said at least one mesh node*”). Ex.1005, [0007].

70. A third reason for a POSITA to find it obvious to incorporate a dedicated scanning radio in a routing node for scanning potential parent nodes is because it allows for continuous scanning, and thus faster discovery, of candidate parent nodes. Castagnoli discloses that “a routing node attempts to discover its neighbor routing nodes” by “switching across all available antennas[and] scan[ning] all available operating channels.” Ex.1005, [0049]. It is logical to conclude that having a dedicated scanning radio would be more efficient for the neighbor discovery process instead of searching or waiting for available antennas to scan all available operating channels, which can be numerous. It is my opinion that, if the upstream radio were dedicated entirely to parent-finding, which is to be accomplished during only a handful of contention slots—and only if the traffic flow is low enough that those slots aren’t needed/used for parent/child communications, then scanning the other frequencies (potentially many of them) would be slow. Ex.1005, [0136] (disclosing the circumstances when a routing node uses its contention slots for neighbor discovery).

71. A fourth reason for a POSITA to find it obvious to incorporate a dedicated scanning radio in a routing node for scanning potential parent nodes is because it was well known prior to the claimed priority date of the '385 patent to include a dedicated scanning radio into a routing node, so that the routing node can monitor its RF environment while engaging in data communication without disruption. Ex.1005, [0007]. Castagnoli teaches just as much when disclosing it was “typical[]” for a routing node to have radio(s) dedicated for each of “access,” “servic[ing] the backhaul,” and “monitoring the RF environment and other conditions on multiple radio frequencies.” Ex.1005, [0007]. That is, dedicating one radio for scanning the RF environment for potential parent nodes was merely the use of a known technique (a dedicated scanning radio) to improve similar devices (Castagnoli’s routing nodes of Figure 1) in the same way (allowing RF scanning to occur without disrupting data communications occurring on other radios).

72. In summary, Castagnoli describes a routing node of a wireless mesh network (“*at least one mesh node of the mesh network*”) (1) using a dedicated scanning radio (“*a dedicated scanning radio*”) and (2) scanning the RF environment (“*configured to scan a Radio Frequency (RF) environment*”) for potential parent nodes (“*new potential parent mesh node for connecting with said at least one mesh node*”), rendering obvious this claim limitation.

- d. [2.3] *wherein said at least one mesh node includes, in addition to the scanning radio, at least two relay radios in each mesh element¹ and*

73. Under Patent Owner's litigation theories, Castagnoli renders obvious this limitation because it discloses a routing node of a wireless mesh network that includes a radio for scanning an RF environment and multiple radios for servicing backhaul traffic. Ex.1036, 32-34. Castagnoli explains that "wireless mesh routing nodes can be one-, two-, or multiple radio systems," with the multiple radio systems dedicating "one or more [radios] to service the backhaul." Ex.1005, [0007]. Castagnoli's explanation of the use of more than one radios for backhaul traffic expressly contemplates using at least two backhaul traffic radios. Backhaul traffic occurs when "routing nodes [] transmit wireless packets between each other." Ex.1005, [0033]. That is, a POSITA would have understood Castagnoli's reference to "backhaul" traffic to be referring to the forwarding of packets among the routing nodes. Therefore, under Patent Owner's litigation theories, Castagnoli's

¹ I note that there is no earlier introduction of a "mesh element" in claim 2. Further, the specification never uses this phrase. For the purposes of my analysis, I assume that the "mesh element" recited here is supposed to refer to the at least one mesh node, or a component thereof. In either case, Castagnoli's two or more backhaul traffic radios discussed in [2.3] render this limitation obvious.

description of a routing node with “one or more [radios] to service the backhaul” renders obvious “*said at least one mesh node includes ... at least two relay radios in each mesh element.*” The obviousness of employing “at least two relay radios” is also demonstrated by Castagnoli’s discussion of using separate channels for upstream and downstream communications among the routing nodes, discussed in [2.4] below.

74. As discussed in [2.2] above, the radios for “servic[ing] the backhaul” (“*at least two relay radios*”) are dedicated radios separate from, i.e., are *in addition to*, the scanning radios (“*the scanning radio*”) dedicated for “monitoring the RF environment ... on multiple radio frequencies.” Ex.1005, [0007].

75. Accordingly, under Patent Owner’s litigation theories, Castagnoli discloses a routing radio of a wireless mesh network having two radios that service the backhaul and a scanning radio that is separate from the two backhaul radios, rendering obvious “*wherein said at least one mesh node includes, in addition to the scanning radio, at least two relay radios in each mesh element.*”

e. [2.4] *wherein said scanning radio and said at least two relay radios operate on different non-interfering channels;*

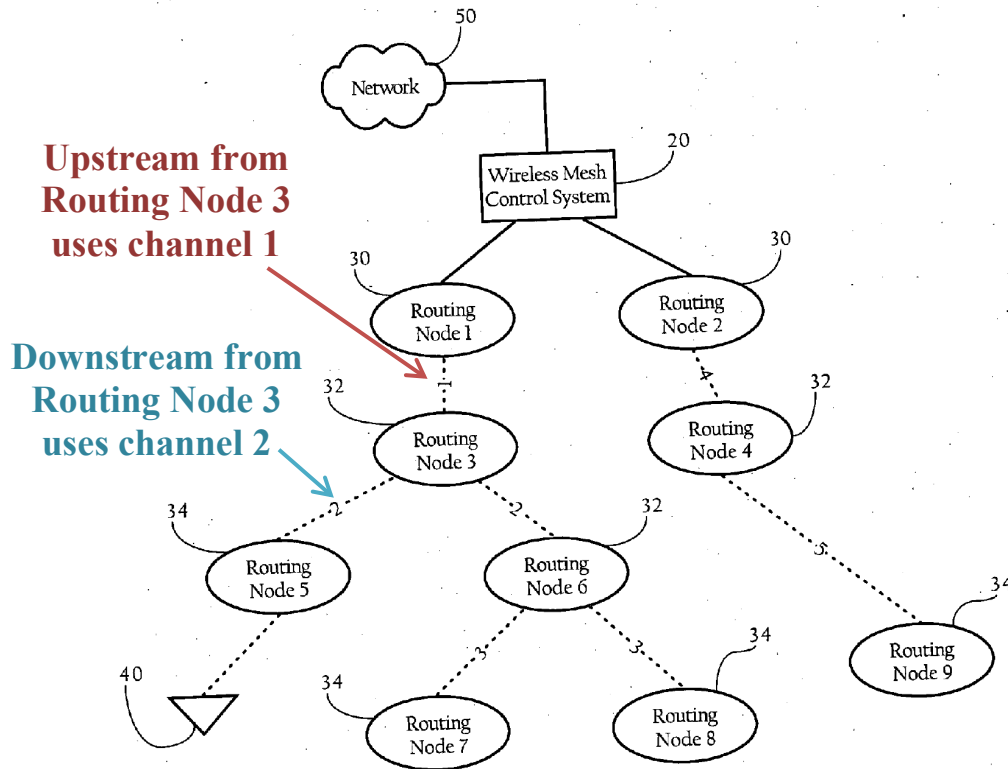
76. Castagnoli renders obvious this limitation because it discloses that routing nodes use different, non-overlapping channels for upstream and

downstream communications and that the selection of channels for a scanning radio and backhaul radios is a matter of engineering choice.

77. Castagnoli describes how routing nodes use different, non-overlapping channels for upstream and downstream communications:

FIG. 1 also illustrates a channel assignment within a given frequency band between routing nodes according to one possible implementation of the present invention. In one implementation, the routing nodes for a given tree and a given hop are set to the same channel. Additionally, for a given routing node, the **operating channel for upstream data transfer, in one implementation, is different than the operating channel used for downstream data transfer**. For example, wireless transmissions between routing node 1 and routing node 3 occur on channel 1, while routing node 3 communicates with routing node 5 and routing node 6 on channel 2. In one implementation, the upstream and downstream channels assigned to a given routing node are **non-overlapping channels....**

Ex.1005, [0034].



Ex.1005, Fig. 1 (annotated).

78. As discussed at [2.3], Castagnoli also suggests for routing nodes to employ two separate radios for “backhaul” traffic, such as the upstream and downstream data transfers discussed in the above quotation. *See, e.g.,* Ex.1005, [0007]. Since the upstream communications use a different channel than the downstream communications, it would have been obvious to a POSITA for a routing node with two backhaul radios to use first radio for upstream communications on the upstream channel, and to use the second radio for downstream communications on the downstream channel. For example, it would have been obvious to a POSITA for the two backhaul radios (“*said at least two*

relay radios”) of routing node 3 in Figure 1 above to use the different, “non-overlapping channels” 1 and 2 (“*operate on different non-interfering channels*”) for upstream and downstream communications, respectively.

79. Additionally, it would have been obvious to a POSITA for a scanning radio of a routing node to use a different channel than those used by the two backhaul radios because Castagnoli teaches that the choice of channels is merely a design choice. That is, the use of “different non-interfering channels” by Castagnoli’s routing nodes would have been obvious because “the **selection of frequency band** for wireless backbone traffic and wireless traffic between clients and routing nodes **is a matter of engineering choice.**” Ex.1005, [0039]. For example, “upstream and downstream channels” may be assigned to a routing node based on whether they are overlapping or non-overlapping channels. Ex.1005, [0034]. As another example, the assignment can be based on a static or a dynamic configuration. Ex.1005, [0034]. Accordingly, because the channel assignment is a design choice, and there are a limited number of potential design choices—the scanning radio operating on a channel that overlaps or interferes with either, both, or none of the channels on which the two backhaul radios operate—a POSITA would have found each of these choices to be obvious. Therefore, it is my opinion that it would be obvious to a POSITA that the claimed *scanning radio* and two relay radios can either operate on interfering channels, or they can operate on

“different non-interfering channels,” teaching “wherein said scanning radio and said at least two relay radios operate on different non-interfering channels.”

- f. ***[2.5] wherein while said at least one mesh node samples potential new parent nodes, packets to be sent to said at least one mesh node from its current parent node are buffered by the current parent node, and***

80. Sampling of potential parent nodes: Castagnoli describes evaluating potential parent nodes by transmitting a “neighbor request packet” to a selected potential parent. Ex.1005, [0075], [0054]. The potential parent replies with a “neighbor response packet” containing various information, including the “detected SNR [signal-to-noise ratio] of the neighbor request packet,” “the detected receive error rate of the neighbor request packet,” and “the number of hops to the root routing node.” Ex.1005, [0047]. These values are then used in choosing a parent node, including whether to switch from a current parent node. Ex.1005, [0052], [0054].

81. A POSITA would have found it obvious for a node to prefer for its parent node to provide a high signal-to-noise ratio, a low error rate, and few hops to the root routing node. Castagnoli discusses “selecting a parent routing node” based on “the ease/effectiveness of a link,” where, for example, “a link that exhibits a low SNR could provide a low data rate either by virtue of the poor SNR itself, or by the effective data rate resulting from a high error rate and consequent re-transmissions.” Ex.1005, [0071]. Castagnoli also teaches a “maximum hop

threshold” parameter, AP_MAXHOPS, that a routing node uses to screen out prospective parent routing nodes when their number of hops is equal to or greater than the threshold. Ex.1005, [0061].

82. Castagnoli discloses that a routing node utilizes the information contained within the neighbor response packet to evaluate neighbor nodes for their potential usefulness as a parent node. Ex.1005, [0060]-[0067]. For example, “[t]he routing node [] compares the number of hops corresponding to each route advertised in the neighbor response packet to an AP_MAXHOPS threshold (575). If any of the number of hops is greater than or equal to the AP_MAXHOPS threshold, the packet is discarded.” Ex.1005, [0061]. As another example, “the routing node [] computes a linkSNR variable and compares it to a threshold value (582). ... If linkSNR is less than the threshold adjMinNeighSNR (582), the packet is discarded.” Ex.1005, [0062]. By measuring these values and evaluating neighbor nodes for their potential usefulness as a parent node, Castagnoli renders obvious that a node “*samples potential new parent nodes*” as claimed.

83. Buffering while sampling: Castagnoli suggests that a node may “attempt neighbor discovery” (i.e., evaluate neighbor nodes as discussed immediately above) during a “contention slot.” Ex.1005, [0136]. However, Castagnoli also explains that “contention slots are optional,” so an “implementation need not include contention slots.” Ex.1005, [0108]. In the

instance that there are no contention slots for a node to use for neighbor discovery, it would have been obvious to a POSITA for the node's current parent node to assign it one or more data slot times for performing neighbor discovery.

84. It would have been obvious for a routing node with a parent node to be assigned a time slot for neighbor discovery because “the routing node continues to broadcast neighbor messages in an effort to discover neighboring routing nodes and update the entries in its adjacency data structure relative to both newly discovered and known routing nodes.” Ex. 1005, [0054]. For example, the routing node “sends directed neighbor request packets to its current parent routing node, as well as a selected subset of previously discovered routing nodes.” Ex. 1005, [0054]. The information gathered about “newly discovered and known routing nodes” enables the routing node “to determine whether to continue operating with its current parent routing node,” based on, for example, “signal quality, route metrics, and the like.” Ex. 1005, [0054].

85. Having the current parent assign the neighbor discovery slot would have been obvious because in Castagnoli's system, “a routing node receives slot scheduling information from its parent node indicating when the parent has scheduled communications with it, and then uses this information to schedule its own child routing nodes.” Ex.1005, [0107]. While Castagnoli describes a scheduling algorithm that does not allocate a time slot for neighbor discovery,

Castagnoli acknowledges that “if contention slots are not used[,] this scheduling algorithm should be modified accordingly.” Ex.1005, [0127].

86. It would have been obvious to a POSITA for a current parent node to buffer packets to be sent to a child node while that child node was performing neighbor discovery (including exchanging packets with a neighbor). Buffering packets during neighbor discovery would have been obvious, in part, because the child node’s uplink radio performing neighbor discovery would tune to the channel of the neighbor’s downlink radio, which Castagnoli shows as a different channel than the child node’s current parent. Ex.1005, Fig. 1; *see also infra*, [3.5]. Because a radio tunes to channels one at a time and its receiver pauses on one to listen to it, as discussed at [2.2], the child node’s uplink radio would not be tuned to its current parent’s downlink channel. Therefore, the child node would not receive a parent node transmission sent while the child node was performing neighbor discovery. Ex.1005, Fig. 1, [0111]. Buffering would prevent such failed transmissions by storing them in queues until the child node is tuned once again to its current parent node’s downlink channel, thereby avoiding a “low” “effective data rate [for the link between the routing nodes] resulting from a high error rate and consequent re-transmissions.” Ex.1005, [0040] (disclosing “wireless frames received from a parent routing node ... are buffered in the downstream transmit/receive queues 78 for transmission to a child routing node”), [0071].

87. To facilitate the buffering of packets, each routing node “maintains separate transmit and receive queues for each of the parent and child routing nodes to which the current node is associated.” Ex.1005, [0040]. Packets to be transmitted are placed in these queues. Ex.1005, [0153]. “For example, wireless frames received from a parent routing node during the parent slot are buffered in the downstream transmit/receive queues 78 for transmission to a child routing node” when the child node is available after the neighbor discovery process. Ex.1005, [0040]. The downstream transmit/receive queues 78 of a routing node is shown below in Figure 2 of Castagnoli. Thus, it would have been obvious for a parent node to enqueue a packet to be transmitted to a child when the parent node was not transmitting packets to the child node, including while the child node was busy performing neighbor discovery procedures. By storing packets in a transmission queue, Castagnoli renders obvious that “*packets to be sent to said at least one mesh node from its current parent node are buffered by the current parent node.*”

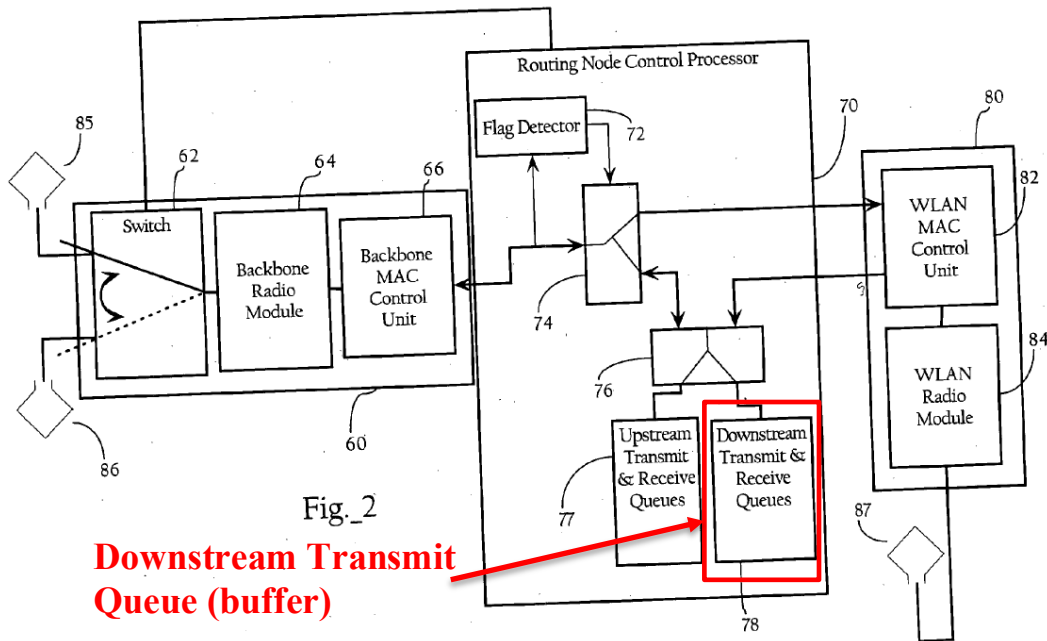


Fig. 2

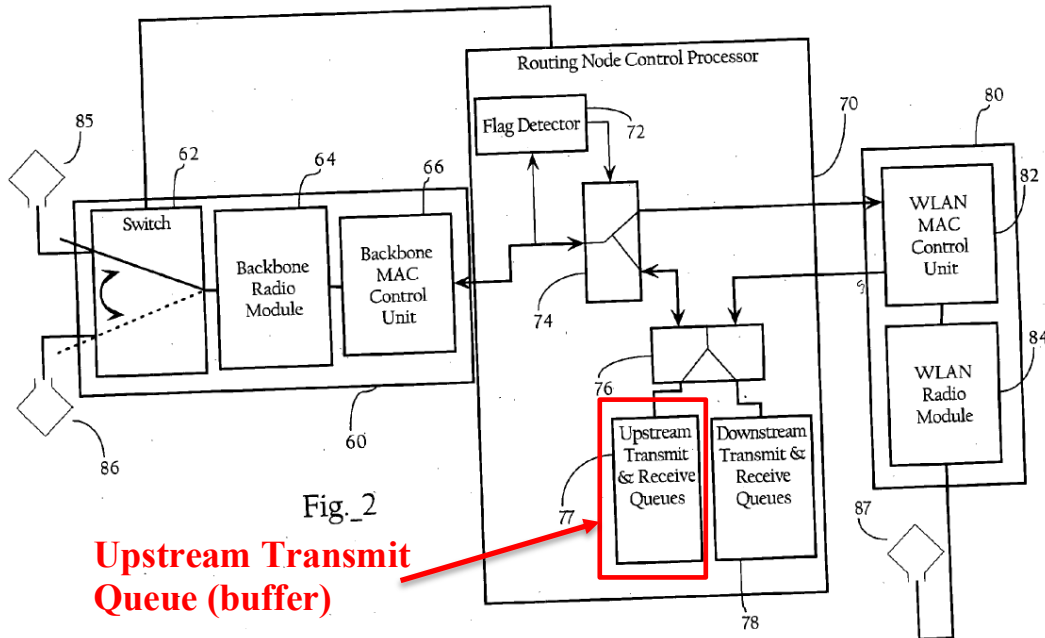
**Downstream Transmit
Queue (buffer)**

Ex.1005, Fig. 2 (annotated).

- g. [2.6] packets to be sent from said at least one mesh node to its current parent are buffered by said at least one mesh node;

88. As discussed at [2.5], Castagnoli renders obvious for a parent node to enqueue (“*buffer[]*”) a packet to be transmitted to a child node. For similar reasons, it would have been obvious for Castagnoli’s nodes to buffer packets waiting to be transmitted in the opposite direction (i.e., from a child node to its parent node). Castagnoli explains that each routing node has a “transmit... queue[] for each of the parent... routing nodes to which the current node is associated,” shown in Figure 2 of Castagnoli below. Ex.1005, [0040]. A child node transmits packets to its current parent during data slots that are “dedicated for flow of traffic between [the current] parent [node] and [the] child node.” Ex.1005, [0124], [0107] (“during

a given data slot, a routing node communicates with only one other routing node (such as its parent routing node...)).



Ex.1005, Fig. 2 (annotated).

89. As discussed at [2.5], 1) during neighbor discovery, a child node's radio is not tuned to the same channel as its current parent and therefore would not be able to send transmissions to its parent node (Ex.1005, [0111]), and 2) buffering prevents loss of transmission data packets by storing them in queues, thereby avoiding a "low" "effective data rate [for the link between the routing nodes] resulting from a high error rate and consequent re-transmissions." Ex.1005, [0040] (disclosing "wireless frames received from a child routing node ... are buffered in the parent slot queue 77 for transmission to the parent routing node"), [0071].

Therefore, it would have been obvious to a POSITA that a child node does not

transmit packets to its current parent while performing neighbor discovery with potential parent nodes (including transmitting and receiving neighbor messages on potentially different channels), but rather enqueues packets to be transmitted to its parent when the child node was not transmitting packets to its current parent node, including while the child node was busy performing neighbor discovery procedures. For example, the child node's upstream radio would be tuned to a different channel to attempt communication with its neighbors (that is, the upstream radio would tune to a channel that the current parent node is not listening to). Ex.1005, [0034]. Accordingly, by storing packets in a transmission queue, Castagnoli renders obvious that "*packets to be sent from said at least one mesh node to its current parent are buffered by said at least one mesh node.*"

- h. [2.7] *wherein sampling times are coordinated among multiple mesh nodes having a common current parent node whereby the common current parent node sends tokens to each of its children in a round-robin manner.***

90. Castagnoli, in combination with Bohm, render obvious this limitation.

91. Sampling times of multiple mesh nodes having a common current parent node: As discussed at [2.5], in the instance where there are no contention slots, a routing node's current parent node assigns the routing node one or more data slot times ("*sampling times*") for performing neighbor discovery. Castagnoli describes a parent node having more than one "child nodes" (*see, e.g., Ex.1005, [0031]*); thus, it would have been obvious to a POSITA that a parent node ("a

common current parent node”) of more than one child nodes (*“multiple mesh nodes having a common current parent node”*) assigns each of the child nodes one or more data slot times (*“sampling times”*) for performing neighbor discovery.

92. Sending tokens to child routing nodes to coordinate neighbor discovery: The '385 patent describes a “token” “as an application specific information element (ASIE) to be used by the children mesh nodes to determine which child node is allowed to sample other potential parent nodes,” thereby “coordinat[ing] all these sampling times.” Ex. 1001, 4:25-33. A “token,” “[i]n networking,” is understood to be information “used to confer transmit privileges to a computer on a local area network,” and “coordinate[] use of [a] control packet network among the nodes connected to it.” Ex.1018, 703.

93. Bohm discloses an example implementation of the use of tokens to coordinate data time slot access by nodes, which “guarantees the slot access to be conflict free, which means that at most one node writes data into the same slot.” Ex.1006, 12:11-13. Bohm explains that “[w]rite access to slots is controlled by slot tokens,” i.e., “each data time slot is associated with a token,” and “[a] node controller may write data into a slot only if it owns the corresponding token.” Ex.1006, 4:56-57, 12:9-11. A “single node controller” is responsible for “manag[ing] all free tokens” in the network and “reserves and transfers tokens ... to the other node[s].” Ex.1006, 13:12-13, 4:62-63. The other nodes then utilize the

tokens to “transmit[] data using the reserved slots” associated with the received tokens. Ex.1006, 13:39-40. In other words, Bohm teaches that a single node controller that is responsible for managing tokens in a network coordinates data transmission by nodes of the network by sending tokens, each of which is associated with a data slot time, to network nodes so that only a node that is in possession of a token can utilize the data slot time that is associated with that token to perform data transmission. Ex.1006, 12:9-13, 4:56-63, 13:12-13, 36-40.

94. As discussed at [2.5], it would have been obvious to a POSITA that Castagnoli’s assignment of time slots to child nodes for performing data transmission would correspond to the assignment of time slots to child nodes for performing neighbor discovery when there are no contention slots. The combination of Castagnoli and Bohm would have suggested to a POSITA that when a parent node assigns each of its child routing nodes one or more data slot times (“*sampling times*”) for performing data transmission (i.e., for performing neighbor discovery), the parent node also transfers tokens associated with the one or more data slot times to the child routing nodes (“*whereby the common current parent node sends tokens to each of its children*”) to coordinate the timing of the nodes’ neighbor discovery and avoid interference between the nodes (“*sampling times are coordinated among multiple mesh nodes having a common current parent node*”).

95. Round-robin: Castagnoli illustrates in Figure 10A a parent node's assignment of 11 data slots to 4 child nodes. The child nodes are labeled as N1 through N4. The parent node setting this schedule assigns data slots "evenly across its child nodes" by "cycling through its child nodes." Ex.1005, [0111]. The figure shows that the time slots are repeatedly assigned from node N1 to node N4, which a POSITA would have recognized as assigning time slots in a "*round-robin manner*" as claimed.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	...
1d	2d	3d	4d	5d	6d	7d	8d	9d	10d	11d	1c	2c	3c	4c	5c	6c	1d	2d	3d	4d	5d	...
N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	P	P	P	C	C	C	N4	N1	N2	N3	N4	...

Fig. 10A

Parent node assigns time slots to its four child nodes N1 to N4 in a "*round-robin manner*"

Ex.1005, Fig. 10A (annotated).

96. Because assigning time slots to child nodes for performing neighbor discovery corresponds to Castagnoli's assignment of time slots to child nodes for performing data transmission, as shown above in this section, a POSITA would have found it obvious for a parent node to use the same cyclical time-slot assignment technique when allocating time slots to child nodes during which the child nodes would perform neighbor discovery. Further, because the parent node sends tokens associated with the time slots to the child nodes when assigning the time slots to the child nodes, a POSITA would have found it obvious for the parent

node to send the tokens to the child nodes in the same manner as it assigns the time slots, i.e., in a cyclical “*round-robin manner*.” The round-robin scheduling algorithm was a simple and well-known scheduling algorithm, and therefore would have been an obvious choice for allocating neighbor discovery time slots among child nodes as well as sending the tokens associated with the time slots to the child nodes. Ex.1029, [0893] (“Otherwise a simpler algorithm such as **round-robin** may be used or any other sharing algorithms **well-known to those skilled in the art**.”); Ex.1030, 17:15-18 (“...a scheduling algorithm (**well-known examples include** Weighted Fair Queuing, Priority, FIFO and **Round Robin**)...”); Ex.1031, [0007] (“For example, these scheduling algorithms may include a **round robin scheduling algorithm**, a proportional fair scheduling algorithms, as well as other **well-known scheduling algorithms**.”); Ex.1016, 142 (“One of the oldest, simplest, fairest and **most widely used** algorithms is **round robin**”).

97. Accordingly, Castagnoli describes assigning time slots to child nodes in a repeated sequential order, and Bohm discloses a single node controller sending other nodes tokens that are associated with data time slots so that only a node that is in possession of a token can use the data time slot associated with that token, the combination of Castagnoli and Bohm thereby rendering obvious “*wherein sampling times are coordinated among multiple mesh nodes having a common*

current parent node whereby the common current parent node sends tokens to each of its children in a round-robin manner.”

5. Claim 3

a. [3.0] *A mesh network comprising:*

98. Claim limitation [3.0] is the same as [2.0] and would have been obvious for the reasons discussed above.

b. [3.1] *a plurality of mesh nodes;*

99. Claim limitation [3.1] is the same as [2.1] and would have been obvious for the reasons discussed above.

c. [3.2] *wherein each node within said plurality of nodes comprises at least three radios further including:*

100. As discussed at [2.2] and [2.3], Castagnoli describes wireless mesh routing nodes that each have at least three radios dedicated to various purposes:

The wireless mesh routing nodes can be one-, two-, or multiple radio systems.... Multiple radio designs typically dedicate one radio **for access**, one or more to service the **backhaul**, and may also dedicate a radio for the purposes of **monitoring the RF environment**....

Ex.1005, [0007].

101. It would have been obvious to a POSITA for the nodes in Castagnoli’s Figure 1 mesh network to each have three radios because the description of a three-radio node is part of Castagnoli’s discussion of how wireless mesh communication

networks “typically” work. Ex.1005, [0007]. Thus, Castagnoli renders obvious this limitation.

d. [3.3] *a first relay radio operating on a first RF channel at a first point in time and dedicated to uplink connections to a single current parent node;*

102. As discussed at [3.2], Castagnoli describes a typical mesh node dedicating “one **or more** [radios] to service the backhaul.” Ex.1005, [0007]. As discussed at [2.3], this disclosure of multiple backhaul radios renders obvious a mesh node having “*at least two relay radios.*”

103. Because Castagnoli discloses (i) an “upstream” hierarchical relationship between routing nodes and (ii) assignment of channels to connections between routing node pairs, it would have been obvious to a POSITA for a mesh node in Castagnoli to have one backhaul radio “*dedicated to uplink connections to a single current parent node.*” Castagnoli describes a “hierarchical” network topology, shown in Figure 1 (annotated below), in which each mesh node is in communication with one parent node. Ex.1005, [0032]. These node-to-node communications are what Castagnoli refers to as the “backhaul,” which follows from Castagnoli’s description of a routing node having “one or more [radios dedicated] to service the backhaul” and “one radio [dedicated] for [providing network] access” “to wireless clients or mobile stations,” such as “backbone radios ... transmit[ting] wireless packets between each other” while a “second radio ...

interact[s] with wireless clients.” Ex.1005, [0007], [0033]. It would have been obvious to a POSITA for the internode communications to include “*uplink connections*,” since Castagnoli describes “upstream” communications from wireless clients to a “wired network at the top of the hierarchy” (Ex.1005, [0007]):

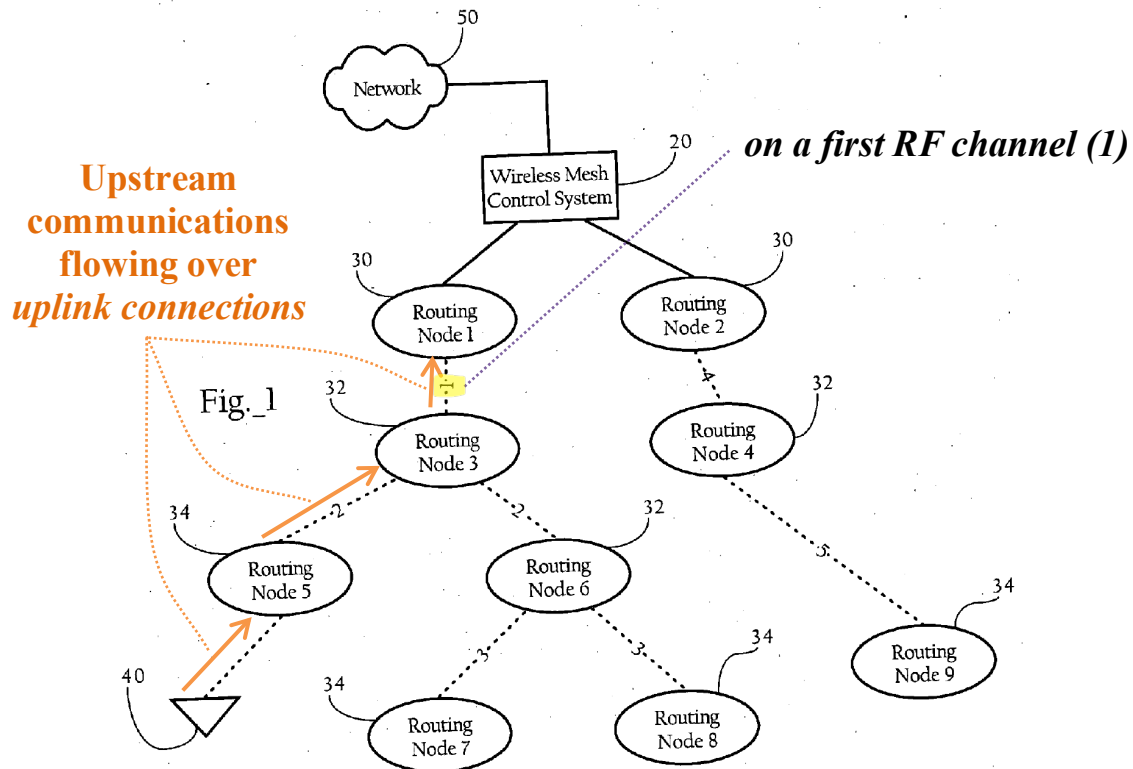
FIG. 1 illustrates a wireless mesh network according to an implementation of the present invention. In one implementation, the wireless mesh network includes a wireless mesh control system 20, and a plurality of routing nodes. In one implementation, a hierarchical architectural overlay is imposed on the mesh network of routing nodes to create a downstream direction towards leaf routing nodes 34, and **an upstream direction toward the root routing nodes 30**. For example, in the hierarchical mesh network illustrated in FIG. 1, first hop routing node 130 is the parent of intermediary routing node 332. In addition, intermediate routing node 332 is the parent to leaf routing node 534, and intermediate routing node 632. In one implementation, this hierarchical relationship is used in routing packets between wireless clients 40, or **between wireless clients 40 and network 50**.

Ex.1005, [0032].

104. Figure 1 also shows, for connections between two nodes, “a channel assignment within a given frequency band,” which corresponds an “*RF channel*.”

Ex.1005, [0034]. I have annotated a portion of the upstream communications on

Castagnoli's Figure 1 below to illustrate one example of the channel assignments, where Routing Node 3 receives upstream communications on channel 2 and transmits upstream communications to Routing Node 1 (*"uplink connections to a single current parent node"*) on channel 1 (*"a first RF channel"*).



Ex.1005, Fig. 1 (annotated).

105. As noted immediately above, Castagnoli's Routing Node 3 receives upstream (backhaul) communications on a different channel than it transmits upstream (backhaul) communications. Ex.1005, [0034]. Further, as discussed in [2.3], Castagnoli teaches that a routing radio (such as Routing Node 3) has two backhaul radios. Therefore, it would have been obvious to a POSITA for one of the

backhaul-dedicated radios (“*a first relay radio*”) to be dedicated to upstream communications with Routing Node 1 on channel 1 and the other to be dedicated to upstream communications with Routing Nodes 5 and 6 on channel 2, so that each backhaul-dedicated radio remains on its assigned frequency and minimizes the amount of time lost to switching between channels as well as the chance of failing to receive a communication because a radio was tuned to a different channel.

106. In summary, Castagnoli describes dedicating radios to backhaul service and shows a routing node communicating with a parent node on an assigned channel, which renders obvious “*a first relay radio operating on a first RF channel at a first point in time and dedicated to uplink connections to a single current parent node.*”

- e. **[3.4]** *a second relay radio operating on a second RF channel at a first point in time and dedicated to downlink connections to zero or more child nodes; and*

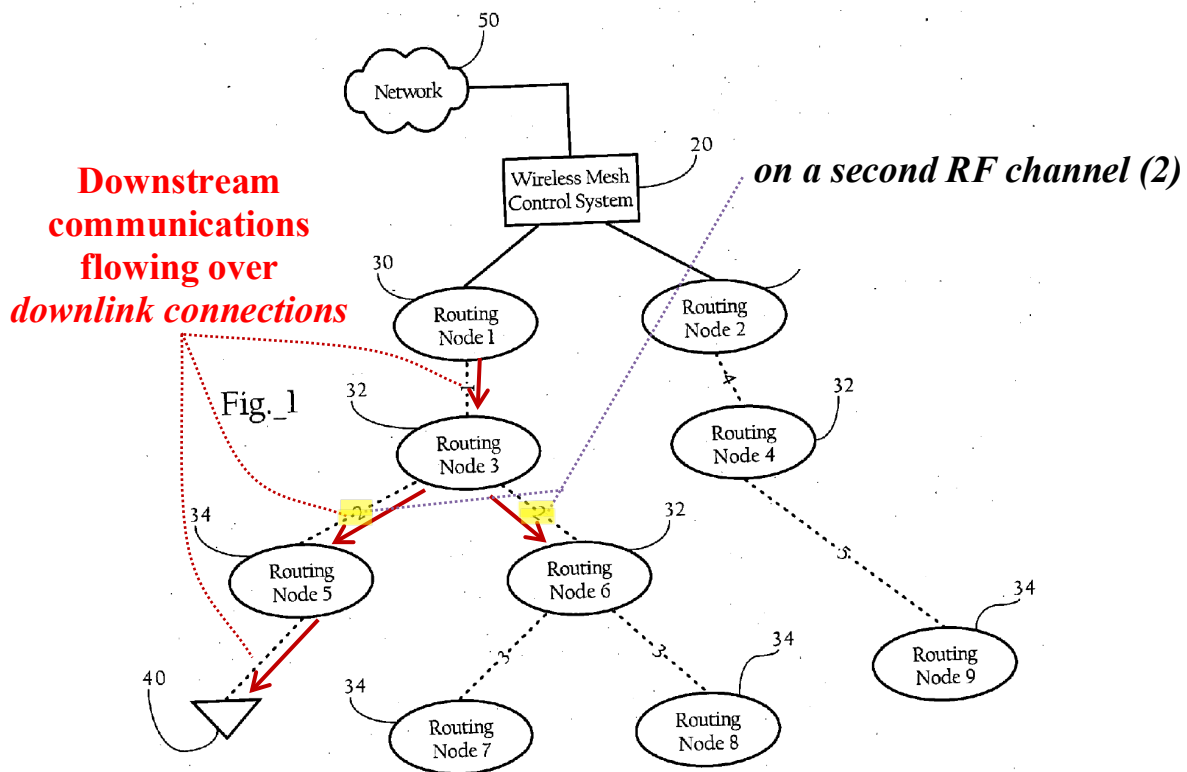
107. In [3.3], it was shown that, because Castagnoli discloses (i) an “upstream” hierarchical relationship between routing nodes and (ii) assignment of channels to connections between node pairs, it would have been obvious to a POSITA for a mesh node in Castagnoli to dedicate one of two “backhaul” radios to handling upstream traffic to a parent node, teaching “*a first relay radio ... dedicated to uplink connections to a single current parent node.*” It would also

have been obvious to a POSITA for a mesh node in Castagnoli to dedicate one of two “backhaul” radios to handling downstream traffic to child nodes, teaching “*a second relay radio ... dedicated to downlink connections to zero or more child nodes,*” because Castagnoli describes a “hierarchical” network topology with “downstream” communications from a “wired network at the top of the hierarchy” to “wireless clients or mobile stations” (Ex.1005, [0007]):

FIG. 1 illustrates a wireless mesh network according to an implementation of the present invention. In one implementation, the wireless mesh network includes a wireless mesh control system 20, and a plurality of routing nodes. In one implementation, a hierarchical architectural overlay is imposed on the mesh network of routing nodes to create **a downstream direction towards leaf routing nodes 34**, and an upstream direction toward the root routing nodes 30. For example, in the hierarchical mesh network illustrated in FIG. 1, first hop routing node 130 is the parent of intermediary routing node 332. In addition, intermediate routing node 332 is the parent to leaf routing node 534, and intermediate routing node 632. In one implementation, this hierarchical relationship is used in routing packets between wireless clients 40, or **between wireless clients 40 and network 50**.

Ex.1005, [0032].

108. Figure 1 shows, for connections between two nodes, “a channel assignment within a given frequency band,” which corresponds to an “*RF channel*.” Ex.1005, [0034]. I have annotated a portion of the downstream communications on Castagnoli’s Figure 1 below to illustrate one example of the channel assignments, where Routing Node 3 receives downstream communications on channel 1 and transmits downstream communications to Rounding Nodes 5 and 6 on channel 2.



Ex.1005, Fig. 1 (annotated).

109. As noted immediately above, Castagnoli’s Routing Node 3 transmits downstream (backhaul) communications on a different channel than it receives

downstream (backhaul) communications. Ex.1005, [0034]. Further, as discussed in [2.3], Castagnoli teaches that a routing radio (such as Routing Node 3) has two backhaul radios. Therefore, it would have been obvious to a POSITA for one of the backhaul-dedicated radios to be dedicated to downstream communications with Routing Node 1 on channel 1 and the other to be dedicated to downstream communications with Routing Nodes 5 and 6 on channel 2 (*“second relay radio operating on a second RF channel... dedicated to downlink connections to zero or more child nodes”*), so that each backhaul-dedicated radio remains on its assigned frequency and minimizes the amount of time lost to switching between channels as well as the chance of failing to receive a communication because a radio was tuned to a different channel.

110. A POSITA would have immediately recognized that with the upstream and downstream radios operating on different channels, both radios may be operated simultaneously without interfering with one another. This is because when “a first channel (frequency) is used for transmission and a second channel (frequency) is used for reception,” thereby allowing “downlink transmission and uplink transmission to occur simultaneously,” “physical interference between the transmit and receive channels” would be avoided by having a separation between the first frequency and the second frequency. Ex.1008, [0064] (“Duplexing techniques include frequency division duplexing (FDD) and time division

duplexing (TDD). In FDD, **a first channel (frequency) is used for transmission and a second channel (frequency) is used for reception.** To avoid physical **interference** between the transmit and receive channels, the frequencies must have a separation known as the duplex spacing.”); Ex.1009, [0039] (“Alternatively, the transmission can be frequency division duplex (FDD). That is, the **downlink transmission can be at a different frequency than the uplink transmission.** FDD allows **downlink transmission and uplink transmission to occur simultaneously.**”). Thus, it would have been obvious for Castagnoli’s downstream radio (“*second relay radio*”) to operate while the upstream radio is also operating (“*at [the] first point in time*”).

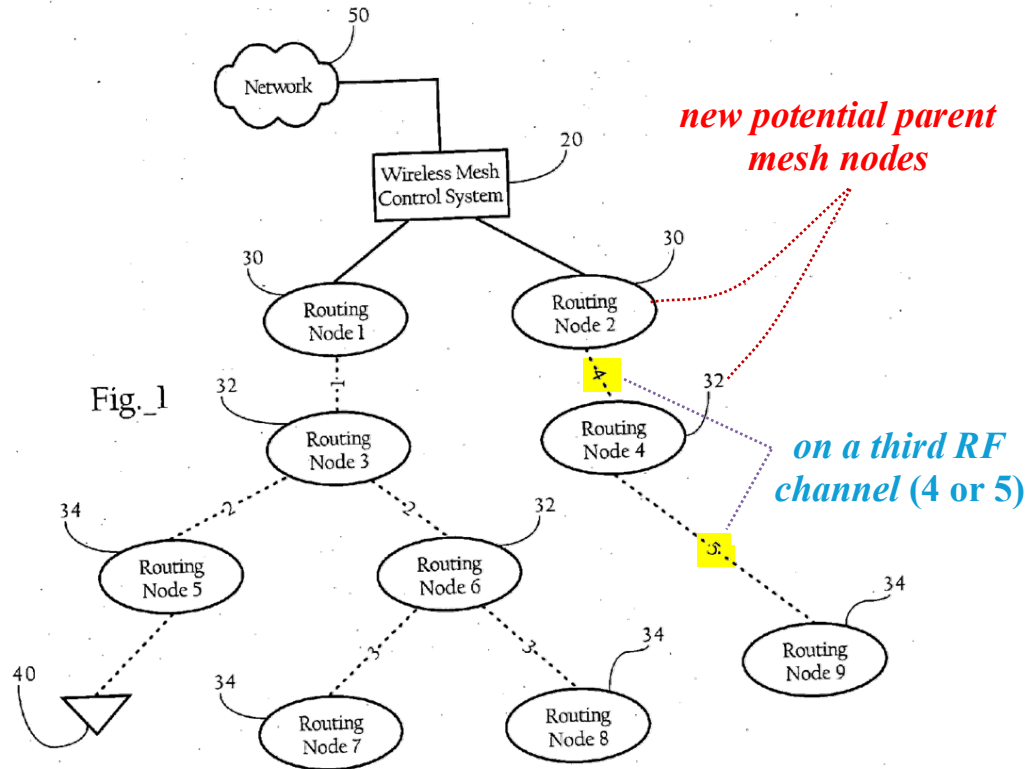
111. In summary, Castagnoli describes a routing node with multiple radios conducting upstream and downstream communications on separate channels, which renders obvious “*a second relay radio operating on a second RF channel at a first point in time and dedicated to downlink connections to zero or more child nodes.*”

- f. **[3.5] *a dedicated scanning radio operating on a third RF channel at [the] first point in time and configured to scan a Radio Frequency (RF) environment to discover new potential parent mesh nodes for connecting with said first relay radio;***

112. As discussed at [2.2], Castagnoli renders obvious for a mesh node to include a “*dedicated scanning radio*” “*configured to scan a Radio Frequency (RF)*

environment... to determine a new potential parent mesh node.” Ex.1005, [0007], [0046], [0049]. It would have been obvious for Castagnoli’s scanning radio to identify **multiple** “*new potential parent mesh nodes*” for the reasons discussed at [1.5].

113. For the reasons discussed at [2.4] and [1.3], it would have been obvious to a POSITA for the scanning radio to operate on a “third RF channel” different from the uplink and downlink channels discussed at [3.3] and [3.4]. Figure 1 of Castagnoli (annotated below) shows that Routing Node 3 has as potential neighbor nodes Routing Node 2 and Routing Node 4, whose respective downlink channels are channels 4 and 5. Ex.1005, Fig. 1. Thus, Routing Node 3 would discover these potential neighbors when Routing Node 3’s scanning radio of tunes to channels 4 and 5 (each a “third RF channel”). Because the scanning radio is “dedicate[d]” (Ex.1005, [0007]) to the task of monitoring the RF environment, it would have been obvious to a POSITA for the scanning radio to operate at the same time as the uplink and downlink radios discussed [3.3] and [3.4], i.e., “*at [the] first point in time.*” Alternatively, it would have been obvious for the scanning radio to operate substantially continuously, and as a result they would be operating “*at [the] first point in time.*”



Ex.1005, Fig. 1 (annotated).

114. Castagnoli’s description of a node performing a “scan[] [of] all available operating channels” by “switching across all available channels” to “discover its neighbor routing nodes” renders obvious that Castagnoli’s nodes would be “configured to scan a Radio Frequency (RF) environment to discover new potential parent mesh nodes.” Ex.1005, [0049]. This is because, as Castagnoli describes, the neighbor routing nodes are potential parent nodes. Ex.1005, [0049] (“the routing node evaluates the neighbor routing nodes it discovered to identify a potential parent routing node”).

115. Further, because one of the backhaul-dedicated radios (“*a first relay radio*”) is dedicated to upstream communications (“*uplink connections to a single current parent node*”), as shown in [3.3], it would be obvious to a POSITA that the potential parent nodes are to be connected to that backhaul-dedicated radio, rendering obvious “*for connecting with said first relay radio.*” See also my analysis of [1.6] (explaining why “*sampling*” of a potential parent node would be performed by the node’s uplink radio).

116. In summary, Castagnoli describes using a dedicated scanning radio and scanning the RF environment to identify potential parent nodes, which renders obvious *a dedicated scanning radio operating on a third RF channel at [the] first point in time and configured to scan a Radio Frequency (RF) environment to discover new potential parent mesh nodes for connecting with said first relay radio.*

g. **[3.6] *wherein said first, second, and third RF channels are different from each other***

117. Claim limitation [3.6] is substantially the same as [2.4] and would have been obvious for the reasons discussed above.

h. **[3.7] *wherein after said dedicated scanning radio discovers a potential new parent node, said first relay***

radio samples the RF link to said potential new parent node using its uplink radio and

118. As discussed at [2.5], Castagnoli describes how a mesh node exchanges “neighbor” packets with a potential parent node. Ex.1005, [0075], [0054]. This exchange provides various information used to choose whether to switch to a new parent node. Ex.1005, [0047], [0052], [0054]. This exchange corresponds to “*sampl[ing] the RF link.*” Thus, the neighbor packet exchange is Castagnoli’s mechanism to “*sample[] the RF link to said potential new parent node.*”

119. As discussed at [1.6], it would have been obvious for Castagnoli’s node to use its upstream radio (“*an uplink radio*”) to perform this “*sampling.*”

120. Castagnoli also teaches that the overall neighbor-discovery process includes first “scan[ning] all available operating channels,” and then “broadcasting neighbor request packets and listening for neighbor response packets.” Ex.1005, [0049]. Thus, it would have been obvious for Castagnoli’s node to exchange neighbor packets (“*sample[] the RF link...*”) only after first identifying a potential parent node using its scanning radio. Sequencing actions in this order would also have been obvious because Castagnoli describes how a neighbor request packet includes the MAC address of the potential parent. Ex.1005, [0075] (“request packets are directly transmitted to the neighbor (i.e., the MAC address of the neighbor is used).”). It would have been obvious for Castagnoli’s node to obtain

the MAC address of the potential parent by listening to transmissions from the potential parent using its scanning radio. For example, Castagnoli teaches that “routing nodes in the mesh network learn the MAC addresses of their parent and child routing nodes” from “route discovery packets [that] traverse the hierarchy of routing nodes,” allowing “the routing nodes in the path [to] record the information in the Message Routing Header.” Ex.1005, [0151]-[0153], Fig. 15 (showing MAC addresses in the Message Routing Header). Thus, Castagnoli renders obvious for the uplink radio to conduct neighbor packet exchange “*after said dedicated scanning radio discovers a potential new parent node.*”

- i. **[3.8] concurrent with said sampling, packets to be sent to the mesh node from its current parent node are buffered by the current parent node, and**

121. In [2.6], it was shown that it would have been obvious for a child node to enqueue a packet to be transmitted to its parent when the child node was not transmitting packets to its current parent node, including while the child node was busy performing neighbor discovery procedures. That is, as discussed at [2.6], it would have been obvious from Castagnoli for a mesh node to buffer packets to be sent to its current parent node while its uplink radio is conducting a neighbor packet exchange (“*said sampling*”) with a potential new parent node, teaching “*concurrent with said sampling, packets to be sent to the mesh node from its current parent node are buffered by the current parent node.*”

- j. ***[3.9] packets to be sent from the mesh node to its current parent node are buffered by the mesh node***

122. Claim limitation [3.9] is substantially the same as [2.6] and would have been obvious for the reasons discussed above.

- k. ***[3.10] wherein sampling times are coordinated among multiple mesh nodes having a common current parent node whereby the common current parent node sends tokens to each of its children in a round-robin manner.***

123. Claim limitation [3.10] is the same as [2.7] and would have been obvious for the reasons discussed above.

B. Ground 2: Claim 1 would have been Obvious over Castagnoli in view of Bohm and Liu.

1. Summary of Liu

124. U.S. Patent Publication No. 2006/0198346 to Liu et al. (“Liu”) was filed on March 4, 2005, and published on September 7, 2006. Ex.1006, 1 (fields 22 (filing date) and 43 (publication date)). Liu is titled “Method and Apparatus for Dynamic Neighbor Discovery within Wireless Networks Using Time Division Multiple Access (TDMA).” Ex.1006, 1 (field 54). Liu was not before the Examiner during prosecution of the ’385 patent.

125. Liu is analogous art to the ’385 patent for two reasons. First, it is directed to the same field of endeavor as the ’385 patent. The ’385 patent is directed to “Wireless Multiple Radio Mesh” networks. Ex.1001, Title, Abstract. Likewise, Liu is directed to “[a]n Ad-Hoc wireless network,” where a “[network]

node 10 includes a transmitter 22 [and] a receiver 24” that transmits and receives “radio frequency (RF) signals,” respectively. Ex.1006, Abstract, [0037].

126. Second, Liu is analogous art to the ’385 patent because it is reasonably pertinent to a problem the inventors of the ’385 patent attempted to solve. The ’385 patent attempts to address problems that arise when a node is in motion and has to “sample throughput available from [] potential parents and collect sufficient samples to make an informed decision” about acquiring a new parent. Ex.1001, 3:49-61. Likewise, Liu addresses the problem of “nodes mov[ing] or travel[ing] constantly” such that they “acquire a new neighbor or lose an existing neighbor.” Ex.1007, [0008]; *see also* [0068]. Thus, Liu is analogous art to the ’385 patent.

2. Reasons to Combine Castagnoli with Liu

127. Castagnoli is directed to “wireless mesh communication networks” of nodes that can be arranged in “a variety of hierarchical configurations.” Ex.1005, [0006], [0032]. “[T]he hierarchical configuration may be dynamic in that the parent and child relationships between routing nodes may change depending on factors, such as congestion, node failures and the like.” Ex.1005, [0032]. Castagnoli provides other factors or reasons that cause “[a] given routing node [to] lose synchronization with its parent node,” such as “a hardware failure on the parent routing node, or [] the parent node being taken out of service,” or “environmental changes, such as a new source of RF interference”. Ex.1005, [0145].

128. Liu, which is also directed to “multi-hop wireless Ad-Hoc networks,” provides movement of nodes as a reason for changes in a node’s neighbors, explaining that “[s]ince nodes are mobile in a wireless Ad-Hoc network, a node may acquire a new neighbor or lose a prior neighbor.” Ex.1007, [0008]. In particular, “in a mobile environment (e.g., military battlefield, etc.), nodes move or travel constantly. A node may acquire a new neighbor or lose an existing neighbor.” Ex.1007, [0008]. Liu describes “nodes that have moved from or within the network” as “lost nodes.” Ex.1007, [0008].

129. A POSITA would have been motivated to modify Castagnoli with Liu because Castagnoli discloses that “factors, such as congestion, node failures and the like” cause changes in “the parent and child relationships between routing nodes,” and Liu teaches another factor that causes changes in a node’s relationship with its neighbors, *viz.*, the movement of the nodes. Ex.1005, [0032]. A POSITA would have understood that a parent-child relationship between nodes is an example of a neighbor relationship. Liu further teaches that nodes that move away from the network disconnect from the network and become “lost nodes.” Ex.1007, [0008]. The combination of Castagnoli and Liu would have been obvious to a POSITA because it is the combination of prior art elements (Castagnoli teaching example factors that change its nodes’ parent-child relationship, which is a form of neighbor relationship between nodes, and Liu teaching movement of its nodes being a factor

that changes nodes' neighbor relationship, including a node disconnecting and being lost when it moves from the network) according to known methods (a node's movement causing a change in a node's neighbor relationships, as taught by Liu) to yield a predictable result (Castagnoli's child node moving away from the network so that its connection to its parent node is lost).

3. Claim 1

a. [1.0] *A method for operating a mesh network having a plurality of mesh nodes, comprising:*

130. To the extent that the preamble is limiting, Castagnoli discloses it or renders it obvious.

131. Castagnoli discloses “[m]ethods ... directed to synchronizing transmissions among parent and child routing nodes in a hierarchical wireless mesh network.” Ex.1005, Abstract. At [2.0] and [2.1], it was shown that Castagnoli's wireless mesh network having a plurality of routing nodes teaches “*a mesh network having a plurality of mesh nodes.*” Accordingly, Castagnoli's methods for “synchronizing transmissions among parent and child routing nodes” (“*A method for operating*”) in wireless mesh network having a plurality of routing nodes teach “*a method for operating a mesh network having a plurality of mesh nodes.*”

b. [1.1] *for at least one mesh node of the mesh network, scanning a Radio Frequency (RF) environment using a dedicated scanning radio to determine a new potential*

parent mesh node for connecting with said at least one mesh node;

132. Claim limitation [1.1] is substantially the same as [2.2] and would have been obvious for the reasons discussed above.

- c.** ***[1.2] wherein said at least one mesh node includes, in addition to said scanning radio, at least two relay radios in each mesh element and***

133. Claim limitation [1.2] is substantially the same as [2.3] and would have been obvious for the reasons discussed above.

- d.** ***[1.3] wherein said scanning radio and said at least two relay radios operate on different non-interfering channels;***

134. Claim limitation [1.3] is the same as [2.4] and would have been obvious for the reasons discussed above.

- e.** ***[1.4] wherein said at least one mesh node is moving sufficiently rapidly that it may lose connectivity with its current parent mesh node, and²***

135. Castagnoli and Liu render this limitation obvious because Castagnoli describes nodes that move and Liu describes that the movement of nodes causes the nodes' neighbors to change.

² The '385 patent provides no objective bound on the sufficient rapidity of a mesh node's movement that it *may* lose connectivity with its parent mesh node.

However, under any interpretation of this limitation, Castagnoli's and Liu's

136. Castagnoli describes nodes that move, for example, by discussing how to “maintain wireless connections with mobile stations.” Ex.1005, [0033]. Liu provides further details about moving nodes, including that movement causes a node’s neighbors to change:

[I]n a mobile environment (e.g., military battlefield, etc.), nodes move or travel constantly. **A node may** acquire a new neighbor or **lose an existing neighbor**. If the nodes move at a fast rate, the frequency of HELLO packets must be increased in order to track the changing neighbors.

Ex.1006, [0008].

Since nodes are mobile in a wireless Ad-Hoc network, a node may acquire a new neighbor or lose a prior neighbor.

Ex.1006, [0068].

137. Liu further labels “nodes that have moved from or within the network” as “lost nodes.” Ex.1006, [0068].

138. Accordingly, it would have been obvious to a POSITA from Castagnoli and Liu that a mesh node may lose connectivity with its parent node, such as due to rapid movement away from the parent node. Liu expressly

disclosure of a mesh node having moved so rapidly, i.e., so far enough in a period of time, that it has lost its connection to its parent routing node renders this limitation obvious for reasons discussed in [1.4].

contemplates that a node may “move[] away beyond a radio propagation range” of another node, in which instance the node will not receive the other node’s transmissions. Ex.1006, [0070]; *see also* Ex.1005, [0032] (“...the parent and child relationships between routing nodes may change...,” so nodes “adapt to changing conditions of the hierarchical mesh network”). It would have been obvious to a POSITA that if a node has in fact moved so rapidly that it lost connectivity with its parent node, that the node must have been “*moving sufficiently rapidly that it may lose connectivity with its current parent mesh node.*”

f. [1.5] *wherein said dedicated scanning radio is utilized for discovery of potential new parent nodes and*

139. As discussed at [2.2], Castagnoli renders obvious for a mesh node to include a “*dedicated scanning radio*” “*configured to scan a Radio Frequency (RF) environment... to determine a new potential parent mesh node.*” Ex.1005, [0007], [0046], [0049].

140. Castagnoli’s description of a node performing a “scan” to “discover its neighbor routing nodes” renders obvious that Castagnoli’s nodes would be “*configured to scan a Radio Frequency (RF) environment to discover new potential parent mesh nodes.*” Ex.1005, [0049]. Discovering multiple potential parent nodes would have been obvious because, as Castagnoli describes, the multiple neighbor routing nodes are potential parent nodes. Ex.1005, [0049] (“the

routing node evaluates the neighbor routing nodes it discovered to identify a potential parent routing node”).

- g. [1.6] *sampling of discovered potential new parent nodes is performed by an uplink relay radio of said at least one mesh node;***

141. As discussed at [2.5], Castagnoli describes how a mesh node exchanges “neighbor” packets with a potential parent node. Ex.1005, [0075], [0054]. The information obtained via this exchange is then used by a node to decide whether to change its parent node. Ex.1005, [0047], [0052], [0054]. In other words, the neighbor packet exchange is Castagnoli’s mechanism to “*sample[] the RF link to said potential new parent node.*”

142. Castagnoli does not expressly state which of a node’s multiple radios is used for exchanging neighbor packets, but it would have been obvious to a POSITA for Castagnoli’s mesh node to use its “upstream” radio to exchange neighbor packets with a potential parent node. By “upstream” radio, I mean the radio that in normal operation is in communication with a parent node on an upstream channel, as I annotated in discussing limitation [2.4]. Ex.1005, [0036]. Using this upstream radio (i.e., the node’s “*uplink relay radio*”) for the claimed “*sampling*” would have been obvious for multiple reasons.

143. First, a POSITA would have found it obvious to avoid using the scanning radio (discussed at [2.2] and [1.1]) for neighbor packet exchanges

because Castagnoli states that the scanning radio is “dedicate[d]” to “monitoring the RF environment and other conditions.” Ex.1005, [0007]. Using the scanning radio to conduct neighbor packet exchanges would mean that the scanning radio would no longer be “dedicate[d]” as Castagnoli teaches. At a minimum, the scanning radio would have to cease its “monitoring” activity while transmitting a neighbor request packet. Ex.1026, [0015] (“Most wireless transceivers operate in a half-duplex mode, however, and cannot simultaneously transmit and listen for ongoing network activity.”). Thus, a POSITA would have found it obvious not to use the scanning radio for neighbor packet exchanges because doing so would be contrary to Castagnoli’s disclosure.

144. Second, a POSITA would have found it obvious to use the upstream radio (discussed at [2.4]) Castagnoli describes using “directional antennas whose peak gains are oriented depending on the location of the parent and child routing nodes.” Ex.1005, [0041]. Castagnoli describes antennas oriented toward child routing nodes as “downstream directional antennas” when disclosing that “the peak gain and beamwidth of the downstream directional antennas” place limitations “on the separation between the child routing nodes.” Ex.1005, [0041]. It would have been obvious, therefore, that antennas oriented toward parent routing nodes are “upstream directional antennas” and that the upstream radio would be coupled to such an antenna that is oriented toward parent routing nodes. In contrast, the

downstream radio would be coupled to an antenna oriented toward child routing nodes, and thus the downstream radio would likely struggle to communicate effectively (if it could communicate at all) with a potential parent node.

145. Third, a POSITA would have found it obvious to use the upstream radio because Castagnoli explains that neighbor request and response messages will include the MAC addresses of the sending and receiving interfaces. Ex.1005, [0047], [0057]. A POSITA would have been familiar with the use of MAC addresses and would have known that a MAC address is generally assigned to an interface, not to a node as a whole. Ex.1013, 2:29, 34-35 (“Each NIC [Network **Interface** Controller] is configured with a **unique, single address MAC address**”), Abstract (“DLL [data link layer] **devices** are built with **multiple MAC address instead of a single MAC address.**”); Ex.1010, [0004] (“When **network interface cards** were first developed, each card was **assigned a unique MAC (Media Access Control) address** that was ‘burned’ into the memory of the interface card. Modern **network interface cards** support the ability to **dynamically assign MAC addresses.**”), [0034] (“The virtual **MAC address is assigned to a network interface** and will typically be associated with an application”). Thus, a node having multiple radios would have multiple MAC addresses, with one MAC address assigned to each radio interface. Since Castagnoli’s nodes use the MAC address as a key value for storing information

related to neighbors (Ex.1005, [0057], [0062]), it would have been obvious for Castagnoli's node to use its upstream radio when conducting neighbor discovery exchanges with potential parent nodes. By doing so, the potential parent nodes would begin to store information about the potential child node using the MAC address of the potential child node's upstream radio, which is the radio (and MAC address) that will be used if a parent-child relationship is later formed.

146. At least for all these reasons, a POSITA would have found it obvious that *“sampling of discovered potential new parent nodes is performed by an uplink relay radio of said at least one mesh node.”*

- h.** *[1.7] wherein while said at least one mesh node samples potential new parent nodes, packets to be sent to said at least one mesh node from its current parent node are buffered by the current parent node, and*

147. Claim limitation [1.7] is the same as [2.5] and would have been obvious for the reasons discussed above.

- i.** *[1.8] packets to be sent from said at least one mesh node to its current parent are buffered by said at least one mesh node; and*

148. Claim limitation [1.8] is the same as [2.6] and would have been obvious for the reasons discussed above.

- j.** *[1.9] wherein sampling times are coordinated among multiple mesh nodes having a common current parent*

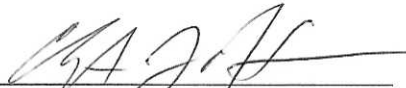
***node whereby the common current parent node sends
tokens to each of its children in a round-robin manner.***

149. Claim limitation [1.9] is the same as [2.7] and would have been obvious for the reasons discussed above.

IX. CONCLUSION

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

Dated: September 19, 2025


Christopher Hansen, Ph.D.