

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

CISCO SYSTEMS INC.,
Petitioner

IPR2026-00008
U.S. Patent No. 8,520,691

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

TABLE OF CONTENTS

I.	INTRODUCTION	4
II.	QUALIFICATIONS AND PROFESSIONAL EXPERIENCE	6
III.	LEVEL OF ORDINARY SKILL IN THE ART	10
IV.	RELEVANT LEGAL STANDARDS	11
V.	BACKGROUND	13
VI.	OVERVIEW OF THE '691 PATENT	14
VII.	CLAIM CONSTRUCTION	19
VIII.	IDENTIFICATION OF HOW THE CLAIMS ARE UNPATENTABLE....	19
A.	Ground 1: Claims 1, 18, and 35 would have been Obvious over Castagnoli in view of Bauer and Gil.	20
1.	Summary of Castagnoli.....	20
2.	Summary of Bauer	25
3.	Summary of Gil.....	27
4.	Reasons to Combine Castagnoli and Bauer.....	29
5.	Reasons to Combine Castagnoli, Bauer, and Gil.....	34
6.	Claim 1	36
7.	Claim 18.....	73
8.	Claim 35.....	76
B.	Ground 2: Claims 9-11 and 15-16 would have been Obvious over Castagnoli in view of Bauer, Gil and Zeng.....	87
1.	Summary of Zeng.....	87
2.	Reasons to Combine Castagnoli, Bauer, Gil, and Zeng	90
3.	Claim 9.....	93
4.	Claim 10.....	101
5.	Claim 11	104
6.	Claim 15.....	106

7.	Claim 16.....	113
C.	Ground 3: Claim 19 would have been Obvious over Castagnoli in view of Bauer, Gil, and Papadoglou.	113
1.	Summary of Papadoglou.....	113
2.	Reasons to Combine Castagnoli, Bauer, Gil, and Papadoglou	115
3.	Claim 19.....	116
IX.	CONCLUSION.....	119

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. 8,520,691 (“the ’691 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, 9-11, 15-16, 18-19, and 35 (“the Challenged Claims”) of the ’691 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 ’691 patent, Ex.1001;
- b. the prosecution history of the ’691 patent (“’691 File History”), Ex.1002;
- c. U.S. Patent Publication No. 2006/0215581 to Castagnoli (“Castagnoli”), Ex.1005;

- d. U.S. Patent Publication No. 2007/0140239 to Bauer et al.
("Bauer"), Ex.1006;
- e. U.S. Patent Publication No. 2009/0213730 to Zeng et al.
("Zeng"), Ex.1007;
- f. U.S. Patent No. 7,852,819 to Gil et al. ("Gil"), Ex.1008; and
- g. U.S. Patent Publication No. 2008/0214175 to Papadoglou et al.,
Ex.1009.

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 network communications and security as described below, as well as portions of the following additional materials:

- a. IEEE Standard 802.11-1997, Ex.1011;
- b. A. S. Tanenbaum, Computer Networks, 4th ed. (Prentice Hall PTR), Ex.1014;
- c. Henry, 802.11s Mesh Networking (White paper) (The Certified Wireless Network Professional (CWNP) Program), Ex.1015;
- d. U.S. Patent Publication No. 2006/0047835 to Greaux, Ex.1016;
- e. U.S. Patent Publication No. 2005/0253722 to Droms et al.,
Ex.1017;

f. U.S. Patent Publication No. 2003/0033393 to Larson et al.,
Ex.1018;

g. U.S. Patent Publication No. 2008/0013474 to Nagarajan et al.,
Ex.1019; and

h. U.S. Patent Publication No. 2007/0271372 to Deninger et al.,
Ex.1020.

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 802.11_{ay}) 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 ’691 patent, as of January 2009,¹ 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 ’691 patent, including familiarity with standards such as IEEE 802.11. For example, the ’691 patent uses (without explanation) the acronyms AP and BSS (Ex.1001, 3:4-6), which a POSITA would have understood to stand for “access

¹ While I am applying a priority date of January 30, 2009 for purposes of the analysis below, the level of skill in the art would be the same for the earlier non-provisional applications.

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 had a bachelor’s degree in computer science, computer engineering, or an equivalent, and two years of professional experience working in the field of network communications. 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 ’691 patent.

IV. RELEVANT LEGAL STANDARDS

23. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the ’691 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 ’691 patent includes patents and printed publications in the relevant art that predate the priority date of the ’691 patent. For purposes of this Declaration, I am applying January 30, 2009, as the priority date of the ’691 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 at 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 at 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 at 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 at 292-295. Products implementing these standards quickly dominated the market for low-cost, high-speed wireless computer networking. Ex.1014 at 302.

28. The IEEE 802.11 standards describe two operating modes or architectures. Ex.1014 at 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 at 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 at 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 at 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 at 3-5. Networks that support packet retransmission between wireless nodes are sometimes called “mesh” networks. Ex.1015 at 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 '691 PATENT

31. The '691 patent purports to address the issue of maintaining client connectivity as a mesh network loses or gains a connection to an external network. Ex.1001, 3:66-4:17. The patent acknowledges that mesh networks were generally

known and provided “additional functionality not available using other network topologies.” Ex.1001, 1:40-60. A mesh network that is formed from “[m]esh nodes implemented with [] a multi-radio backhaul” and has “a hierarchical tree-like network topology [is] called a ‘[s]tructured [m]esh’” network. Ex.1001, 3:9-11. Multi-radio backhaul can be implemented with “one radio for the uplink backhaul and another ... [for] the downlink backhaul.” Ex.1001, 3:6-9.

32. A mesh network is considered “grounded” when it has a connection to an external network and “floating” or “isolated” when it lacks one. Ex.1001, 7:32-34, 63-65. “[B]oth the grounded network [] and the floating or isolated networks ... encompass nodes with at least one node being a root node for all networks having more than one node.” Ex.1001, 8:15-19. Figure 4 of the ’691 patent below shows both a grounded network, which “includes the full function root [FFR] 350 as well as the sub-network 410 comprising [full function] nodes [FFNs] 411,” and an “isolated network 430,” which includes the limited functionality root (LFR) node 460 and limited functionality nodes (LFNs) 461. Ex.1001, 8:49-53, 8:62, FIG. 4, 6:10-13 (“LFR”), 6:55-57 (“LFN”).

33. FFR nodes 350 have direct connection to the external network 108 and FFNs 411 are able to communicate with the external network 108 via FFR node 350. Ex.1001, 7:52-57, 8:52-54. LFR node 460 and LFNs 461, and clients associated thereto, are “unable to establish communication with any full function

nodes,” or otherwise obtain access to the external network 108. Ex.1001, 8:62-64, 7:67-8:5. The clients are, however, able to communicate within the isolated network. Ex.1001, 8:64-67. Each mesh node of the isolated network includes its own Dynamic Host Configuration Protocol (DHCP) server to service its clients, i.e., to assign IP addresses to clients. Ex.1001, 12:4-13.

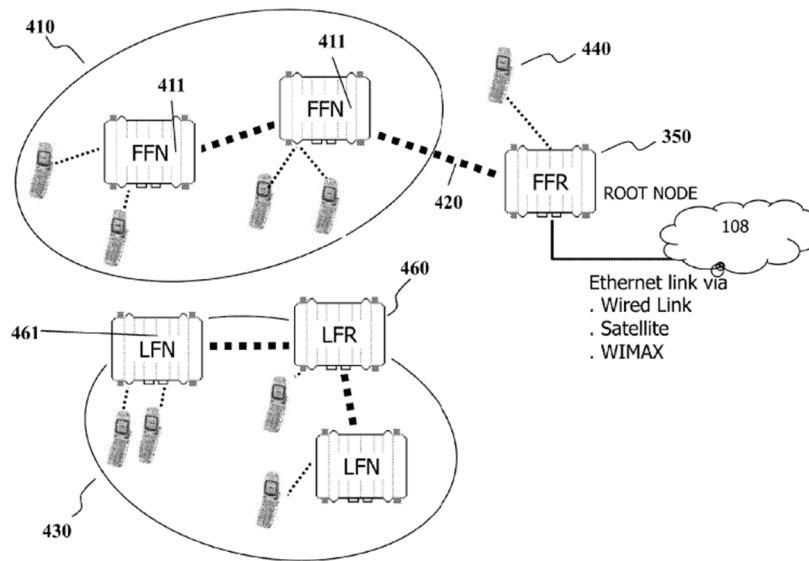


Figure 4

Ex.1001, Fig. 4.

34. Figure 5 of the '691 patent below shows “a change of configuration of the system wherein the node 461 establishes a communication link 520 with a full-functionality node 411.” Ex.1001, 9:11-13. This change of configuration enables the isolated network 430 to become a grounded network (part of network 510) where “[a]ll nodes in the newly established network 510 have become full function nodes inasmuch as every node in the network 510 is connected to the external network 108 through the full function root node 550.” Ex.1001, 9:16-20.

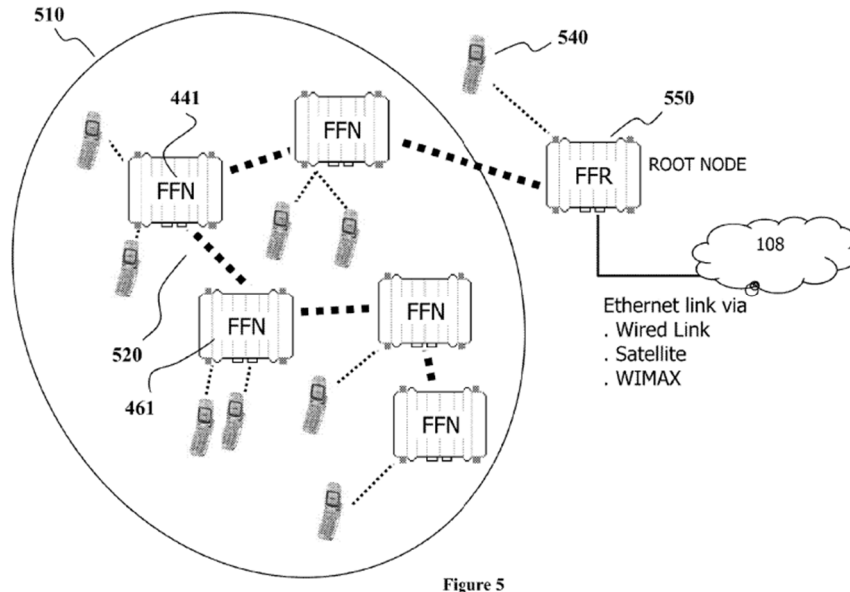


Figure 5

Ex.1001, Fig. 5.

35. In “a two-radio mesh network, [] each mesh node includes one radio for the uplink backhaul and another servicing clients and providing the downlink backhaul to other nodes (descendent nodes) of the network.” Ex.1001, 3:5-9. The radios utilize distinct frequencies or channels:

[T]he mesh nodes ... utilize a separate uplink and downlink communications means. ... each uplink and downlink communication means comprises a wireless radio wherein the frequency or channel of each respective radio is distinct and therefore non-conflicting. Every backhaul radio is on a different, non-interfering channel.

Ex.1001, 13:6-13.

36. In one-radio mesh networks, mesh nodes have a single radio that “utilize separate frequencies for uplink and downlink connections” or “utilize the

same frequency for uplink and downlink, essentially making [all the] channels [of the mesh network] all the same.” Ex.1001, 6:30-35.

37. Each mesh node of a mesh network “contains connectivity logic which allows the node to adopt one or more ... contention resolution policies.” Ex.1001, 16:23-25. An example contention resolution policy is one that resolves “the choice of a new root node” when two floating or isolated networks with respective root nodes join together. Ex.1001, 11:1-20. For instance, the policy may direct the root node that is “closest to the external network maintain[] its status.” Ex.1001, 11:27-28. Other policy directives include allowing “the root node traversed by more traffic ... to keep its status,” selecting “a root node ... such that the resulting network’s traffic must traverse the fewest number of nodes in order to reach its destination,” or selecting a root node such that the resulting network’s latency is minimized. Ex.1001, 11:35-49.

38. In summary, the ’691 patent merely combines known elements—multi-radio mesh networking, distinct uplink and downlink frequency channels, and a connectivity logic that implements node contention resolution policies—into one system. As I will explain below, these mesh networking features recited in the Challenged Claims were already known in the art as of the priority date of the ’691 patent, and combining the features into a single system would have been obvious to a POSITA.

VII. CLAIM CONSTRUCTION

39. It is my understanding that in order to properly evaluate the '691 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.

40. I have reviewed the entirety of the '691 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 express construction.

VIII. IDENTIFICATION OF HOW THE CLAIMS ARE UNPATENTABLE

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

42. 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.

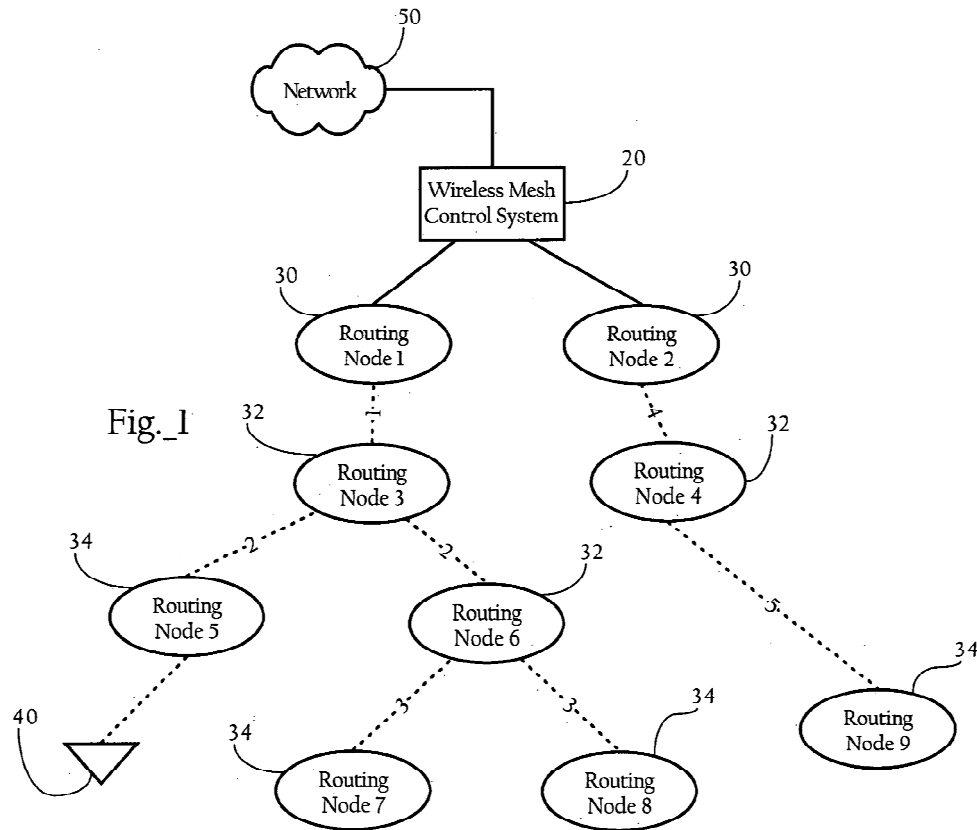
43. It is my opinion that the alleged invention recited in the Challenged Claims would have been obvious in view of the teachings of the asserted prior art and the knowledge of a POSITA.

A. Ground 1: Claims 1, 18, and 35 would have been Obvious over Castagnoli in view of Bauer and Gil.

1. Summary of Castagnoli

44. U.S. Patent Publication No. 2006/0215581 to Castagnoli (Ex.1005) was filed on August 26, 2005, and published on September 28, 2008. Castagnoli is titled “Configuration of Failure and Acquire Timeouts to Facilitate Recovery From Failures in Hierarchical Mesh Networks.”

45. Like the '691 patent, Castagnoli is directed to structured wireless mesh networks operating in a tree-like connection topology. Castagnoli explains that “[w]ireless mesh communication networks typically consist of a plurality of wireless routing nodes that operate in a peer-to-peer fashion to establish communication paths to one another for the purposes of providing network access to wireless clients or mobile stations.” Ex.1005, [0007]. Castagnoli specifically contemplates hierarchical wireless mesh networks, “with the routing nodes that bridge wireless traffic onto a wired network at the top of the hierarchy.” Ex.1005, [0007]. An example of a hierarchical wireless mesh network is shown in Figure 1, below:



Ex.1005, Fig. 1.

46. Castagnoli illustrates a hierarchical wireless mesh network that includes “a plurality of routing nodes.” Ex.1005, [0033]. More specifically, Castagnoli explains that “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.” Ex.1005, [0033]. Castagnoli’s hierarchical wireless mesh network “is used in routing packets between wireless clients 40, or between wireless clients 40 and network 50.” Ex.1005, [0033]. Further, a “mesh network control system 20,”

which functionally “may be integrated into other network devices, such as root routing nodes 30,” operates “to bridge wireless traffic from the mesh network onto network 50.” Ex.1005, [0155]-[0156].

47. Castagnoli explains that the routing nodes within the hierarchical wireless mesh network “generally comprises routing node control processor 70, wireless backbone interface unit 60, and WLAN interface unit 80.” Ex.1005, [0037]. While Figure 2, below, shows an example of a routing node that “comprises first and second antennas 85 and 86, switch 62, backbone radio module 64, and backbone MAC control unit 66,” Castagnoli explains that the routing nodes “can be one-, two-, or multiple radio systems including omni-directional and/or directional antennas.” Ex.1005, [0038], [0007]. These routing nodes also include a “routing node control processor 70,” which includes “hardware modules (e.g., processor, memory), software modules (e.g., drivers, etc.) and data structures (e.g., frame buffers, queues, etc.) that control operation of the routing node.” Ex.1005, [0041]; *see also* Ex.1005, claims 10-11 (claiming “a routing node application...comprising instructions operable to cause the one or more processors and the wireless network interface to” manage operations including parent acquisition and synchronization).

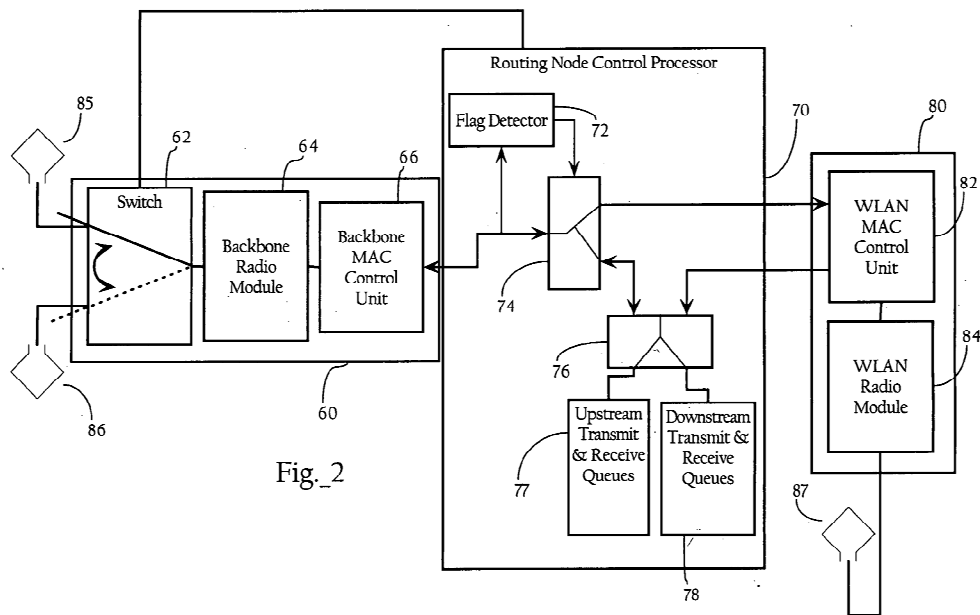


Fig. 2

Ex.1005, Fig. 2.

48. Castagnoli's routing nodes use separate antennas (in the case of one-radio systems) or separate radio systems (in the case of two-radio systems) to communicate with parent and child routing nodes. For instance, with respect to the routing node illustrated in Figure 2, above, "[f]irst antenna 85...can be used for data transfer with a parent routing node, while second antenna 86 can be used for transfer with one or more child routing nodes." Ex.1005, [0042]. Alternatively, in a two-radio system, "one radio unit typically provides access point service to wireless clients as well as child routing nodes, while the other radio unit is used as a backhaul to a parent routing node." Ex.1005, [0007]. Castagnoli explains that "each routing node in the mesh network...is operative to transmit and receive packets from other routing nodes according to a mesh routing hierarchy" and that

“for a given routing node, the operating channel for upstream data transfer...is different than the operating channel used for downstream data transfer.” Ex.1005, [0035]-[0036].

49. Castagnoli specifically focuses on “an efficient failure recovery mechanism in hierarchical wireless mesh networks.” Ex.1005, Abstract. “Hierarchical wireless mesh networks inherently create certain dependencies.” Ex.1005, [0010]. These dependencies mean that a failure event will propagate down the network, causing “child nodes to seek to re-acquire another parent node.” Ex.1005, [0010]. In turn, “child nodes will generally stop servicing their own child nodes,” causing “the overhead and delay associated with having a failure event [to] propagate down the hierarchy,” ultimately “extend[ing] the time required for the wireless mesh to recover from the failure event at only one node.” Ex.1005, [0010]. While Castagnoli seeks to “mitigate[] the effect of synchronization loss between a parent and child node on the hierarchical wireless mesh network,” Castagnoli pertains to loss of connection between two nodes, rather than between the hierarchical wireless mesh network and the external network to which it bridges wireless traffic. Ex.1005, Claim 1.

50. Castagnoli is analogous art because Castagnoli describes techniques for mobile mesh network communications. For example, Castagnoli describes “an efficient failure recovery mechanism in hierarchical wireless mesh networks.”

Ex.1005, Abstract. This subject matter falls in the same field of endeavor as the '691 patent, which describes a “structured wireless mesh network” that “becomes isolated.” Ex.1001, Abstract.

2. Summary of Bauer

51. U.S. Patent Publication No. 2007/0140239 to Bauer *et al* (Ex.1006) was filed on December 19, 2006, and published on June 21, 2007. Bauer is titled “Distributed Services for Mesh Networks.”

52. Like Castagnoli and the '691 patent, Bauer describes useful communication techniques for use in a wireless “mesh network.” Ex.1006, Abstract; [0002]-[0004]. Bauer explains that such networks provide communications using Internet Protocol (IP), and thus they support “IP-based applications.” Ex.1006, [0002]. These applications, in turn, may require “centralized IP services such as the Network Time Protocol (NTP), the Domain Name System (DNS), and the Dynamic Host Configuration Protocol (DHCP).” Ex.1006, [0002]. These services may not be available, however, when a mesh network “operates in a stand-alone manner disconnected from the infrastructure.” Ex.1006, [0004].

53. Bauer describes the operation of nodes within “a mesh network [] configured to access centralized Internet Protocol (IP) services whenever the Internet infrastructure is accessible and then dynamically switch to providing the

IP services locally in the mesh network when the Internet infrastructure is not accessible[.]” Ex.1006, Abstract, [0005]. As reflected in Figure 1, Bauer illustrates “computing devices that are capable of sending, receiving, and forwarding IP packets directly to other nodes.” Ex.1006, [0023]. While Bauer refers to these “computing devices” as nodes 1-4, Bauer explains that “the nodes 1-4 can be Personal Computers (PCs), Personal Digital Assistants (PDAs), cellular telephones with IP capabilities, digital pagers, or any other IP device that may need to operate in a mesh network.” Ex.1006, [0023]. These nodes 1-4 communicate either “directly with other nodes,” or “indirectly to other nodes through one or more intermediary nodes that relay the IP communications to the destination node,” e.g., routing nodes. Ex.1006, [0024].

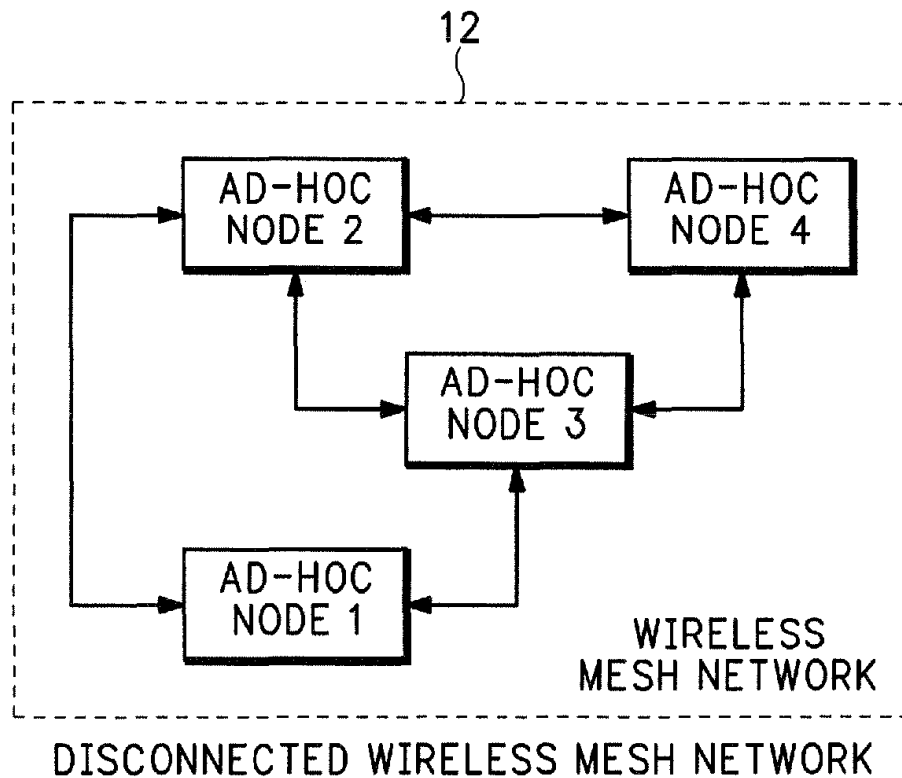


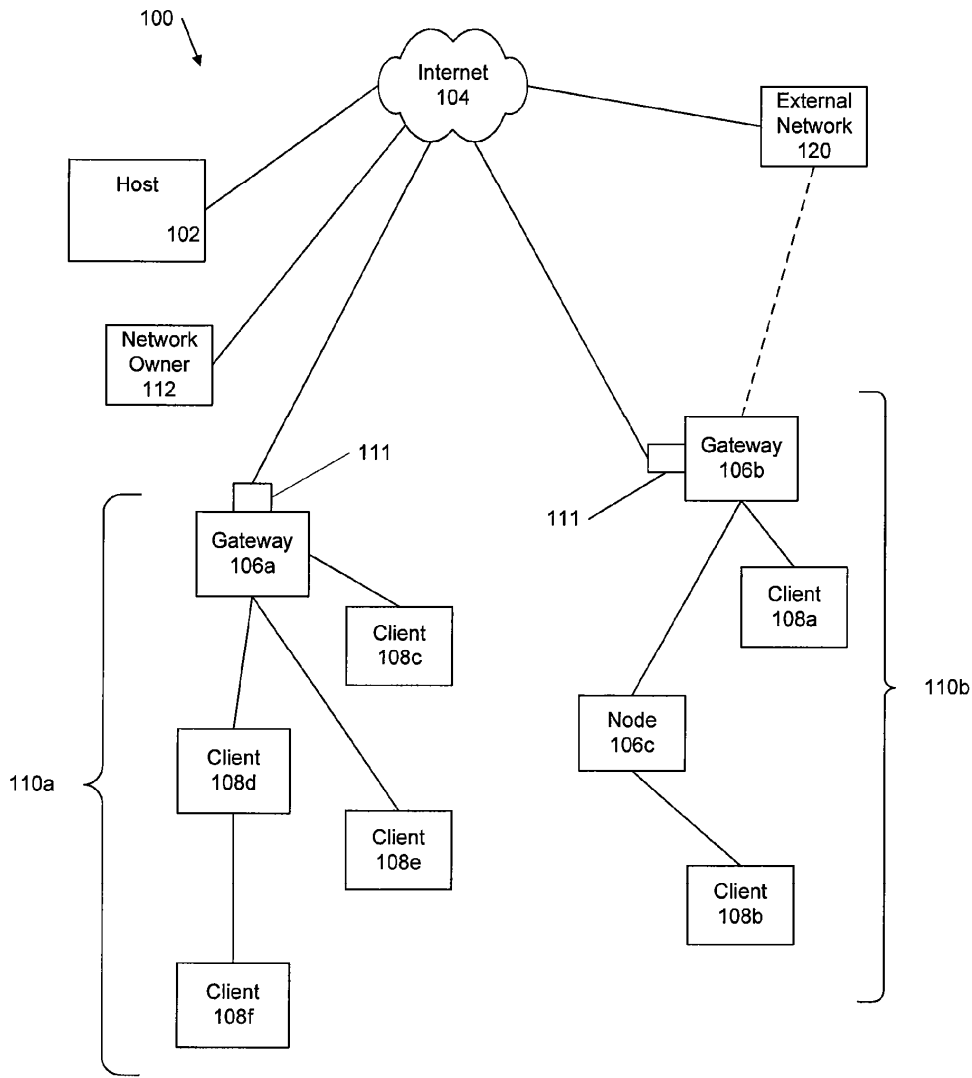
FIG.1

Ex.1006, Fig. 1.

3. Summary of Gil

54. Gil provides further details regarding wireless mesh networks, such as the types of networks contemplated by Castagnoli. Gil explains that “[w]ireless computer networks comprise mesh networks that include at least one node connecting the mesh network to a wide area network (WAN) through a backhaul connection. The WAN can comprise, for example, the Internet, and the backhaul connection node is referred to as a gateway.” Ex.1008, 1:26-30. Like Castagnoli, Gil explains that “nodes of the wireless network typically comprise wireless access

points that communicate with the backhaul connection.” Ex.1008, 1:33-35; *see* Ex.1005, [0007] (“In one-radio systems, the radio unit is used for purposes of **acting as an access point to its clients**, as well as acting as a **backhaul to a parent routing node**. In two-radio systems, one radio unit typically provides **access point service to wireless clients as well as child routing nodes**, while the other radio unit is used as a **backhaul to a parent routing node**.”). However, Gil notes that “[d]eployment of wireless networks is hindered by the requirement for the wired backhaul connection node.” Ex.1008, 1:45-46. Gil seeks to address the “need for wireless access points that can be more easily and economically used in connection with more than one network.” Ex.1008, 2:8-11. Accordingly, Gil provides a solution where “[t]he external connection between” a gateway node and an external network “can comprise...a wireless connection.” Ex.1008, 4:29-31. This is reflected in Figure 1, below, which shows a dotted line signifying a connection between Gateway 106b and External Network 120:



Ex.1008, Fig. 1.

4. Reasons to Combine Castagnoli and Bauer

55. A POSITA would have combined Castagnoli and Bauer because both references relate to networking, and more specifically, to the operation of mesh networks in different failure situations. Castagnoli provides recovery mechanisms for when a mesh network experiences a failure of a connection between two nodes

of the network. Ex.1005, Abstract. And Bauer teaches mesh network operation when the connection to an external network is not present, e.g., when the connection is lost. Ex.1006, Abstract.

56. More specifically, Castagnoli is concerned with “providing an efficient failure recovery mechanism in hierarchical wireless mesh networks.” Ex.1005, Abstract. Castagnoli explains that it “mitigates the effect of synchronization loss between a parent and child node on the hierarchical wireless mesh network.” Ex.1005, Abstract. Because of the dependencies of hierarchical wireless mesh networks, a failure event with a node “will generally cause its child nodes to seek to re-acquire another parent node.” Ex.1005, [0010]. Such failure events propagate down the network in situations where a child node, seeking to re-acquire another parent node, stops servicing its own child nodes, causing them to seek another parent node as well. Ex.1005, [0010]. Accordingly, Castagnoli provides a solution to mitigate failure when a node loses synchronization with its parent. Ex.1005, [0146]. More specifically, Castagnoli explains that after a set period for which a routing node does not receive messages from its parent routing node, it searches for and attempts synchronization with a new tentative parent routing node. Ex.1005, [0147]; *see generally* Ex.1005, [0146]-[0150] (discussing re-acquisition of parent routing nodes).

57. Thus, while Castagnoli focuses on mitigating failure between nodes, Bauer provides details concerning how its hierarchical wireless mesh network should respond in instances where the connection between a mesh network to an external network is lost. Ex.1006, [0005], [0023], [0025]. Accordingly, a POSITA would have looked to teachings addressing other types of failure situations, such as those described in Bauer, because Castagnoli emphasizes why mesh network failure is undesirable. Ex.1005, [0010].

58. More specifically, Bauer teaches “[n]odes in a mesh network [] configured to access centralized Internet Protocol (IP) services when the Internet infrastructure is accessible [which] dynamically switch to providing the IP services locally in the mesh network when the Internet infrastructure is not accessible.” Ex.1006, [0005]. Bauer explains that a “mesh network 12 over its lifetime may be connected or disconnected from an Internet infrastructure.” Ex.1006, [0023]. Mesh networks can be “permanently connected or disconnected to Internet 14,” or “intermittently connected to Internet 14” depending on the circumstances. Ex.1006, [0025]. Routing and data distribution software allows mesh nodes to “know when they are part of a connected or disconnected mesh network[.]” Ex.1006, [0026].

59. Bauer also discusses the operation of devices on a mesh network. Bauer discusses a mesh network comprising “nodes 1-4”, explaining that each of

the nodes are “computing devices...that are capable of sending, receiving, and forwarding IP packets directly to other nodes.” Ex.1006, [0023]. Bauer uses the term nodes to instead refer to “Personal Computers (PCs), Personal Digital Assistants (PDAs), cellular telephones with IP capabilities, digital pagers, or any other IP device that may need to operate in a mesh network.” Ex.1006, [0023]. These devices are connected “through one or more intermediary nodes that relay the IP communications to the destination node.” Ex.1006, [0024]. In this way, some of Bauer’s “nodes 1-4” correspond to Castagnoli’s “client devices” (e.g., when a Bauer node is an endpoint of a communication) and some of the other “nodes 1-4” correspond to Castagnoli’s “routing nodes” (e.g., when a Bauer node is relaying a communication).

60. A POSITA would have been motivated to combine the teachings of Castagnoli and Bauer and doing so would have been within the POSITA’s skillset. The combination would have been obvious because it represents merely the use of a known technique (providing the IP services locally in a mesh network when the external network is not accessible) to improve similar devices (Castagnoli’s hierarchical wireless mesh network) in the same way (enabling dynamically switching operation of Castagnoli’s hierarchical wireless mesh network when a an external network is connected or disconnected, per Bauer) to yield predictable results. Castagnoli provides extensive disclosure about mesh network operation

and failure recovery, but focuses on node-to-node failures. Ex.1005, [0010], [0146]-[0150]. Bauer discloses additional details relevant to a different type of failure that can occur in Castagnoli's network, i.e., in the connection to the external network, and focuses on operations of client devices and routing nodes within the mesh network. Ex.1006, Abstract, [0023]-[0025].

61. In the combination, routing nodes within Castagnoli's hierarchical wireless mesh network would maintain operations as disclosed, including regular operations to maintain network connectivity and operation when two nodes lose connection within the network. However, when a connection is instead lost at the root node, i.e., between the root node and external network, Bauer's teachings regarding the provision of IP services locally would be implemented.

62. A POSITA would have had a reasonable expectation of success in combining Castagnoli and Bauer because the teachings of Castagnoli and Bauer are complimentary; each providing handling for different failure events within a mesh network. Further, the teachings of Castagnoli and Bauer focus on different aspects of a mesh network: Castagnoli focuses on routing node operation and connectivity to parent routing nodes, while Bauer focuses on client device and routing node operation to dynamically switch to providing IP services locally or through Internet infrastructure, depending on the connectivity to the external network. As such, a POSITA would have recognized how Bauer's teachings of

maintaining network operation when connection to an external network is lost would apply to Castagnoli's hierarchical wireless mesh network. Additionally, such combination would be desirable because it would allow for the client devices within Castagnoli's hierarchical wireless mesh network to maintain functionality, and the routing nodes to maintain synchronization, until the connection to the external network is restored, limiting the impacts of an external network failure.

5. Reasons to Combine Castagnoli, Bauer, and Gil

63. A POSITA would have combined Castagnoli and Bauer with Gil because each of the references relates to networking, and more specifically, to implementation details of a wireless mesh network. Castagnoli provides recovery mechanisms for when a mesh network experiences a failure of a connection between two nodes of the network. Ex.1005, Abstract. Bauer teaches mesh network operation when the connection to an external network is not present, e.g., when the connection is lost. Ex.1006, Abstract. And Gil provides further implementation details regarding the connection of a mesh network to an external network, explaining that such connections can be a wired connection or a wireless connection. Ex.1008, 4:29-31.

64. A POSITA would have been motivated to combine the teachings of Castagnoli and Bauer with Gil and doing so would have been within the POSITA's skillset. The combination would have been obvious because it represents merely

the use of a known technique (connecting a wireless mesh network to an external network using a wireless connection) to improve similar devices (Castagnoli's hierarchical wireless mesh network) in the same way (enabling Castagnoli's root routing nodes to utilize uplink radios that are already included as part of the node to connect with external networks wirelessly, per Gil) to yield predictable results. Castagnoli notes that in a hierarchical wireless mesh network, "the routing nodes bridge wireless traffic onto a wired network at the top of the hierarchy" without explaining the types of connections that would be utilized. Ex.1005, [0007]. Gil provides further teachings to suggest using a wireless connection instead. Ex.1008, 4:25-31.

65. A POSITA would have been motivated to combine the teachings of Castagnoli and Bauer with Gil and doing so would have been obvious to try. While Castagnoli does not explain how exactly a root routing node would be connected to an external network, Gil presents known and finite alternatives for such connections: (1) a wired connection, or (2) a wireless connection. Ex.1005, [0007]; Ex.1008, 4:25-31. Indeed, Gil's teaching directly solves the known issue that "[d]eployment of wireless networks is hindered by the requirement for the wired backhaul connection node" by instead allowing a wireless connection between networks. Ex.1008, 1:45-46. In the combination, Castagnoli's hierarchical wireless

mesh network would maintain operations, bridging traffic to an external network by implementing Gil's teaching of doing so via a wireless link.

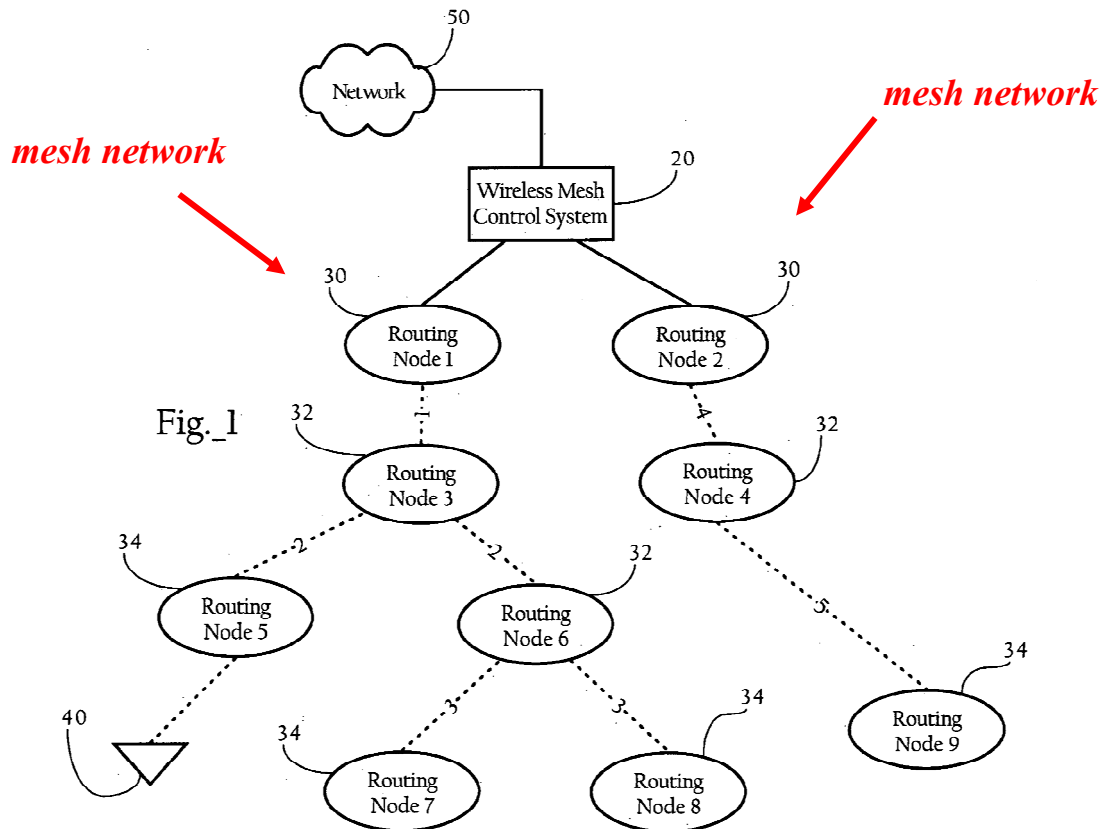
66. A POSITA would have had a reasonable expectation of success in combining Castagnoli, Bauer, and Gil because the teachings of Castagnoli, Bauer, and Gil are complimentary; each providing teachings regarding the operations of a wireless mesh network. Further, the teachings of Castagnoli, Bauer, and Gil focus on different aspects of a network: Castagnoli focuses on routing node operation and connectivity to parent routing nodes, Bauer focuses on client device and routing node operation to dynamically switch to providing IP services locally or through Internet infrastructure, depending on the connectivity to the external network, and Gil provides additional teachings regarding the mechanisms for connecting a mesh network to an external network. Additionally, such combination would be desirable because it would allow for the root routing node within Castagnoli's hierarchical wireless mesh network to connect to another network using its uplink radio, allowing for broader deployment and mobility of the mesh network.

6. Claim 1

a. [1.0] *A structured mesh network capable of isolated operation, comprising:*

67. To the extent the preamble is limiting, Castagnoli in combination with Bauer renders it obvious.

68. First, Castagnoli details a “hierarchical wireless mesh network,” two examples of which are illustrated in Figure 1, annotated below.
Ex.1005, [0033].

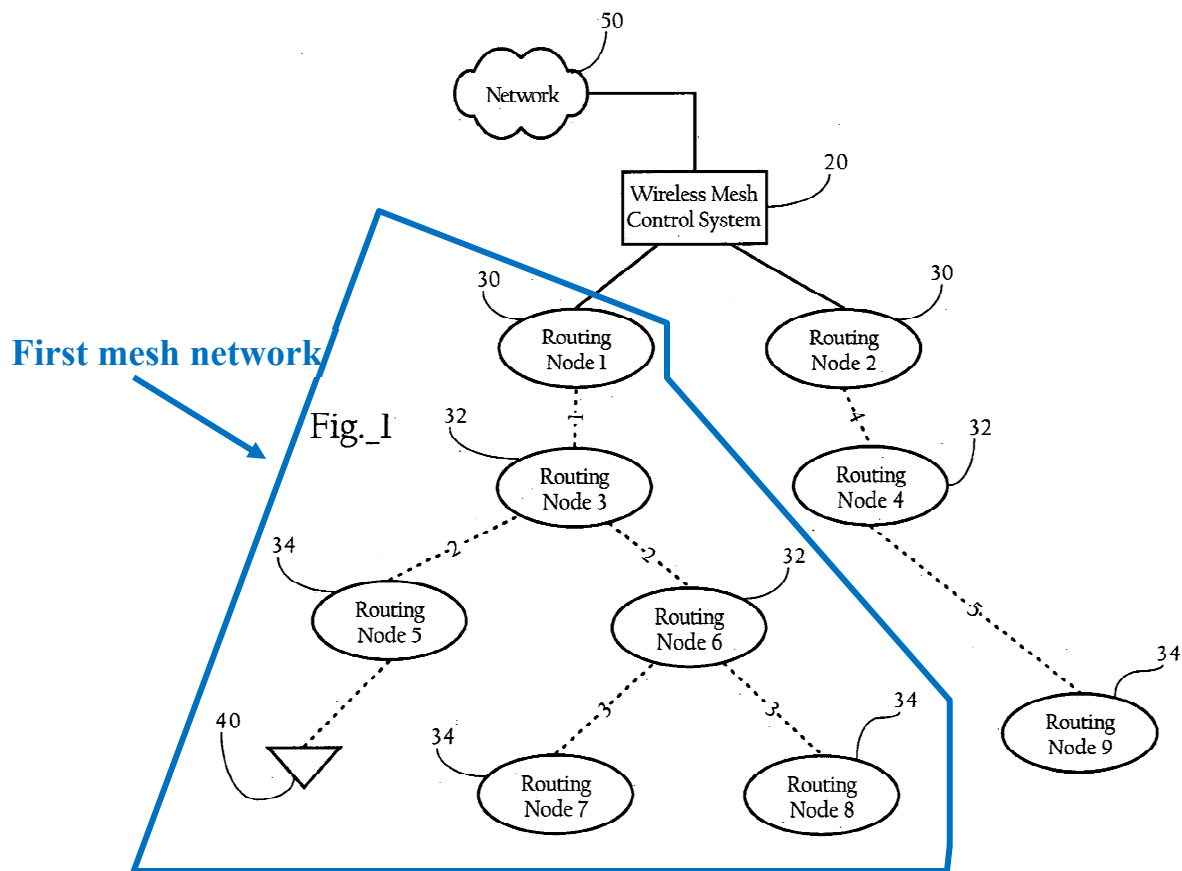


Ex.1005, Fig. 1 (annotated).

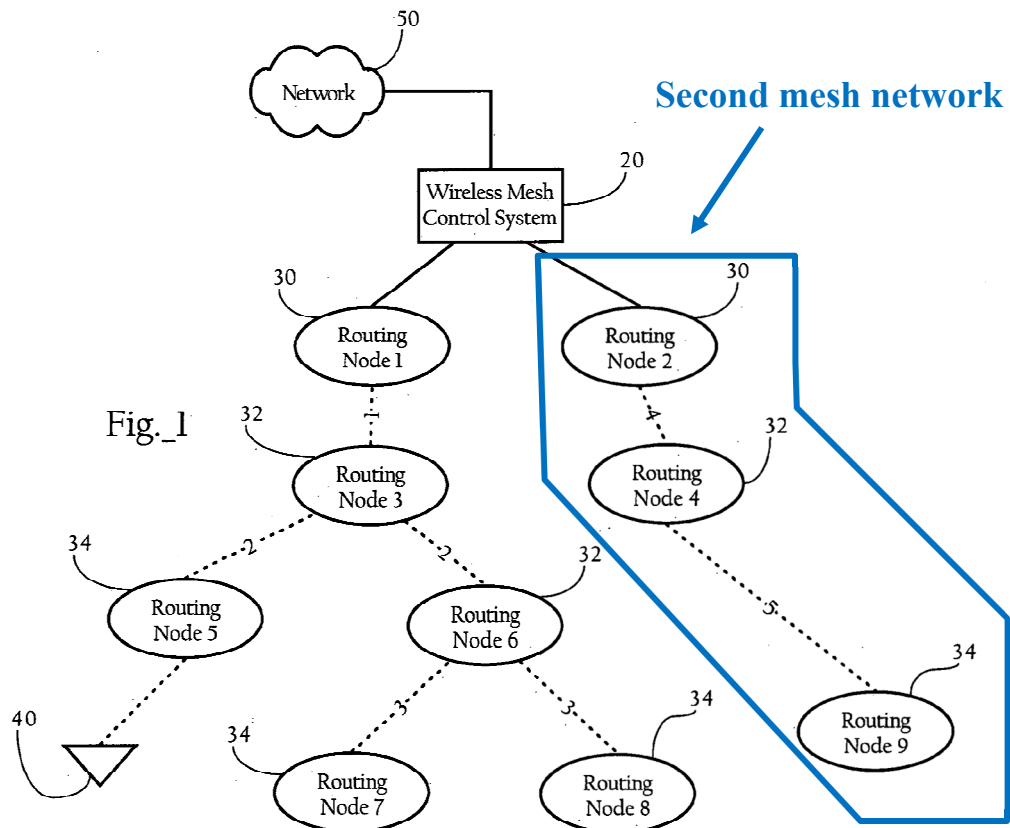
69. Castagnoli’s wireless mesh network is a *structured mesh network* because it is a “hierarchical wireless mesh network” that “can operate in a wide variety of hierarchical mesh network configurations.” Ex.1005, [0033]. Figure 1 shows “a hierarchical architectural overlay is imposed on the mesh network of

routing nodes to create a downstream direction towards leaf routing nodes 34, and an upstream direction toward the root routing nodes 30.” Ex.1005, [0033].

70. More specifically, Castagnoli illustrates two hierarchical wireless mesh networks—a first mesh network with root routing node 1 (left side in Fig. 1, above), and a second mesh network with root routing node 2 (right side in Fig. 1, above). Each of Castagnoli’s hierarchical wireless mesh networks (*a structured mesh network*) includes “routing nodes that bridge wireless traffic onto a wired network at the top of the hierarchy,” e.g., network 50. Ex.1005, [0007]. As illustrated in Figure 1, each routing node 3-9 is wirelessly connected via respective uplink radios to root routing node 1 or root routing node 2, either directly or through connections to parent routing nodes, to create “an upstream direction toward the root routing nodes 30.” Ex.1005, [0033], Fig. 1. Root routing node 1 and root routing node 2, in turn, “bridge wireless traffic onto a wired network at the top of the hierarchy,” e.g., network 50, for their respective hierarchical wireless mesh networks. Ex.1005, [0007]. Each annotated Figure 1 below reflects the respective hierarchical wireless mesh networks illustrated by Castagnoli:



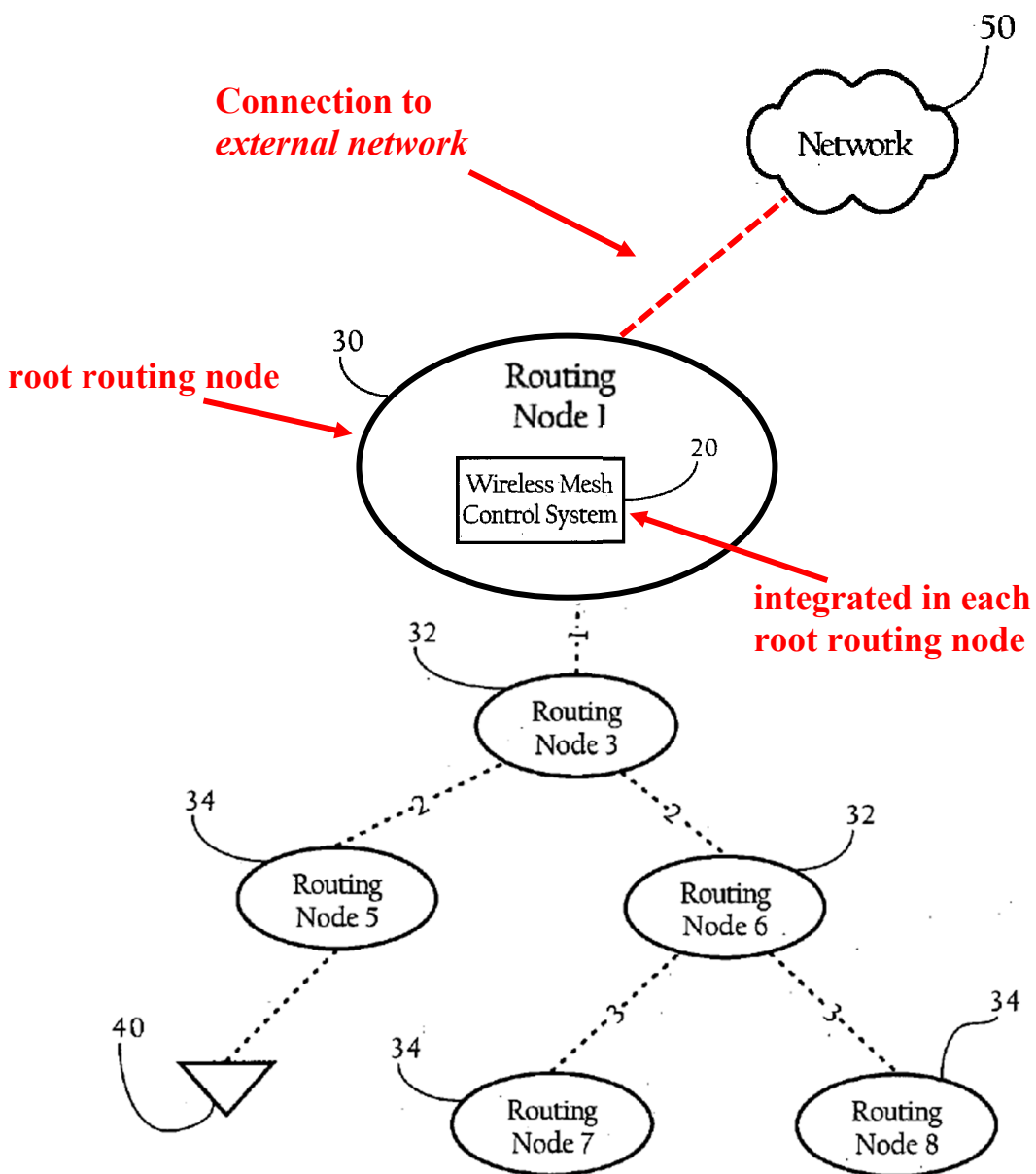
Ex.1005, Fig. 1 (annotated).



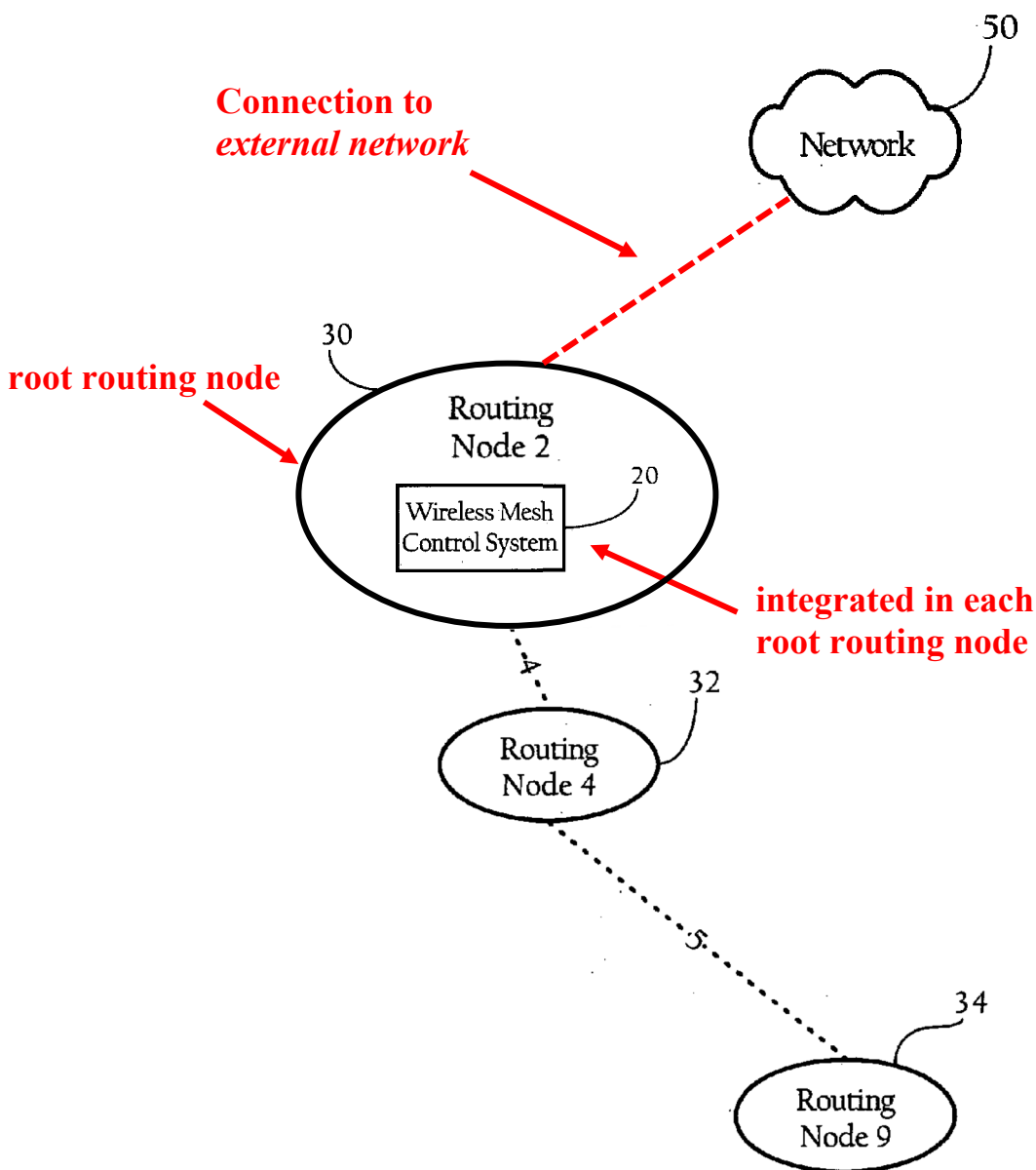
Ex.1005, Fig. 1 (annotated).

71. Further, Castagnoli's Figure 1 illustrates a "wireless mesh control system 20" above the hierarchical wireless mesh network. Castagnoli explains that wireless mesh control system 20 may perform various functions related to message routing, packet headers, client association with routers, route discovery, and monitoring the network. Ex.1005, [0155], [0153], [0035]. While Figure 1 illustrates a single wireless mesh control system 20, Castagnoli explains that "the functionality of mesh network control system 20 may be integrated into other network devices, such as root routing nodes 30." Ex.1005, [0156]. Accordingly, in

such instances, each root routing node is the link that bridges traffic to the external network 50. Each annotated Figure 1 below, modified in view of Castagnoli's teaching of integrating the wireless mesh control system 20 into the root routing nodes, reflects the respective hierarchical wireless mesh networks illustrated by Castagnoli:



Ex.1005, Fig. 1 (modified, annotated).



Ex.1005, Fig. 1 (modified, annotated).

72. The '691 Patent explains that it is “based on a two-radio mesh network,” where mesh nodes “form a hierarchical tree-like network topology called a ‘Structured Mesh’[.]” This was a known design for wireless mesh networks, and the nodes in Castagnoli’s wireless mesh network are similarly arranged in “hierarchical tree structures.” Ex.1005, [0033]. Thus, each of

Castagnoli's wireless mesh networks (reflected in the modified Figure 1 annotations, above) renders obvious the claimed *structured mesh network*. While the two hierarchical wireless mesh networks illustrated by Castagnoli (with root routing node 1, and with root routing node 2) are each *a structured mesh network*, the analysis of claim 1 focuses on the hierarchical mesh network with root routing node 1 when discussed with respect to the claimed *structured mesh network*.

73. Second, the combination of Castagnoli and Bauer renders obvious *a structured mesh network capable of isolated operation* as discussed in further detail in the analysis of [1.7] below (addressing *the second isolated configuration*). As discussed in Section IX.A.3 above, a POSITA would have been motivated to combine Castagnoli and Bauer to implement Bauer's teachings of providing IP services locally when Castagnoli's hierarchical wireless mesh network loses connection to the external network 50.

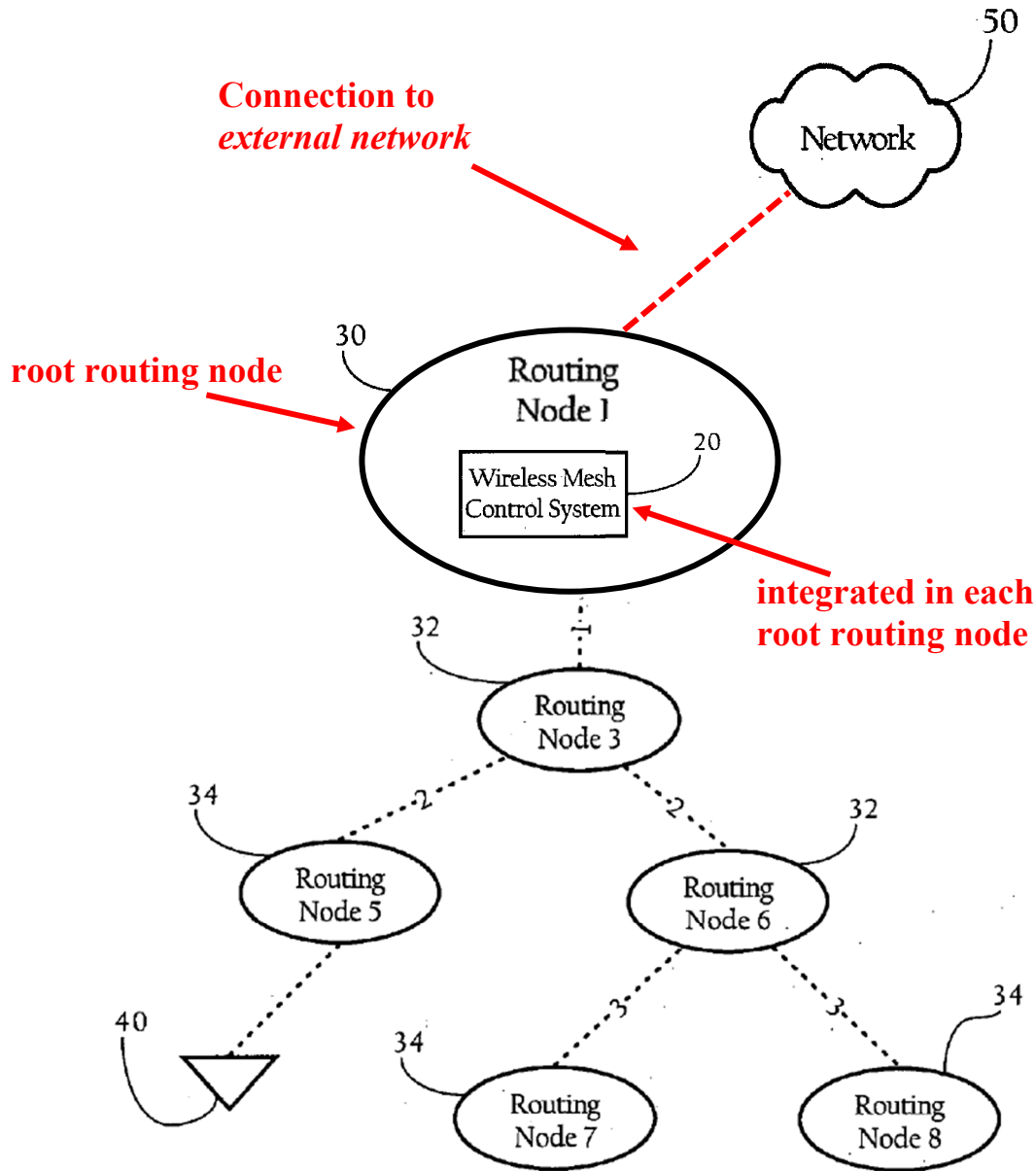
74. Bauer explains that when the mesh network is "disconnected from an Internet infrastructure," wireless clients such as "computing devices [] are capable of sending, receiving, and forwarding IP packets directly to other nodes." Ex.1006, [0023]. In this disconnected state, the wireless clients within Castagnoli's hierarchical wireless mesh network "communicate indirectly to other nodes through one or more intermediary nodes that relay the IP communications to the destination node," e.g., through routing nodes. Ex.1006, [0024]; *see also* Ex.1006,

Abstract (nodes are configured to “provid[e] the IP services locally in the mesh network when the Internet infrastructure is not accessible”).

75. Thus, Castagnoli in view of Bauer renders obvious *a structured mesh network* (Castagnoli’s wireless mesh network) *capable of isolated operation* (the mesh network maintains IP connectivity when a connection to the outside network is lost, per Bauer)

b. [1.1] *at least two structured mesh nodes;*

76. Castagnoli discloses or renders obvious *at least two structured mesh nodes* because Castagnoli illustrates “a plurality of routing nodes” in a hierarchical wireless mesh network. Ex.1005, [0033]. As shown in Figure 1, below, Castagnoli’s wireless mesh network includes a “plurality of routing nodes.” Ex.1005, [0033].



Ex.1005, Fig. 1 (modified, annotated).

77. More specifically, Castagnoli discloses “root routing nodes 30,” intermediary routing node[s] 32,” and leaf routing nodes 34,” as indicated in modified Figure 1 above. Ex.1005, [0033]. Further, as discussed in [1.0], Castagnoli’s wireless mesh network is a *structured mesh network*. Similarly, the nodes that form the wireless mesh network are *structured mesh nodes* because “the

routing nodes are arranged in [a] hierarchical tree structure[]” and operate as a root node, intermediary nodes, or leaf nodes within the hierarchy. Ex.1005, [0033].

78. Thus, Castagnoli discloses or renders obvious *at least two structured mesh nodes* (a plurality of mesh nodes arranged in a hierarchical tree structure).

c. [1.2] *wherein each structured mesh node comprises at least a connectivity logic;*

79. Castagnoli discloses or renders obvious that *each structured mesh node comprises at least a connectivity logic* because each of the routing nodes include routing node control processors that control operations of the respective node. Castagnoli illustrates “the logical and/or operating components” of a routing node configuration. Ex.1005, [0037]. Castagnoli explains that “a mesh routing node generally comprises routing node control processor 70, wireless backbone interface unit 60, and WLAN interface unit 80.” Ex.1005, [0037].

80. As reflected in Figure 2, below, routing node control processor 70 includes “hardware modules (e.g., processor, memory), software modules (e.g., drivers, etc.) and data structures (e.g., frame buffers, queues, etc.) that **control operation of the routing node.**” Ex.1005, [0041].

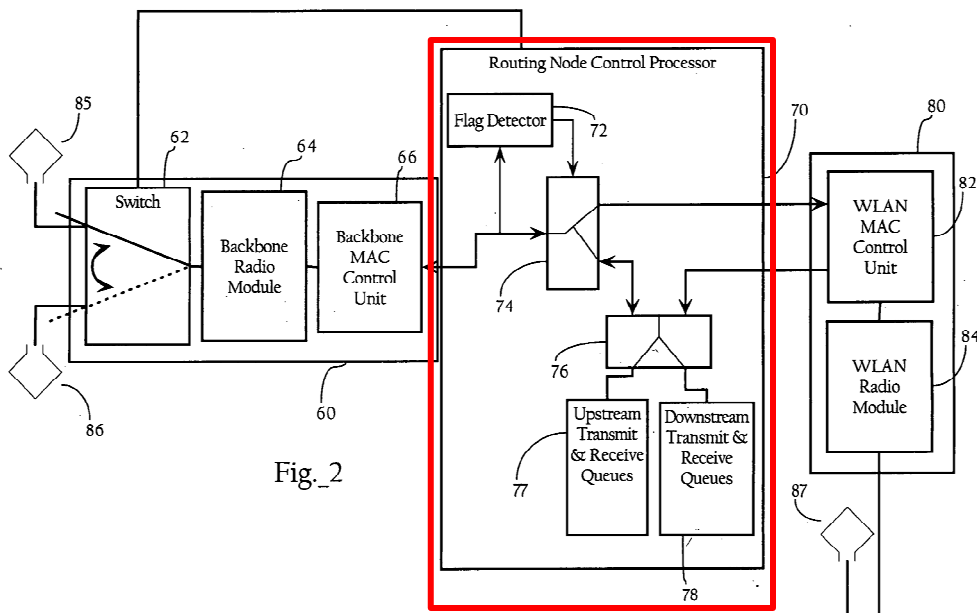


Fig. 2

Ex.1005, Fig. 2 (annotated).

81. The routing node control processor controls the operation of its routing node. For instance, the routing node control processor can include “a routing node application” that allow the routing node to “transmit scheduling messages to at least one child routing node,” “maintain synchronization with the parent routing node,” “attempt to re-acquire the parent routing node,” and “select a neighboring routing node as a tentative parent node.” Ex.1005, Claims 10-11, 14; *see* Ex.1005, [0054]-[0107] (discussing “Neighbor Maintenance State”), [0108]-[0144] (discussing “Slot-Based Transmission Scheduling Mechanism”), [0145]-[0155] (discussing “Mitigation of Synchronization Loss”).

82. Thus, each routing node including a routing node control processor 70 operating to control operation of the respective routing node—scheduling with child

nodes, acquiring parent nodes, and maintaining synchronization with parent nodes—discloses or renders obvious that *each structured mesh node comprises at least a connectivity logic*.

- d. [1.3] *an uplink radio operating on an uplink frequency and a downlink radio operating on a distinct downlink frequency;*

83. Castagnoli renders obvious this limitation because Castagnoli describes two-radio systems and multi-radio systems where one radio is used as a backhaul to its parent routing node (*an uplink radio*) and a second radio provides service to clients and child routing nodes (*a downlink radio*).

84. **First**, Castagnoli discloses *an uplink radio...and a downlink radio* because Castagnoli explains that the “wireless mesh routing nodes can be...two-radio systems” where “one radio unit typically provides access point service to wireless clients as well as child routing nodes, while the other radio unit is used as a backhaul to a parent routing node.” Ex.1005, [0007]. The radio providing a connection to the parent node is *an uplink radio*, and the radio providing a connection to clients and child routing nodes is *a downlink radio*.

85. Figure 2, below, reflects a two-antenna arrangement in the wireless mesh nodes, where “[f]irst antenna 85...can be used for data transfer with a parent routing node, while second antenna 86 can be used for transfer with one or more child routing nodes.” Ex.1005, [0042].

**Antenna for data transfer
with parent routing node**

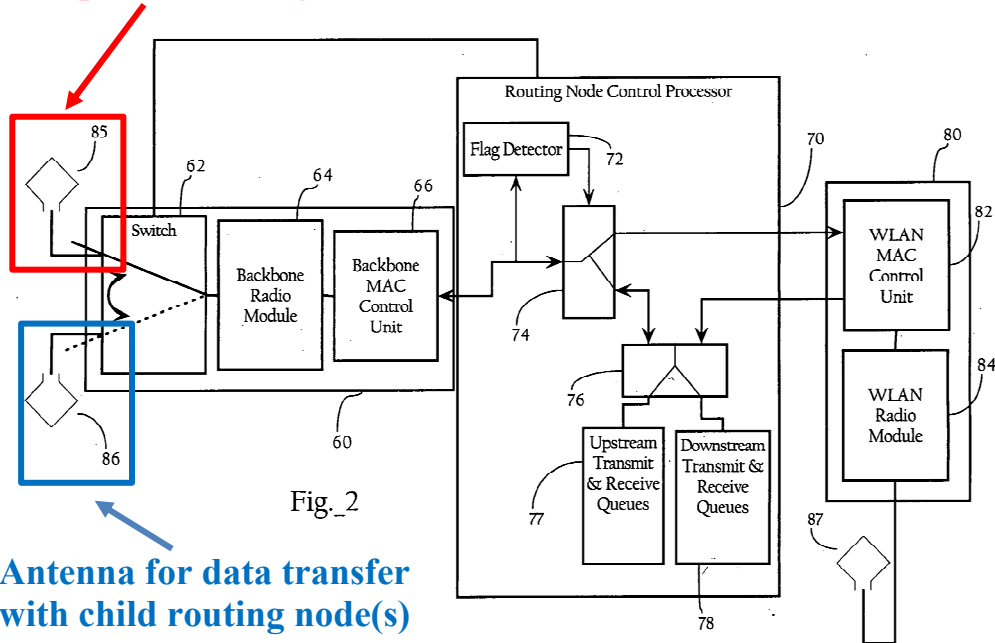


Fig. 2

Ex.1005, Fig. 2 (annotated).

86. While Figure 2 shows a single-radio implementation with two antennas, it would have been obvious to have each disclosed antenna operate in conjunction with its own respective radio in the two-radio systems contemplated by Castagnoli. *See* Ex.1005, Fig. 2, [0007], [0042]. Further, such multi-radio systems, where distinct radios were dedicated to uplink and downlink connections within the systems, were well-known and would have been an obvious choice in view of Castagnoli's explicit disclosure of such systems. *See* Ex.1005, [0007]. Thus, Castagnoli discloses or renders obvious *an uplink radio* (a first radio used as a backhaul to a parent routing node, operating using first antenna 85) and *a*

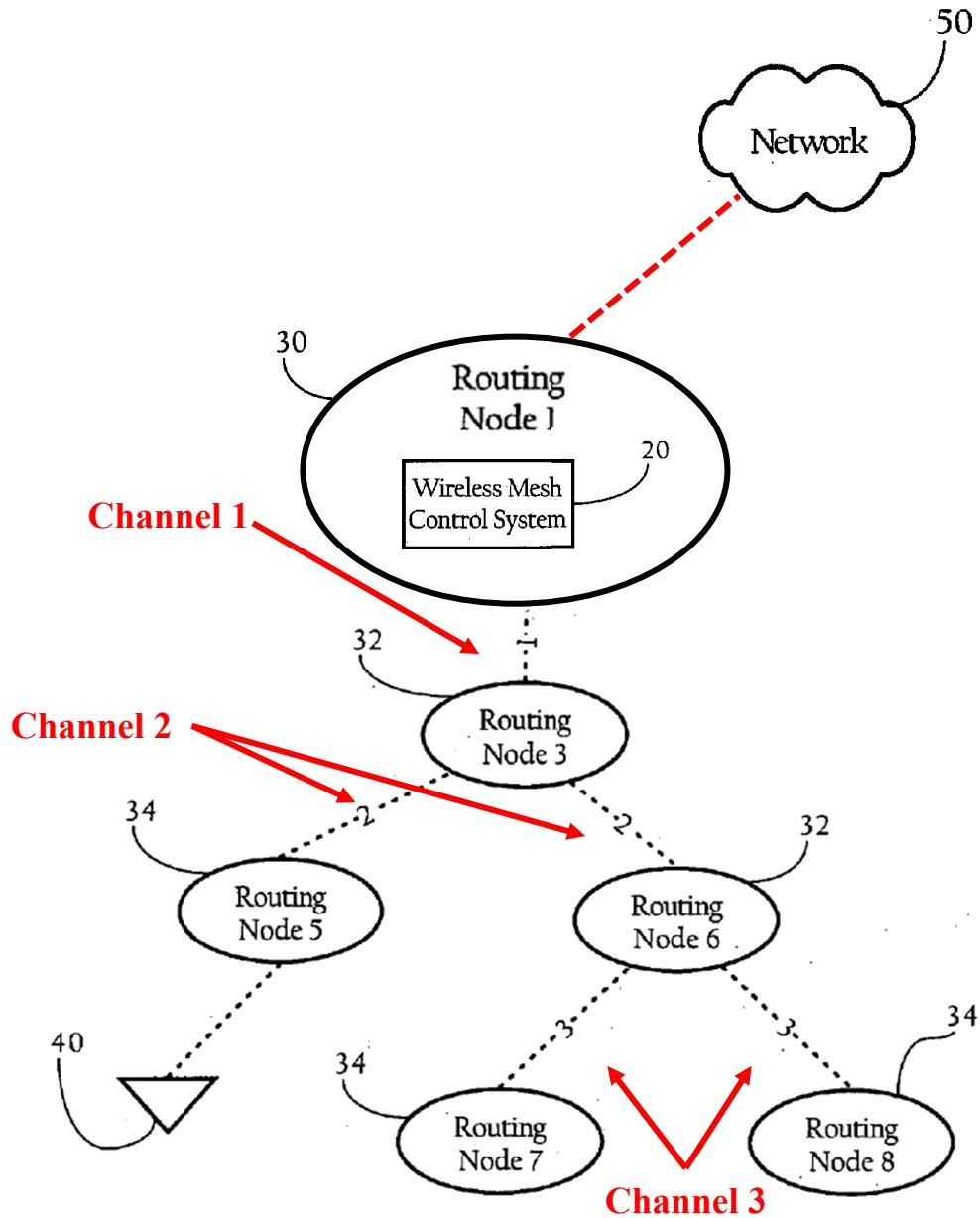
downlink radio (a second radio unit providing access point service to wireless clients and child routing nodes, operating using second antenna 86).

87. **Second**, Castagnoli's uplink and downlink radios operate *on an uplink frequency* and *on a distinct downlink frequency* respectively because Castagnoli explains that each routing node uses different, non-overlapping channels across different radio frequencies for upstream data transfer and downstream data transfer. As Figure 1 illustrates below, Castagnoli explains that different, non-overlapping channels are used for upstream data transfer and downstream data transfer, such that each node has its own distinct downlink channel:

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,**

while in other implementations they are overlapping channels.

Ex.1005, [0035]. It would have been obvious to a POSITA for Castagnoli's non-overlapping channels to correspond to non-overlapping radio frequencies because Castagnoli describes how nodes in a wireless mesh network communicate via multiple radio frequencies. Ex.1005, [0007] (“**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 and other conditions **on multiple radio frequencies.**”).



Ex.1005, Fig. 1 (modified, annotated).

88. Thus, Castagnoli renders obvious *an uplink radio operating on an uplink frequency* (a radio is used as a backhaul to its parent routing node on one channel) *and a downlink radio operating on a distinct downlink frequency* (a radio

provides service to clients and child routing nodes on a different, non-overlapping channel).

- e. [1.4] *wherein the connectivity logic² determines whether each structured mesh node connects with an external network or another node using its uplink radio and client devices or other mesh nodes connect to each node using each node's downlink radio;*

89. Castagnoli renders obvious this limitation because, as discussed above in the analysis of [1.2], Castagnoli discloses or renders obvious that *each structured mesh node comprises at least a connectivity logic*, and Castagnoli further renders obvious that each node's routing node control processor controls the operation of its routing node, including connections with other nodes as parent nodes (*determines whether each structured mesh node connects with...another node using its uplink radio*) and connections with other nodes as child nodes (*determines whether...other mesh nodes connect to each node using each node's downlink radio*).

² The term "the connectivity logic" finds antecedent basis in limitation [1.2], which recites *wherein each structured mesh node comprises at least a connectivity logic*. Accordingly, limitation [1.4] is interpreted as referring to the instance of *the connectivity logic* for each respective node, where the recitation of "each" within this limitation refers to the respective node for that specific instance of the connectivity logic. In other words, the connectivity logic for a specific node determines that specific node's connections using its uplink radio and downlink radio.

90. As noted above in the analysis of limitation [1.2], Castagnoli's routing node control processor can include "a routing node application" that allow the routing node to "transmit scheduling messages to at least one child routing node" (*connect to a child node via the node's downlink radio*), "maintain synchronization with the parent routing node" (*connect with a parent node using its uplink radio*), "attempt to re-acquire the parent routing node" (*connect with a parent node using its uplink radio*), and "select a neighboring routing node as a tentative parent node" (*connect with a parent node using its uplink radio*). Ex.1005, Claims 10-11, 14. Further, each mesh routing node is "operative to establish and maintain wireless connections to one or more wireless client devices 40" (*client devices...connect to each node using each node's downlink radio*). Ex.1005, [0036].

91. Because Castagnoli teaches that the routing node control processor controls the selection of parent and child nodes, and the nodes are further operative to establish connections with wireless clients, Castagnoli renders obvious this limitation

f. [1.5] *wherein the structured mesh network functions in two configurations selected depending on whether a connection to an external network is present;*

92. Castagnoli in view of Bauer renders obvious *the structured mesh network functions in two configurations selected depending on whether a connection to an external network is present*, as discussed in further detail below in

[1.6] and [1.7]. Specifically, Castagnoli details *the first connected configuration* (see [1.6] below), where Castagnoli's hierarchical wireless mesh network operates as normal while a connection to an external network is maintained. Additionally, Castagnoli in view of Bauer renders obvious *the second isolated configuration* (see [1.7] below), where Castagnoli's hierarchical wireless mesh network operates without a connection to an external network, maintaining communication between client devices as taught by Bauer.

93. Further, Castagnoli in view of Bauer renders obvious *select[ing]* the operating configuration based on a connection to an external network. Specifically, Bauer explains that a “mesh network 12 over its lifetime may be connected or disconnected from the Internet 14.” Ex.1006, [0025]. The mesh nodes within a mesh network “know when they are part of a connected or disconnected mesh network 12 through the use of routing and data distribution software[.]” Ex.1006, [0026]; *see also* Ex.1006, [0027] (“These previously described utilities also allow nodes to determine whether the mesh network they are currently part of is either connected to or disconnected from the Internet infrastructure.”). Bauer further explains that “many well known IP-based applications rely on centralized IP services such as the Network Time Protocol (NTP), the Domain Name System (DNS), and the Dynamic Host Configuration Protocol (DHCP).” Ex.1006, [0002].

However, “[t]hese centralized IP services are not always available in a wireless mesh network,” e.g., when disconnected from the infrastructure. Ex.1006, [0004].

94. Accordingly, centralized IP services, such as Network Time Protocol services, are provided (*selected*) using an Internet-based time server when the mesh network is connected to the Internet (*the first connected configuration*), while the IP services are provided locally (*selected*) using a node configured as a Reported Node Time Server, per Bauer, when the mesh network loses connectivity to the Internet (*the second connected configuration*). Ex.1006, Abstract, [0003]. [0028]-[0029], [0032]; *see infra* Claim 2.

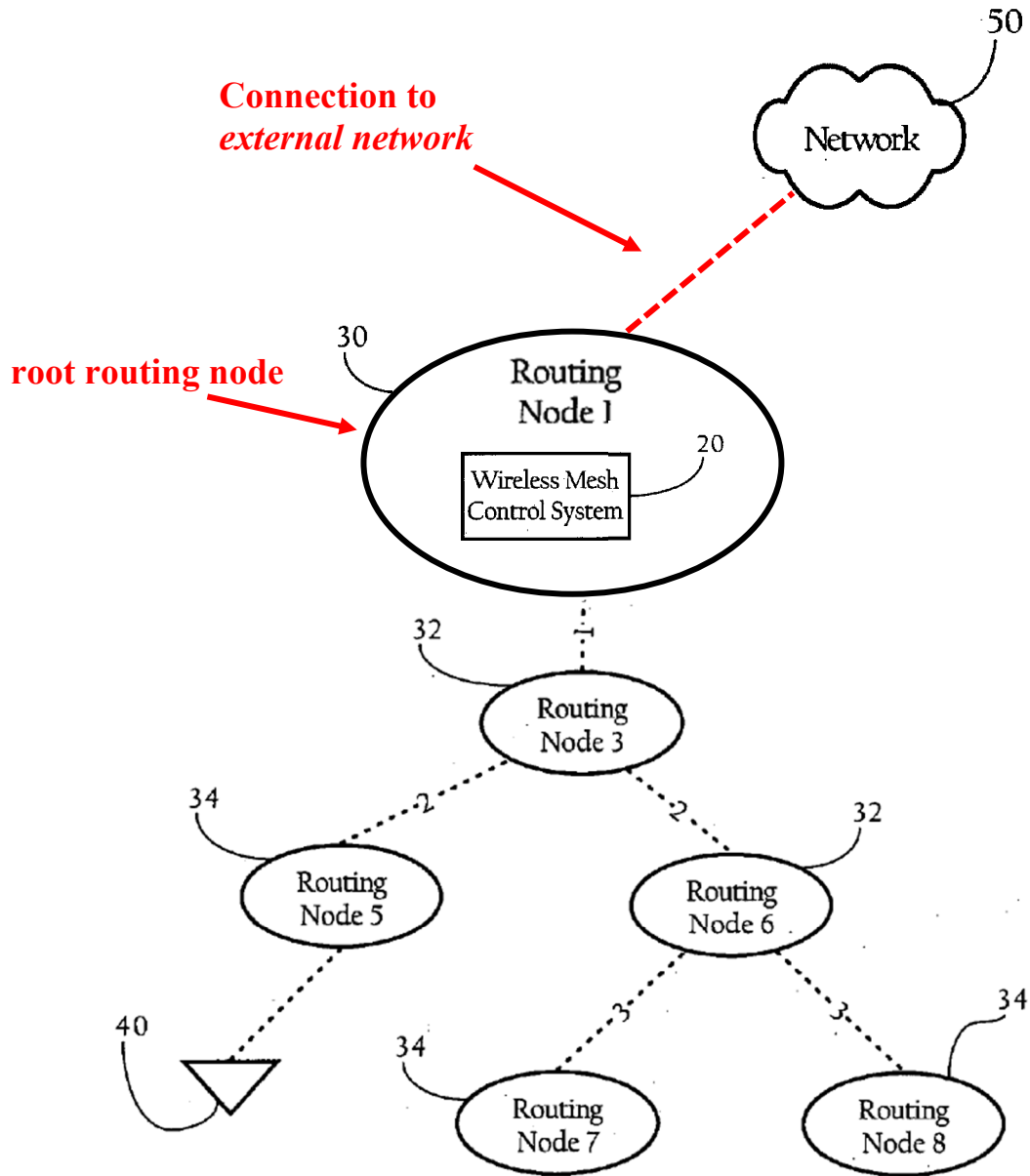
95. Thus, by providing “access [to] centralized Internet Protocol (IP) services” for Castagnoli’s hierarchical wireless mesh network “whenever the Internet infrastructure is accessible and then dynamically switch[ing] to providing the IP services locally in the mesh network when the Internet infrastructure is not accessible,” Castagnoli in view of Bauer renders obvious this limitation. Ex.1006, Abstract.

- g. [1.6] *in the first connected configuration the structured mesh network includes at least one structured mesh node's uplink radio comprising a connection to an external network; and*

96. First, Castagnoli discloses *the first connected configuration* because Castagnoli explains that its hierarchical wireless mesh network connects to an

external network through a root routing node 30 and provides network access to clients and other mobile stations.

97. Castagnoli's wireless mesh network (*the structured mesh network*) includes "routing nodes that bridge wireless traffic onto a wired network at the top of the hierarchy," e.g., network 50. Ex.1005, [0007]. As illustrated in modified Figure 1, each routing node 3 and 5-8 is wirelessly connected via respective uplink radios to root routing node 1, either directly or through connections to parent routing nodes, to create "an upstream direction toward the root routing nodes 30." Ex.1005, [0033], Fig. 1. Root routing node 1, in turn, "bridge[s] wireless traffic onto a wired network at the top of the hierarchy," e.g., network 50, for the hierarchical wireless mesh network Ex.1005, [0007]. "[T]his hierarchical relationship is used in routing packets...between wireless clients 40 and network 50." Ex.1005, [0033].



Ex.1005, Fig. 1 (modified, annotated).

98. Second, Castagnoli in view of Gil renders obvious *at least one structured mesh node's uplink radio comprising a connection to an external network* because Castagnoli teaches that a hierarchical wireless mesh network is connected to an external network, and Gil describes connecting a mesh network to an external network wirelessly.

99. Castagnoli notes that in a hierarchical wireless mesh network, “the routing nodes bridge wireless traffic onto a wired network at the top of the hierarchy,” e.g., network 50. Ex.1005, [0007]. While the external network is described as “wired,” Castagnoli does not describe whether the connection to the external network is itself wired or wireless. Gil explains that “network traffic devices (nodes)...can be provided with the ability to communicate with external networks,” where “[t]he external network connection between the” node and external network “can comprise...a wireless connection.” Ex.1008, 4:25-31.

100. Castagnoli further explains that “each root or leaf routing node can include all the essential physical functionality discussed above, and be configured to operate in a root or leaf routing mode (as appropriate), where the downstream/upstream synchronization functionality is disabled.” Ex.1005, [0045]. This includes the node design described with respect to Figure 2, including the uplink and downlink radios discussed above with respect to limitation [1.3].

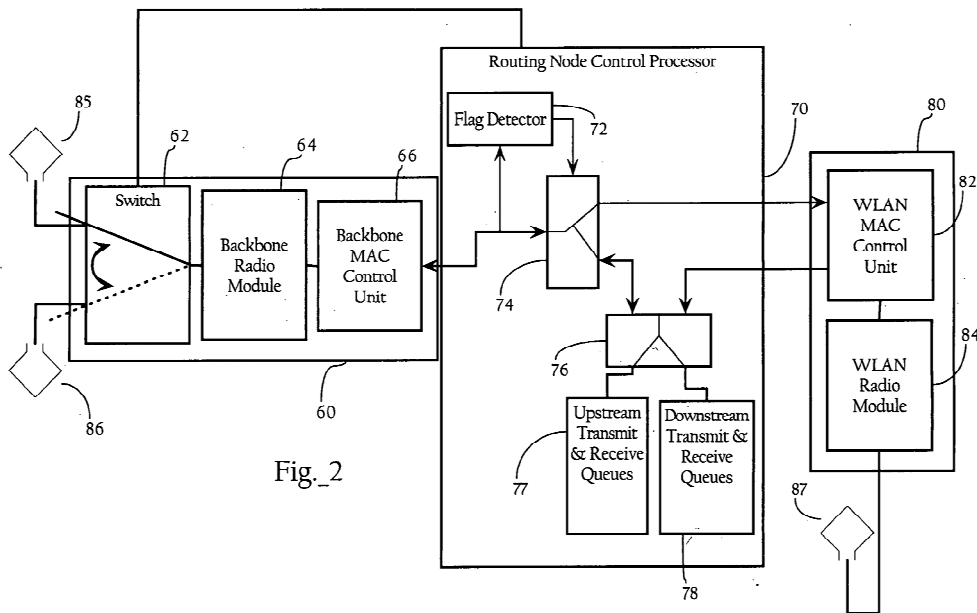
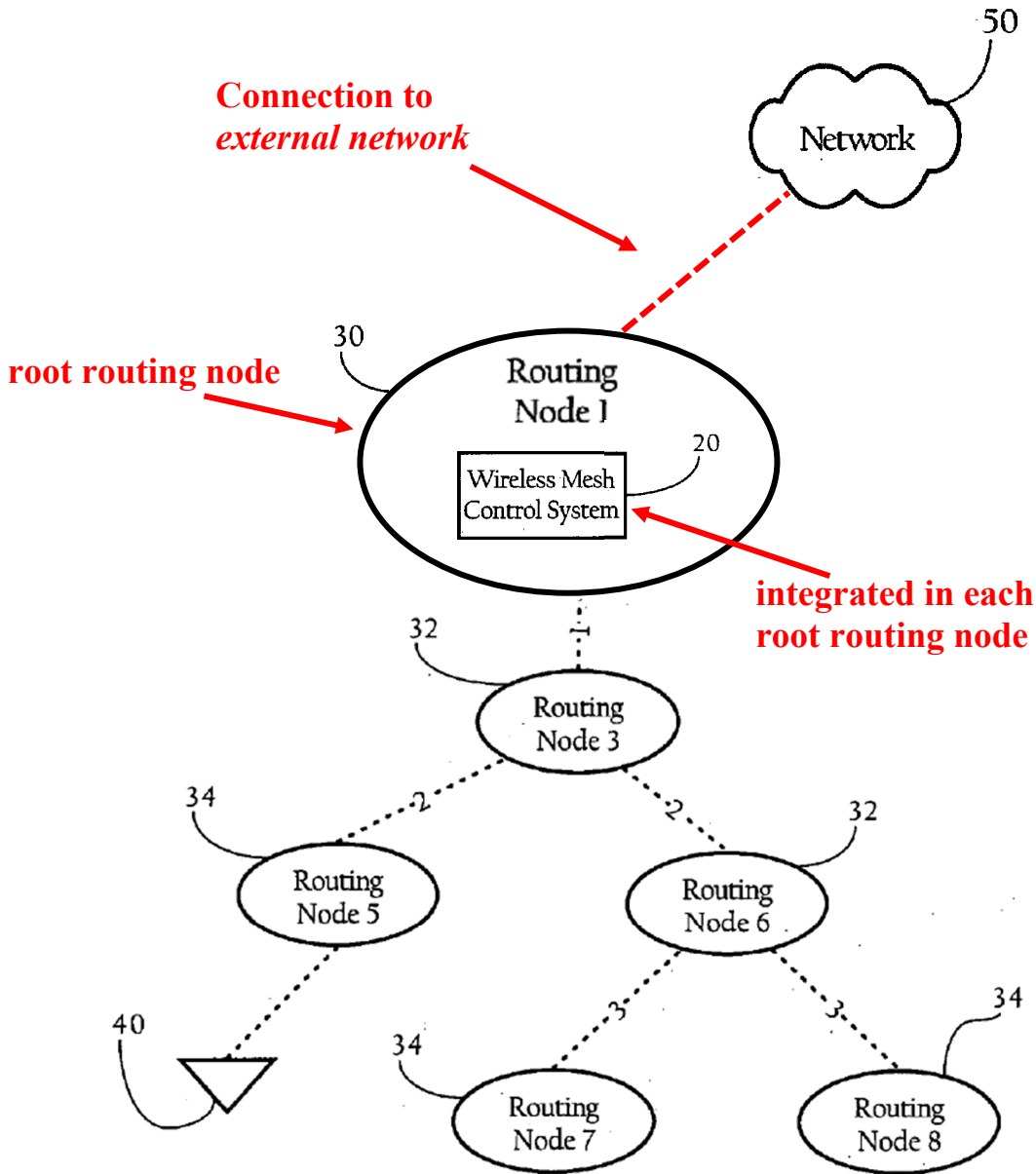


Fig. 2

Ex.1005, Fig. 2.

101. Further, while Castagnoli explains that “upstream synchronization functionality is disabled” for the root routing node, this makes sense as the root routing node does not have a mesh network parent node that would require such upstream synchronization functionality. Ex.1005, [0045]; *see* Ex.1005, [0120] (discussing “maintaining timing synchronization with its parent node”), [0123] (the routing node enters a re-synchronization phase to re-acquire a parent node”). And as discussed above in Section XII.B.5, connecting to an external network using a wireless connection is a simple design decision that a POSITA would have been motivated to implement within Castagnoli’s hierarchical wireless mesh network root routing nodes. Accordingly, in the combination, Castagnoli’s root routing

nodes would utilize the respective uplink radios to connect with external networks, such as network 50, as reflected in Castagnoli's Figure 1. *See* Ex.1005, Fig. 1; Ex.1008, 4:25-31. Further, as noted above in [1.0], Castagnoli is clear that "the functionality of mesh network control system 20 may be integrated into other network devices, such as root routing nodes 30." Ex.1005, [0156]. Accordingly, in such implementations where the functionality of mesh network control system 20 is integrated into root routing nodes, the root routing nodes for each hierarchical wireless mesh network would directly connect to the external network, using a wireless connection as taught by Gil. *See* Ex.1008, 4:25-31.



Ex.1005, Fig. 1 (modified, annotated).

102. Thus, Castagnoli renders obvious *in the first connected configuration* (hierarchical wireless mesh network connected to an external network) *the structured mesh network includes at least one structured mesh node's uplink radio comprising a connection to an external network* (the root node connects to an external network via its uplink radio unit).

- h.** [1.7] *in the second isolated configuration none of the structured mesh nodes' uplink radio comprises a connection to an external network, and one of the structured mesh nodes acts as an isolated network root of the isolated configuration and all remaining nodes connect to the isolated network root node as isolated root children nodes forming a tree configuration;*

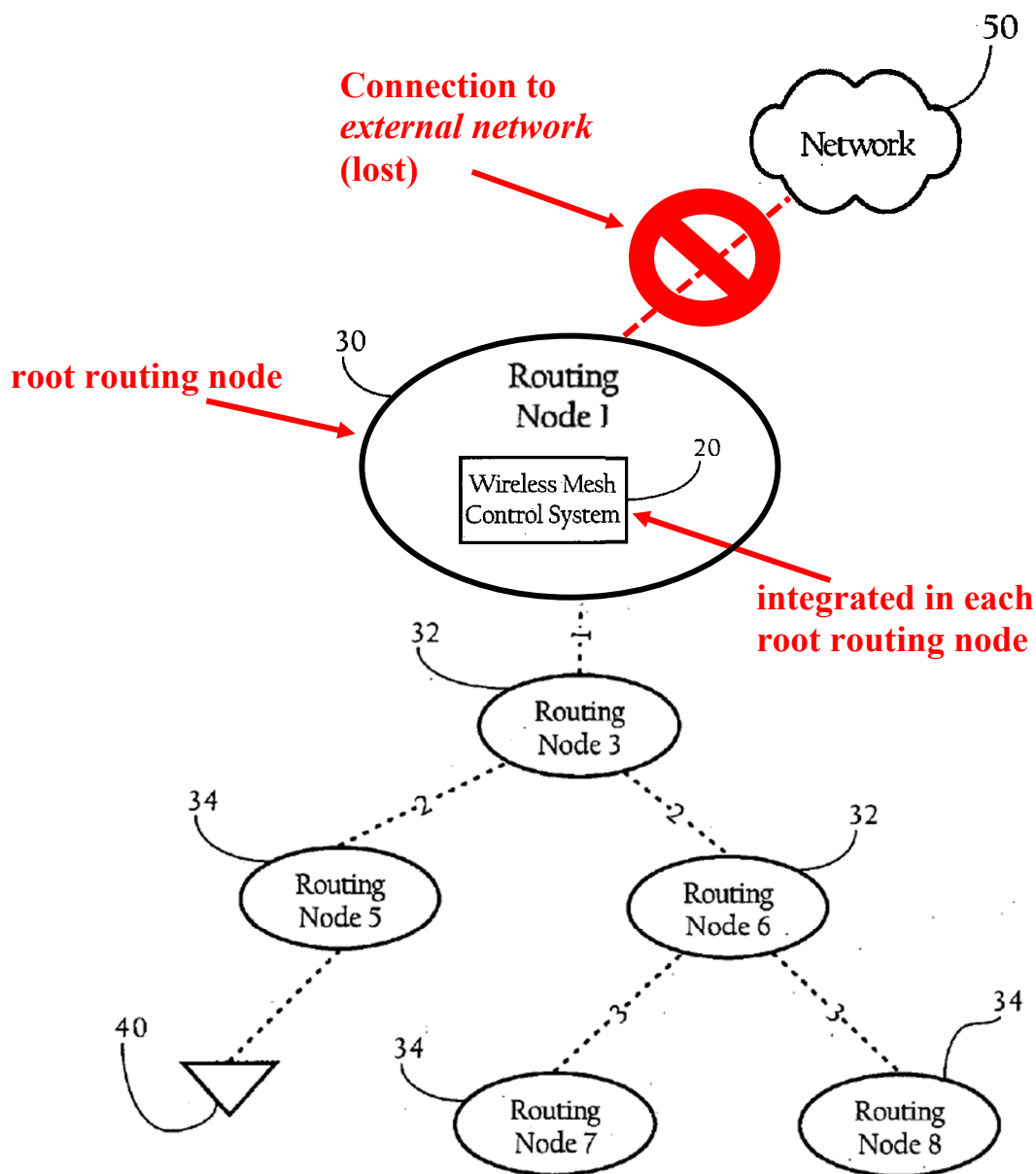
103. First, Castagnoli in view of Bauer renders obvious *the second isolated configuration* because in the combination, Castagnoli's wireless mesh hierarchy retains its structure and functionality between nodes and clients while maintaining operations when an external network connection is lost, as taught by Bauer.

104. As an initial matter, Castagnoli primarily focuses on “an efficient failure recovery mechanism in hierarchical wireless mesh networks” when synchronization is lost between a parent and child node. Ex.1005, Abstract; *see* Ex.1005, [0146] (noting that “[a] given routing node may lose synchronization with its parent node for a variety of reasons”); [0147] (explaining processes for changes “such as a node failure” in a parent routing node). And Castagnoli notes “the overhead and delay associated with having a failure event propagate down the hierarchy are undesirable,” extending time to recover from a failure event. Ex.1005, [0010].

105. Bauer provides additional details for the continued operation of a mesh network in other failure events, explaining that when the mesh network is “disconnected from an Internet infrastructure,” wireless clients such as “computing

devices [] are capable of sending, receiving, and forwarding IP packets directly to other nodes.” Ex.1006, [0023]. And as discussed above in Section IX.A.4, a POSITA would have been motivated to combine Castagnoli and Bauer to enable continued operation of Castagnoli’s hierarchical wireless mesh network when a connection to an external network is lost, per Bauer.

106. In this disconnected state, the wireless clients within Castagnoli’s hierarchical wireless mesh network “communicate indirectly to other nodes through one or more intermediary nodes that relay the IP communications to the destination node,” e.g., through routing nodes. Ex.1006, [0024]; *see also* Ex.1006, Abstract (nodes are configured to “provid[e] the IP services locally in the mesh network when the Internet infrastructure is not accessible”). As reflected in modified Figure 1 below, this would occur when a connection to network 50 is lost, such as due to a failure between root routing node 1 and the network 50:



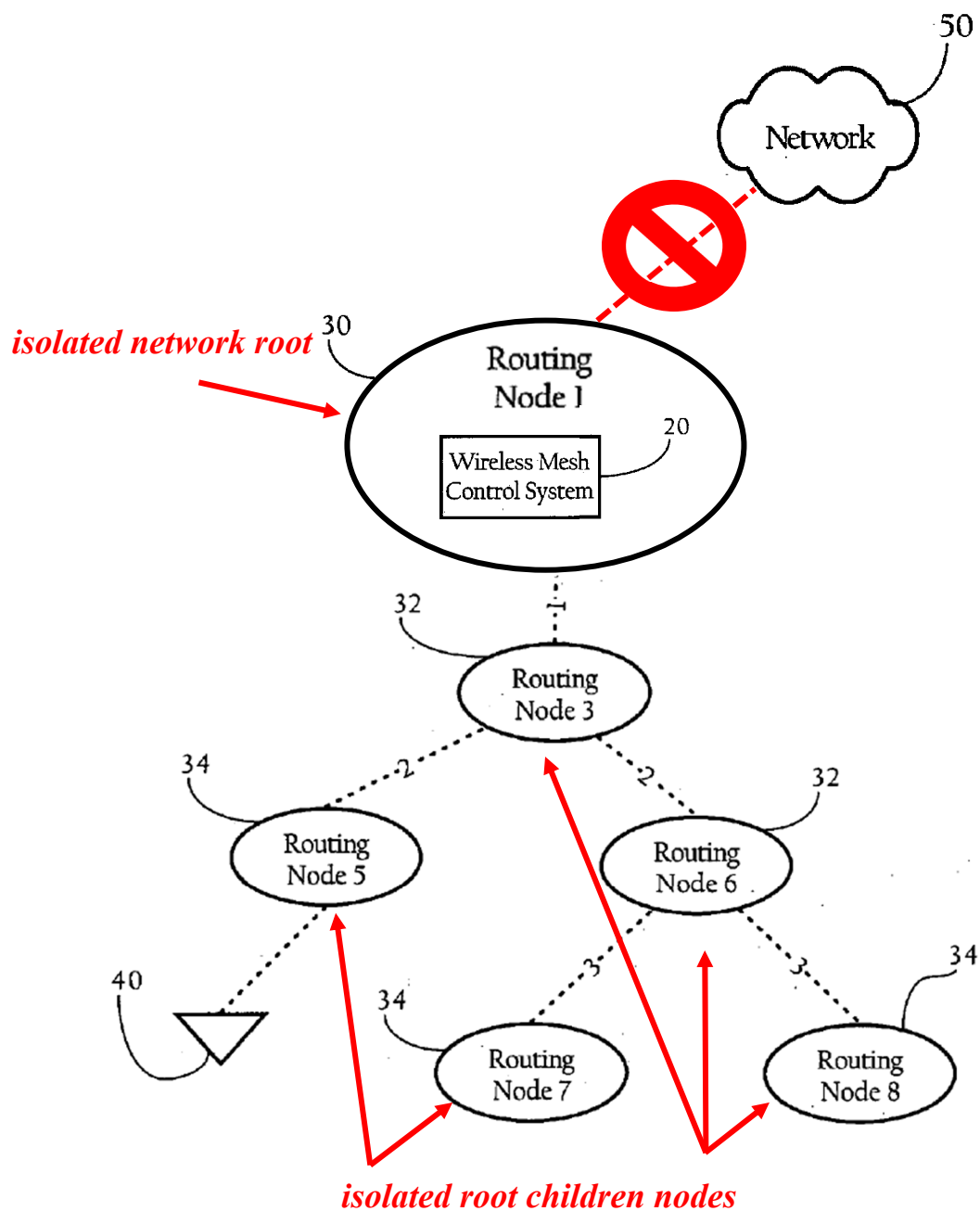
Ex.1005, Fig. 1 (modified, annotated).

107. Accordingly, Castagnoli in view of Bauer renders obvious *in the second isolated configuration* (the hierarchical wireless mesh network is “disconnected from an Internet infrastructure”) *none of the structured mesh nodes’ uplink radio comprises a connection to an external network* (connection to the external network is lost for all routing nodes).

108. Second, Castagnoli in view of Bauer renders obvious *one of the structured mesh nodes acts as an isolated network root of the isolated configuration and all remaining nodes connect to the isolated network root node as isolated root children nodes forming a tree configuration* because Castagnoli teaches that the hierarchical wireless mesh network forms a “hierarchical tree structure” with “a downstream direction towards leaf routing nodes 34, and an upstream direction toward the root routing nodes 30.” Ex.1005, [0033]. Further, Bauer illustrates “dynamically switch[ing] to providing the IP services locally in the mesh network when the Internet infrastructure is not accessible” where the network maintains the same structure. Ex.1006, Abstract, Fig. 1 (disconnected wireless mesh network), Fig. 2 (connected wireless mesh network with the same structure as the disconnected wireless mesh network in Fig. 1); *see also* Ex.1006, [0002] (explaining that “many well known IP-based applications rely on centralized IP services such as the Network Time Protocol (NTP), the Domain Name System (DNS), and the Dynamic Host Configuration Protocol (DHCP)”), [0004] (“These centralized IP services are not always available in a wireless mesh network,” e.g., when disconnected from the infrastructure). It would have been obvious to retain Castagnoli’s hierarchical tree structure when the external network is not accessible because Castagnoli seeks to avoid the impacts of failure events

within a hierarchical wireless mesh network. Ex.1005, [0010] (explaining that it is “undesirable” to have “a failure event propagate down the hierarchy”).

109. Annotated and modified Figure 1, below, provides an example of *the second isolated configuration*, where Castagnoli’s hierarchical wireless mesh network does not have a connection with network 50. In the example below, root routing node 1 *acts as an isolated network root of the isolated configuration*, retaining the same root routing node for the hierarchical wireless mesh network as in the connected configuration discussed in [1.6]. Further, each of the children nodes of routing node 1 *connect to the isolated network root node as isolated root children nodes*. Because root routing node 1 is not connected to the network 50, the root routing node and each of its children routing nodes do not have *a connection to an external network* through any of the respective nodes’ *uplink radio*. The hierarchical wireless mesh network operates to provide IP services locally, per Bauer, until a connection to network 50 can be restored for root routing node 1.



Ex.1005, Fig. 1 (modified, annotated).

110. Thus, Castagnoli in view of Bauer renders obvious this limitation.

- i. **[1.8] *wherein clients of nodes of the structured network in a second isolated configuration retain full connectivity within the structured network during the isolated configuration and***

111. Castagnoli in view of Bauer renders obvious *clients of nodes of the structured network in a second isolated configuration retain full connectivity within the structured network during the isolated configuration* because Castagnoli teaches that the hierarchical wireless mesh network is used in routing packets between wireless devices, and Bauer provides specific implementation details for maintaining such routing despite a lack of external network connectivity.

112. Specifically, Castagnoli explains that the hierarchical wireless mesh network “is used in routing packets between wireless clients 40.” Ex.1005, [0033]. Similarly, Bauer teaches that wireless clients such as “Personal Computers (PCs), Personal Digital Assistants (PDAs), cellular telephones with IP capabilities, digital pagers,” or other computing devices “are capable of sending, receiving, and forwarding IP packets directly to other” wireless clients when the mesh network is “disconnected from an Internet infrastructure.” Ex.1006, [0023]. By allowing wireless clients to communicate with each other regardless of whether a connection to an external network exists, per Bauer, Castagnoli’s wireless clients *retain full connectivity within the structured network during the isolated configuration*.

113. Thus, Castagnoli in view of Bauer renders obvious this limitation.

- j. [1.9] *wherein said client connectivity is uninterrupted during any transition from the isolated configuration to the first connected configuration;*

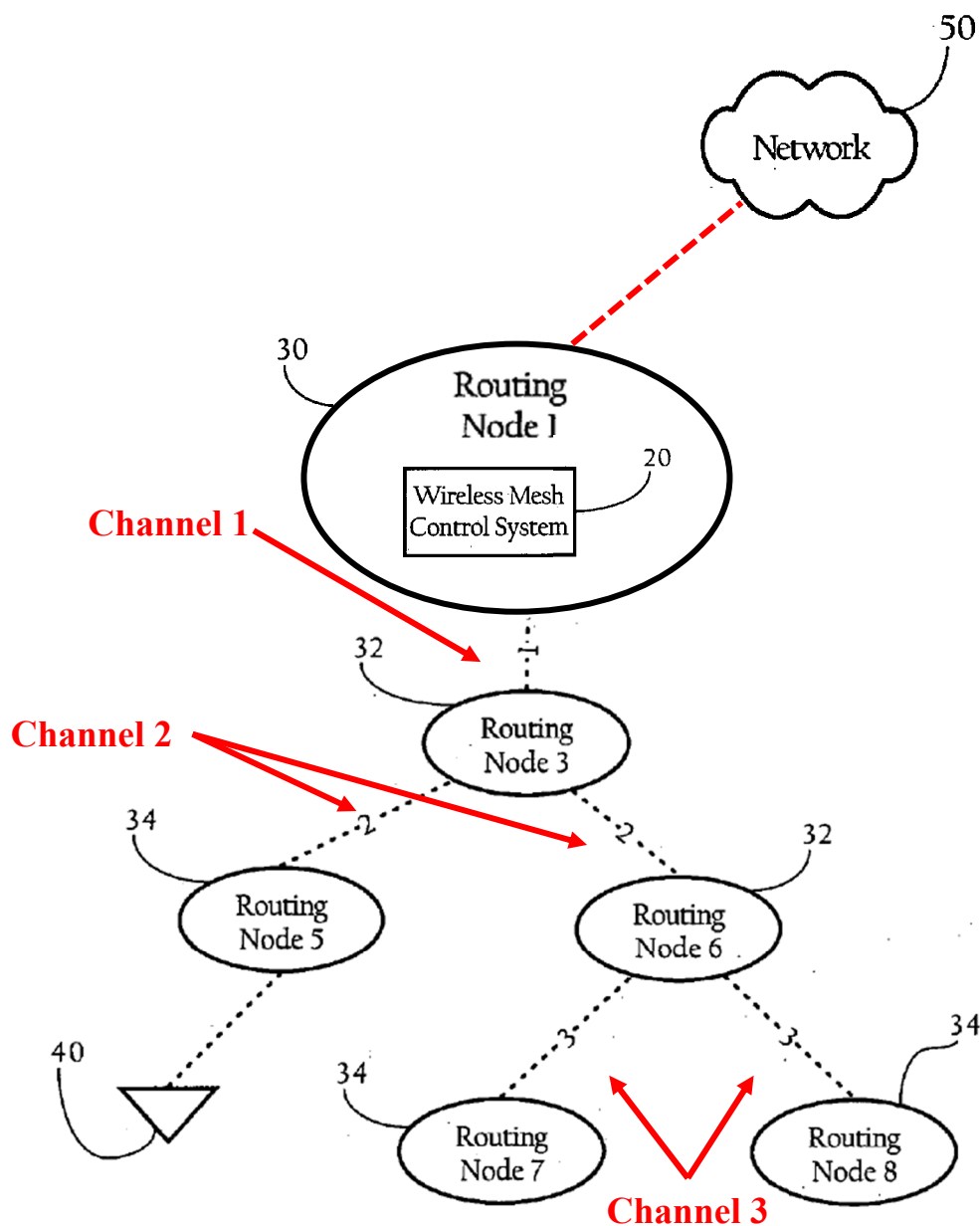
114. Castagnoli in view of Bauer renders obvious *client connectivity is uninterrupted during any transition from the isolated configuration to the first connected configuration* because Bauer teaches that client connectivity is not interrupted by changes in the connection status to an external network. Indeed, Bauer illustrates that the network composition remains the same between the disconnected wireless mesh network (Fig. 1) and connected wireless mesh network (Fig. 2), except for a connection between one or more nodes and the external network. *See* Ex.1005, Figs. 1, 2. Bauer explains that when the mesh network is reconnected to the internet, each of the client devices “may choose to resynchronize with the publicly available [Network Time Protocol] server 32 directly” for clock synchronization purposes. Ex.1006, [0036]. Such synchronization relies on client connectivity to allow the clients to communicate and resynchronize with the Network Time Protocol server. *See* Ex.1006, [0036]. And Bauer explains that nodes simply “stop sending time queries” to the Reported Node Time Server, and instead “dynamically start sending time queries” to the public Network Time Protocol server. Ex.1006, [0036].

115. Thus, Castagnoli in view of Bauer renders obvious this limitation.

- k. [1.10] *wherein distinct downlink frequencies are used by nodes for communication with one or more nodes lower on the tree configuration.*

116. Castagnoli discloses or renders obvious *distinct downlink frequencies are used by nodes for communication with one or more nodes lower on the tree configuration* because each routing node uses distinct channels for uplink and downlink communications with other nodes.

117. As reflected in annotated and modified Figure 1 below, Castagnoli teaches that “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 the wireless hierarchical mesh network. Ex.1005, [0035]. For instance, “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.” Ex.1005, [0035]. Accordingly, each of routing nodes 1, 3, and 6 use *distinct downlink frequencies* for data transfer with respective child nodes in the wireless hierarchical mesh network with root routing node 1. Similarly, each of routing nodes 2 and 4 use *distinct downlink frequencies* for data transfer with respective child nodes in the wireless hierarchical mesh network with root routing node 2. In both cases, no channels are repeated or reused as downlink frequencies for any other routing nodes, as reflected in Figure 1, below:



Ex.1005, Fig. 1 (modified, annotated).

118. Thus, Castagnoli discloses or renders obvious this limitation.

7. Claim 18

- a. [18.0] *The structured mesh network of claim 1 wherein each network node further comprises a DHCP server used to assign addresses to client devices*

***communicating with the node using the node's
downlink radio.***

119. Castagnoli in view of Bauer renders obvious claim 18.

120. Bauer describes how a mesh network operating without an external network connection provides DHCP services by having each of the mesh nodes act as DHCP servers to DHCP clients:

FIG. 10 shows a node 1 just entering the mesh network 20. Node 1 operates as a DHCP client unable to connect to a conventional DHCP server 120 (FIG. 11). Instead, the other **mesh nodes 2-4 act as DHCP servers, responding to DHCP client requests** 112 from node 1 after entering the mesh network 20. This **DHCP service on each mesh node** is referred to as the Mesh Address Allocation Protocol (MAAP) 110. One consideration in MAAP is avoiding collisions with IP address assignments. MAAP servers communicate allocated addresses through the mesh network data distribution described in the '352 application.

Ex.1006, [0056].

121. Using DHCP to assign IP addresses to clients was well-known in the art, as Bauer confirms:

However, many well known IP-based applications rely on centralized IP services such as the Network Time Protocol

(NTP), the Domain Name System (DNS), and the Dynamic Host Configuration Protocol (DHCP).

* * *

Nodes also **use the DHCP service to set IP addresses** and other relevant network parameters.

Ex.1006, [0002]-[0003].

When a DHCP client first arrives in a network, it queries for nearby DHCP servers. These queries may be answered by nearby DHCP servers or may be relayed onwards to DHCP servers further away. A **DHCP client** chooses among the responses received from servers to complete its network configuration.

Ex.1006, [0055].

122. Thus, Castagnoli's routing nodes implementing Bauer's teaching of each mesh node acting as a DHCP server renders obvious for "*each network node further comprises a DHCP server used to assign addresses to client devices.*"

123. It would have been obvious to a POSITA for a mesh node to provide DHCP services to a client *communicating with the node using the node's downlink radio* because clients communicate with a mesh node via the node's downlink radio, as discussed above at [1.4].

124. The DHCP service is an example of an IP service. Ex.1006, [0002].
As discussed in Section VIII.A.4 above, a POSITA would have been motivated to

combine Castagnoli and Bauer to implement Bauer's teachings of providing IP services locally when Castagnoli's hierarchical wireless mesh network loses connection to the external network 50.

125. Thus, Castagnoli in view of Bauer renders obvious claim 18.

8. Claim 35

126. As reflected in the table below, claim 35 is similar to claim 1. Claim 35 contains an additional limitation [35.5] that does not correspond to any limitations in claim 1. Additionally, claim 35 recites a single radio in limitation [35.3], as compared to the two radios in [1.3]. As addressed in the analysis of limitation [35.3] below, Castagnoli's disclosure regarding the operation of nodes and corresponding radios is applicable to one-radio, two-radio, and multi-radio systems. Ex.1005, [0007].

A structured mesh network capable of isolated operation, comprising:	A structured mesh network capable of isolated operation, comprising:
at least two structured mesh nodes;	at least two structured mesh nodes;
wherein each structured mesh node comprises at least a connectivity logic;	wherein each structured mesh node comprises at least a connectivity logic
an uplink radio operating on an uplink frequency and a downlink radio operating on a distinct downlink frequency;	and a radio operating on an uplink frequency and a distinct downlink frequency;
wherein the connectivity logic determines whether each structured mesh node connects with an	wherein the connectivity logic determines whether each structured mesh node connects with an

external network or another node using its uplink radio and client devices or other mesh nodes connect to each node using each node's downlink radio ;	external network or another node on the uplink frequency and client devices or other mesh nodes connect to each node on the downlink frequency ;
	wherein the connectivity logic in each node contains a distributed routing table;
wherein the structured mesh network functions in two configurations selected depending on whether a connection to an external network is present;	wherein the structured mesh network functions in two configurations selected depending on whether a connection to an external network is present;
in the first connected configuration the structured mesh network includes at least one structured mesh node's uplink radio comprising a connection to an external network; and	in the first connected configuration the structured mesh network includes at least one structured mesh node's uplink connection comprising a connection to an external network; and
in the second isolated configuration none of the structured mesh nodes' uplink radio comprises a connection to an external network, and one of the structured mesh nodes acts as an isolated network root of the isolated configuration and all remaining nodes connect to the isolated network root node as isolated root children nodes forming a tree configuration;	in the second isolated configuration none of the structured mesh nodes' uplink connections comprises a connection to an external network, and one of the structured mesh nodes acts as an isolated network root of the isolated configuration and all remaining nodes connect to the isolated network root node as isolated root children and descendant nodes forming a tree configuration;
wherein clients of nodes of the structured network in a second isolated configuration retain full connectivity within the structured	wherein clients of the at least two structured mesh nodes in a second isolated configuration retain full connectivity within the structured

network during the isolated configuration and	network during the isolated configuration and
wherein said client connectivity is uninterrupted during any transition from the isolated configuration to the first connected configuration;	wherein said client connectivity is uninterrupted during any transition from the isolated configuration to the first connected configuration;
wherein distinct downlink frequencies are used by nodes for communication with one or more nodes lower on the tree configuration.	wherein distinct downlink frequencies are used by nodes for communication with one or more nodes lower on the tree configuration.

a. [35.0] *A structured mesh network capable of isolated operation, comprising:*

127. Limitation [35.0] is identical to limitation [1.0] and would have been obvious for the reasons discussed above.

b. [35.1] *at least two structured mesh nodes;*

128. Limitation [35.1] is identical to limitation [1.1] and would have been obvious for the reasons discussed above.

c. [35.2] *wherein each structured mesh node comprises at least a connectivity logic*

129. Limitation [35.2] is identical to limitation [1.2] and would have been obvious for the reasons discussed above.

d. [35.3] *and a radio operating on an uplink frequency and a distinct downlink frequency*

130. Castagnoli discloses or renders obvious this limitation because Castagnoli discloses that its routing nodes are operable with *a radio* that switches

between an antenna used as a backhaul to its parent routing node (*operating on an uplink frequency*) and a second antenna for the same radio used to provide services to clients and child routing nodes (*operating on...a distinct downlink frequency*).

131. First, Castagnoli discloses that its wireless mesh nodes comprise a *radio* because Castagnoli illustrates an implementation where “[t]he routing nodes in the mesh network...include one radio[.]” Ex.1005, [0034]. As reflected in Figure 2, below, Castagnoli’s wireless mesh nodes include a wireless backbone interface unit 60, which includes a backbone radio module 64. Ex.1005, [0034]. Such implementations may utilize two antennas, as Castagnoli illustrates, where “[f]irst antenna 85...can be used for data transfer with a parent routing node, while second antenna 86 can be used for transfer with one or more child routing nodes.” Ex.1005, [0042]. Alternatively, the wireless mesh nodes may use “a single omni-directional antenna.” Ex.1005, [0042].

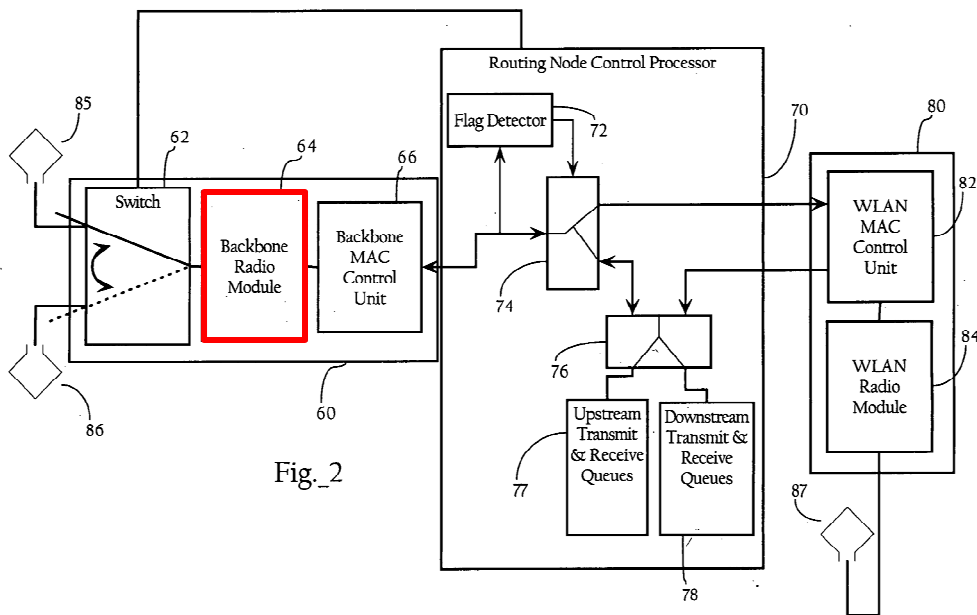


Fig. 2

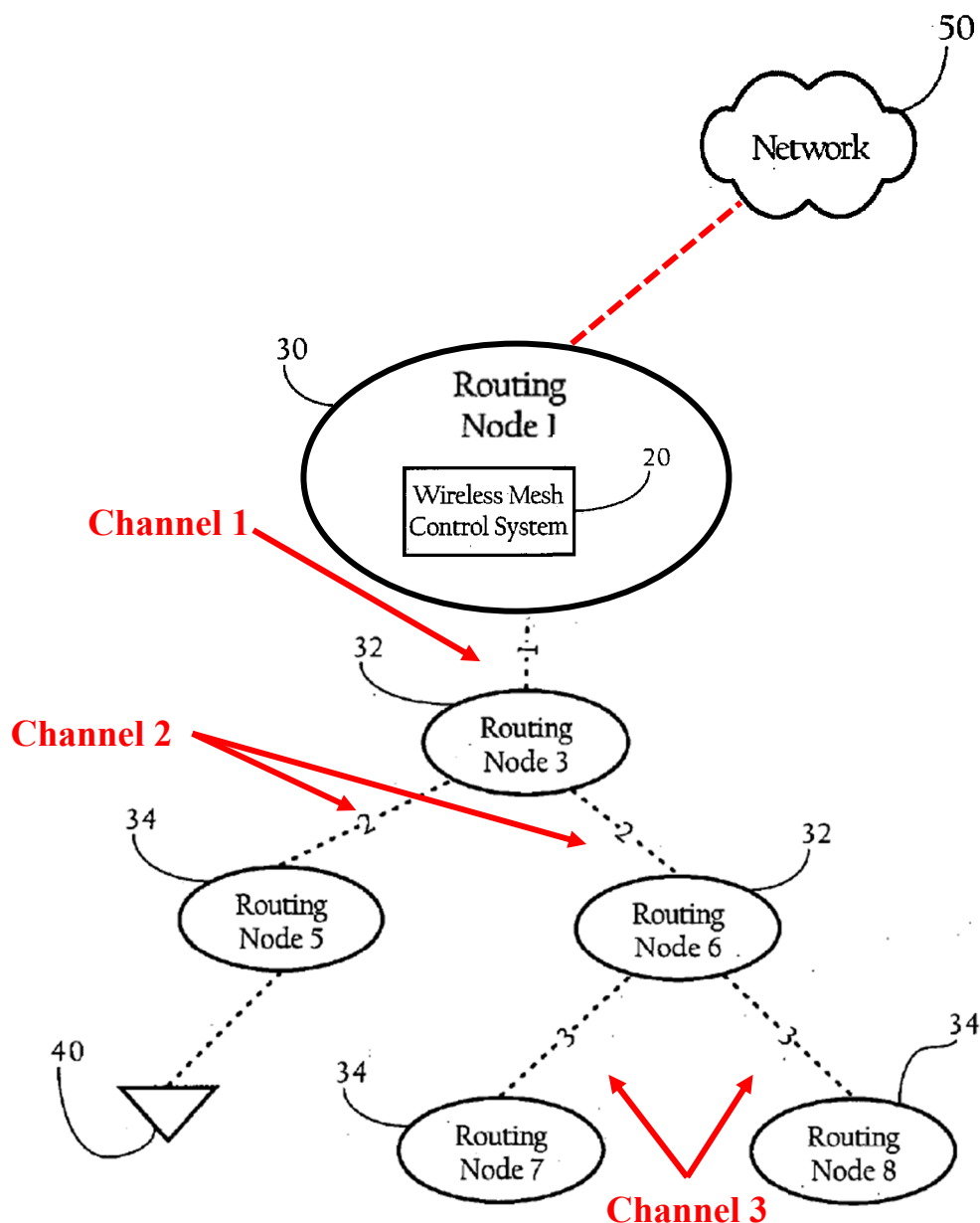
Ex.1005, Fig. 2 (annotated).

132. **Second**, Castagnoli's wireless mesh node radio operates *on an uplink frequency* and *on a distinct downlink frequency* respectively because Castagnoli explains that each routing node uses different, non-overlapping channels for upstream data transfer and downstream data transfer. As modified Figure 1 illustrates below, Castagnoli explains that different, non-overlapping channels are used for upstream data transfer and downstream data transfer, such that each node has its own distinct downlink channel:

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,** while in other implementations they are overlapping channels.

Ex.1005, [0035]; *see also* Section IX.A.6.[1.3] above.



Ex.1005, Fig. 1 (modified, annotated).

133. Thus, Castagnoli discloses or renders obvious *a radio operating on an uplink frequency* (a radio is used as a backhaul to its parent routing node on one channel) *and a distinct downlink frequency* (the radio also provides service to clients and child routing nodes on a different, non-overlapping channel).

- e. **[35.4] *wherein the connectivity logic determines whether each structured mesh node connects with an external network or another node on the uplink frequency and client devices or other mesh nodes connect to each node on the downlink frequency;***

134. Limitation [35.4] is the same as limitation [1.4] except for the use of “frequency” rather than “radio,” and would have been obvious for the reasons discussed above because Castagnoli’s disclosure regarding the operation of nodes and corresponding radio communications over different frequencies is applicable to one-radio, two-radio, and multi-radio systems. Ex.1005, [0007].

- f. **[35.5] *wherein the connectivity logic in each node contains a distributed routing table;***

135. Castagnoli renders obvious limitation [35.5].

136. Castagnoli explains that each of its routing nodes “maintains a table of routing nodes in the adjacency data structure” (*contains a distributed routing table*). Ex.1005, [0072]. These routing tables maintain information based on information passed in “neighbor response packets” and maintains information about possible parent nodes as well as “whether any child nodes have been added or deleted[.]” Ex.1005, [0059], [0063]-[0064]; *cf.* Ex.1001, 3:15-19. Further, this information would have been maintained in the routing node control processor of each respective node (*the connectivity logic in each node*) because Castagnoli explains that the routing node control processor includes “hardware modules (e.g., processor,

memory), software modules (e.g., drivers, etc.) and **data structures** (e.g., frame buffers, queues, etc.) **that control operation of the routing node.**” Ex.1005, [0041].

137. Thus, Castagnoli renders obvious limitation [35.5].

- g. ***[35.6] wherein the structured mesh network functions in two configurations selected depending on whether a connection to an external network is present;***

138. Limitation [35.6] is the same as limitation [1.5] and would have been obvious for the reasons discussed above.

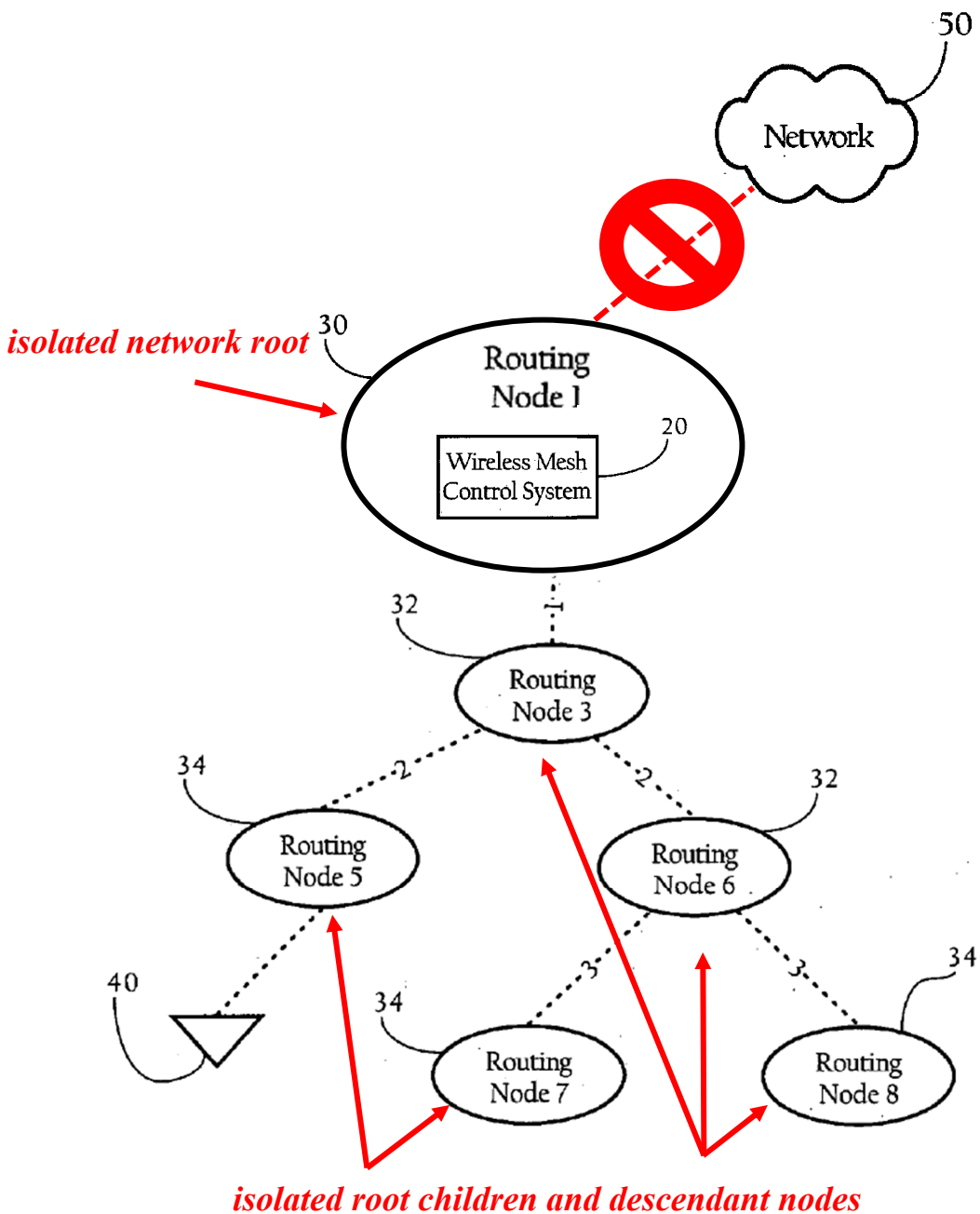
- h. ***[35.7] in the first connected configuration the structured mesh network includes at least one structured mesh node's uplink connection comprising a connection to an external network; and***

139. Limitation [35.7] is substantially similar to limitation [1.6] except for the use of “uplink connection” rather than “uplink radio,” and would have been obvious for the reasons discussed above because Castagnoli’s disclosure regarding the operation of nodes and corresponding radio communications over different frequencies is applicable to one-radio, two-radio, and multi-radio systems. Ex.1005, [0007].

- i. ***[35.8] in the second isolated configuration none of the structured mesh nodes' uplink connections comprises a connection to an external network, and one of the structured mesh nodes acts as an isolated network root of the isolated configuration and all remaining nodes connect to the isolated network root node as isolated***

root children and descendant nodes forming a tree configuration;

140. Limitation [35.8] is substantially similar to limitation [1.7], except it recites “connections” instead of “radio” and contains additional language regarding “descendent nodes.” As discussed above, the analysis provided for claim 1 with respect to the routing nodes’ uplink and downlink radios is applicable to the recited “connections” in claim 35. Additionally, as explained in the analysis of [1.7] and reflected in modified Figure 1 below, Castagnoli’s root routing node 30 connects to the other routing nodes in the hierarchical wireless mesh network either directly, *as isolated root children*, or indirectly, *as descendant nodes* of the direct child nodes:



Ex.1005, Fig. 1 (modified, annotated).

141. Accordingly, limitation [35.8] and would have been obvious for the reasons discussed above with respect to limitation [1.7].

- j. **[35.9] *wherein clients of the at least two structured mesh nodes in a second isolated configuration retain full connectivity within the structured network during the isolated configuration and***

142. Limitation [35.9] is substantially similar to limitation [1.8], except it recites “the at least two structured mesh nodes” instead of “nodes of the structured network.” Because the recited “nodes of the structured network” in limitation [1.8] refers to “at least two structured mesh nodes,” limitation [35.9] would have been obvious for the reasons discussed above with respect to limitation [1.8].

- k. **[35.10] *wherein said client connectivity is uninterrupted during any transition from the isolated configuration to the first connected configuration;***

143. Limitation [35.10] is identical to limitation [1.9] and would have been obvious for the reasons discussed above.

- l. **[35.11] *wherein distinct downlink frequencies are used by nodes for communication with one or more nodes lower on the tree configuration.***

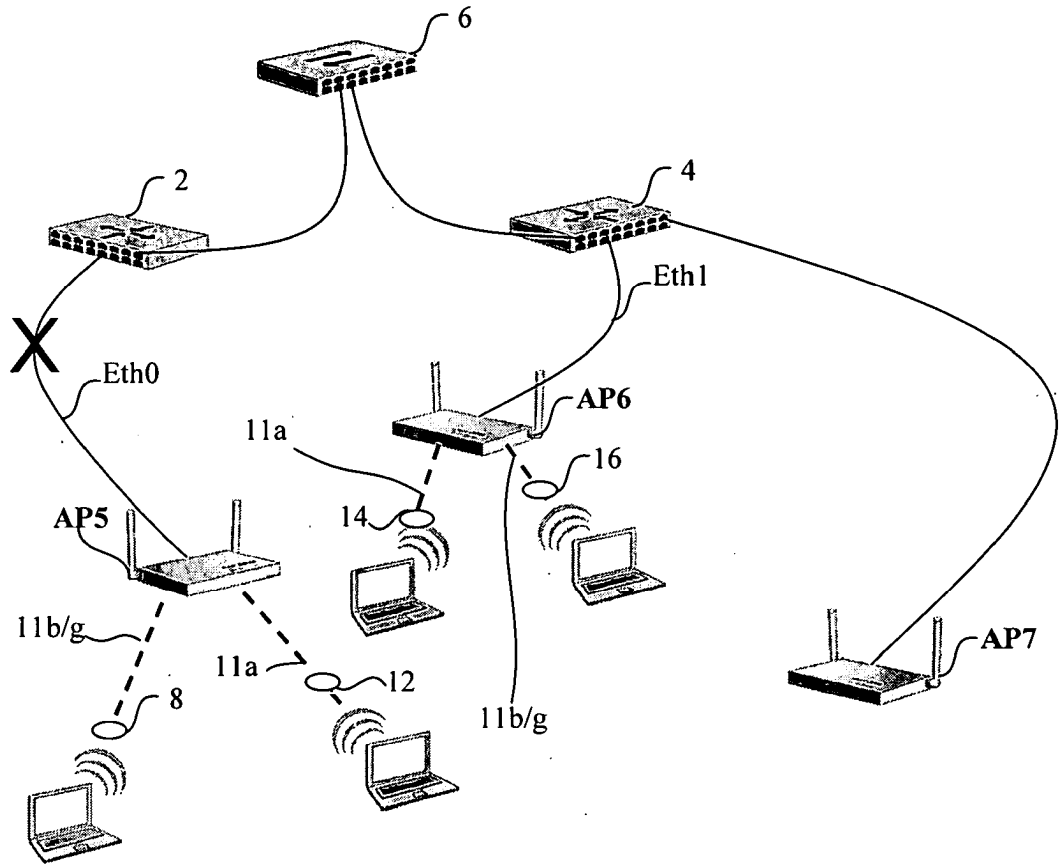
144. Limitation [35.11] is identical to limitation [1.10] and would have been obvious for the reasons discussed above.

B. Ground 2: Claims 9-11 and 15-16 would have been Obvious over Castagnoli in view of Bauer, Gil and Zeng.

1. Summary of Zeng

145. U.S. Patent Publication No. 2009/0213730 to Zeng *et al* (Ex.1007) was filed on February 21, 2008, and published on August 27, 2009. Zeng is titled “Backhaul failover method and system for a wireless network.”

146. Zeng details “[a] method and corresponding system for providing for recovering from a failure” of an external network link “used for communication between the first access point and a wired network.” Ex.1007, Abstract. More specifically, Zeng contemplates “a known backhaul network topology 10 for connecting all access points in a wireless access network to a backhaul network,” where access points at the top of the network hierarchy “each have a wired backhaul connection to an external backhaul network, such as a local area network (LAN) or the Internet.” Ex.1007, [0002]. Further, each of Zeng’s access points include “wireless radio transceivers for providing wireless interfaces to connect client nodes to the backhaul network via these access points.” Ex.1007, [0003]. Zeng’s Figure 4, below, “illustrates an exemplary failure state prior to recovery” of a network where “[t]he wired link between a first access point AP5 and a backhaul switch 2 of the wired backhaul network is lost...such that there is no path between AP4 and the wired network.” Ex.1007, [0019], Fig. 4.



Ex.1007, Fig. 4.

147. Zeng explains that various protocols are employed by the access points to monitor the status of the wired link, “including the Cisco Discovery Protocol (CDP) or the Link Layer Discovery Protocol (LLDP)[.]” Ex.1007, [0026]. When “a determination is made [that] the wired link is lost, indicating there may be failure,” Zeng explains that one of the “radio[s] of the first access point is reconfigured in a backhaul mode[.]” Ex.1007, [0028]. The access point “broadcast[s] a request for backhaul connectivity to neighboring APs,” “detects whether any neighboring AP

responds to the backhaul connectivity request,” and “selects a responding neighboring AP based on at least one predetermined criteria.” Ex.1007, [0030]-[0032]. A wireless link is established between the access point and a suitable neighbor to establish “a communication path to the wired network via a first radio wireless link, a second radio wireless link, and selected neighboring access point's wired link.” Ex.1007, [0036].

2. Reasons to Combine Castagnoli, Bauer, Gil, and Zeng

148. A POSITA would have combined Castagnoli, Bauer and Gil with Zeng because each of the references relate to networking, and more specifically, to different failure situations faced by wireless networks. Castagnoli provides recovery mechanisms for when a mesh network experiences a failure of a connection between two nodes of the network. Ex.1005, Abstract. Bauer teaches mesh network operation when the connection to an external network is not present, e.g., when the connection is lost. Ex.1006, Abstract. Gil provides further implementation details regarding the connection of a mesh network to an external network, explaining that such connections can be a wired connection or a wireless connection. Ex.1008, 4:29-31. And Zeng provides a method of recovering from failure of a link to an external network, e.g., when a second connected network is available to provide a communications path. Ex.1007, Abstract.

149. A POSITA would have been motivated to combine the teachings of Castagnoli and Bauer with Zeng and doing so would have been within the POSITA's skillset. The combination would have been obvious because it represents merely the use of a known technique (enabling a radio for backhaul communications when a node loses its external network connection) to improve similar devices (Castagnoli's hierarchical wireless mesh network) in the same way (enabling Castagnoli's root routing nodes to utilize uplink radios to search for an external network, per Zeng) to yield predictable results. Castagnoli provides extensive disclosure about mesh network operation and failure recovery, but focuses on node-to-node failures. Ex.1005, [0010], [0146]-[0150]. And while Bauer provides details regarding maintaining network operations when a connection is lost, Bauer does not focus on network recovery. Ex.1006, Abstract, [0023]-[0025]. Gil teaches that external network connections can be wired or wireless. Ex.1008, 4:29-31. Zeng in turn provides recovery methods for a node when an external network link failure occurs. Ex.1007, Abstract, [0026]-[0036].

150. In the combination, Castagnoli's hierarchical wireless mesh network would maintain operations while implementing Bauer's teachings regarding the provision of IP services locally when a connection is lost at the root node, as discussed above in Section VIII.A.4. Further, when a connection is lost at the root

node, the root node would use its uplink radio and search for another network to provide additional communication paths and connectivity to child nodes.

151. A POSITA would have had a reasonable expectation of success in combining Castagnoli, Bauer, Gil, and Zeng because the teachings of Castagnoli, Bauer, Gil, and Zeng are complimentary; each providing handling for different failure events within a network, and Gil merely provides additional implementation details regarding the external network connections contemplated by each of Castagnoli, Bauer, and Zeng. Further, the teaching of Castagnoli, Bauer, and Zeng focus on different aspects of a network: Castagnoli focuses on routing node operation and connectivity to parent routing nodes, Bauer focuses on client device and routing node operation to dynamically switch to providing IP services locally or through Internet infrastructure, depending on the connectivity to the external network, Gil provides additional teachings regarding the mechanisms for connecting a mesh network to an external network, and Zeng focuses on the operation of a node that loses its wired connection to an external network. As such, a POSITA would have recognized how Zeng's teachings of recovering from a failure of a connection to an external network would apply to Castagnoli's hierarchical wireless mesh network, for both wired and wireless connections that may be utilized, per Gil. Additionally, such combination would be desirable because it would allow for the root routing node within Castagnoli's hierarchical

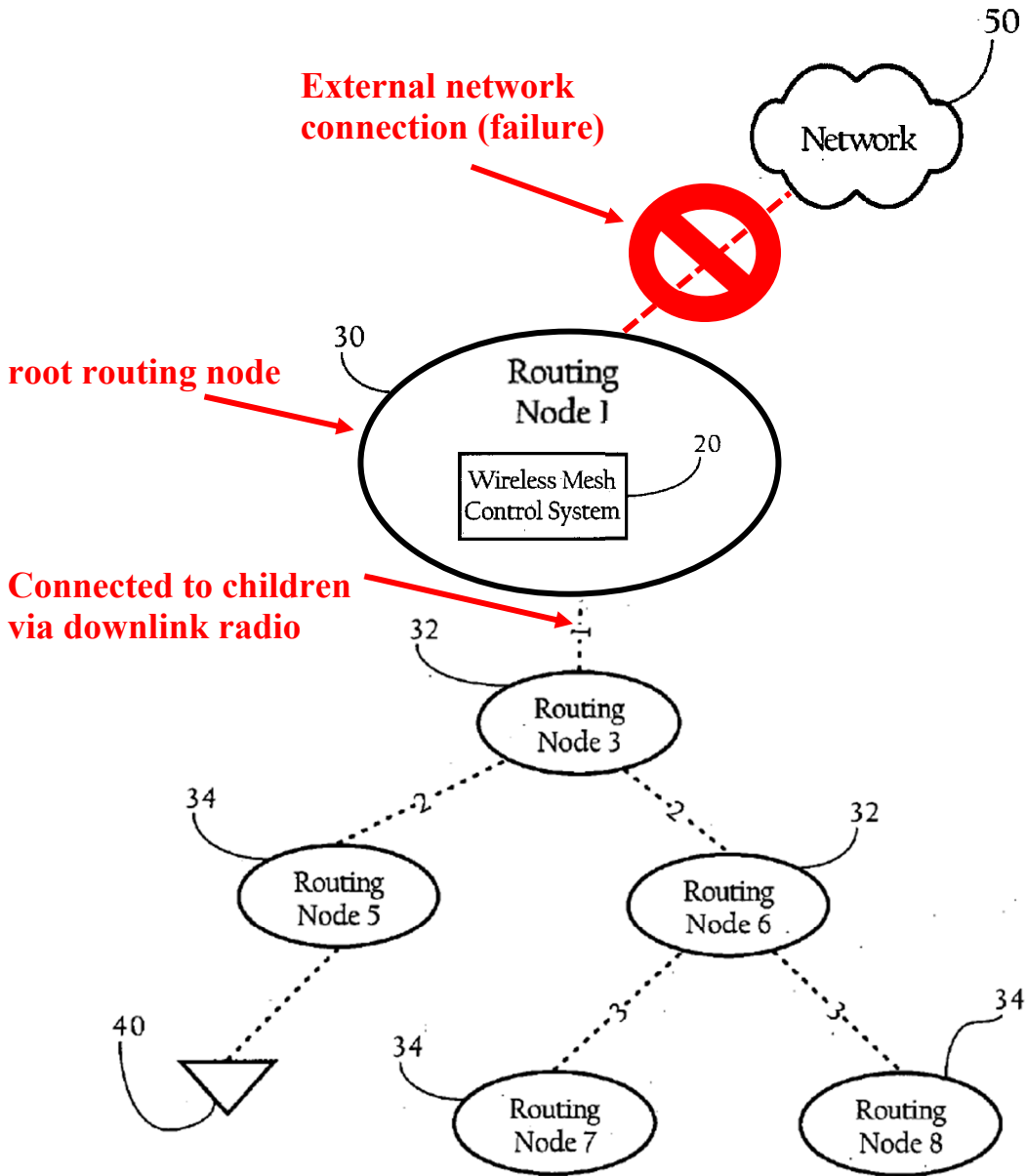
wireless mesh network to seek out and connect to another network when its external network connection fails, allowing for the continued provision of wireless network access to children nodes.

3. Claim 9

- a. **[9.0] *The structured mesh network of claim 1 wherein the connectivity logic contained by the nodes realigns connections between the nodes upon detection of an external network connection to form the connected configuration.***

152. Castagnoli in view of Bauer, Gil, and Zeng renders obvious claim 9.

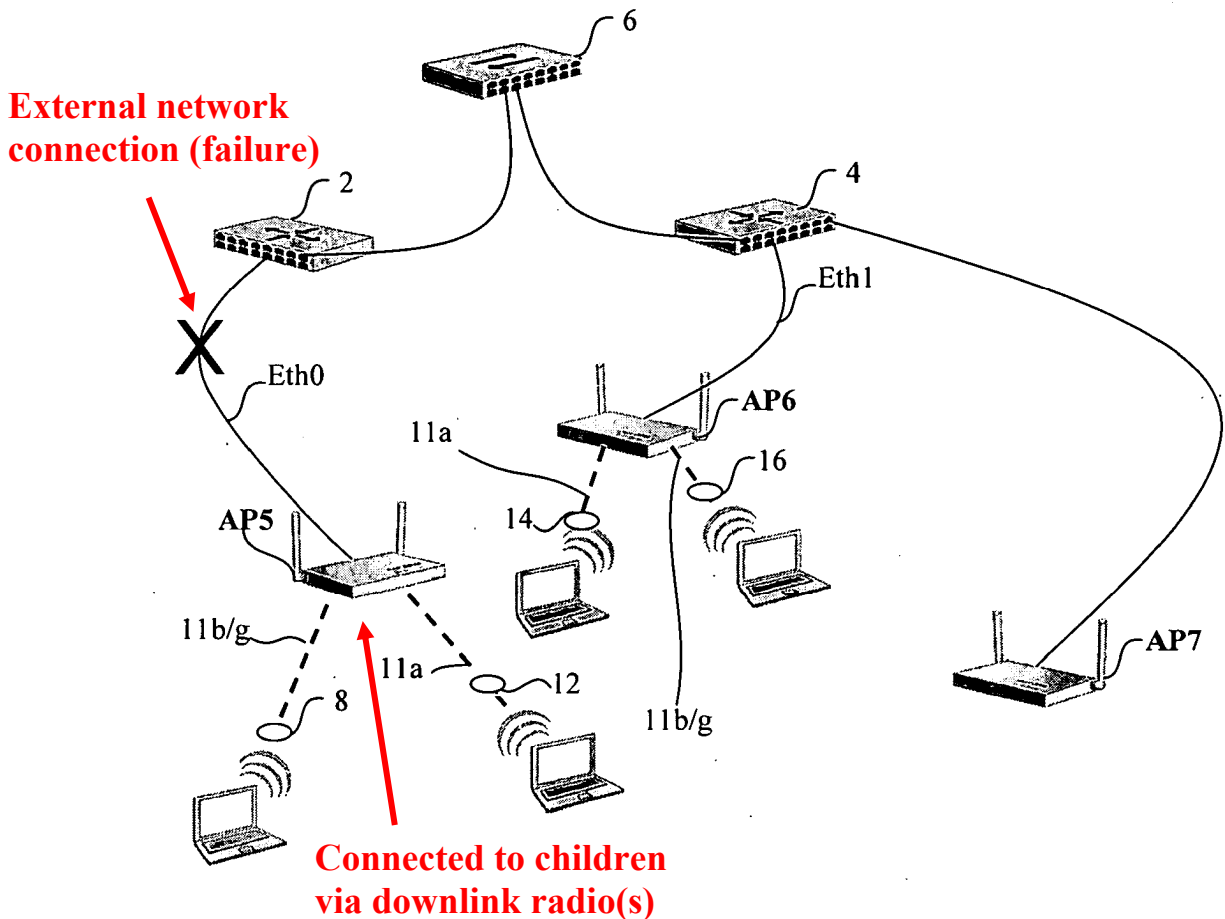
153. As discussed above in Section VIII.A.6, Castagnoli in view of Bauer renders obvious *the structured mesh network of claim 1*. Further, as discussed in [1.2], each of Castagnoli's routing nodes includes a routing node control processor (*connectivity logic contained by the nodes*). And modified Figure 1, below, provides an example of Castagnoli's hierarchical wireless mesh network, where root routing node 1 loses its connection to network 50, e.g., due to failure of its connection to the external network. *See* Section VIII.A.6.[1.7] (discussing a disconnected state in Castagnoli's hierarchical wireless mesh network when a connection to network 50 is lost, such as due to a failure between root routing node 1 and network 50). More specifically, as noted above in [1.0], Castagnoli's Figure 1 shows two different hierarchical wireless mesh networks—a first mesh network with root routing node 1, and a second mesh network with root routing node 2.



Ex.1005, Fig. 1 (modified, annotated).

154. Likewise, Zeng contemplates a scenario where an access point loses its connection to an external network. Zeng's Figure 4, below, "illustrates an exemplary failure state prior to recovery" where the "link between a first access point AP5 and a backhaul switch 2 of the wired backhaul network is lost...such that there is no path between AP4 and the wired network." Ex.1007, [0019], Fig. 4. Like Castagnoli's

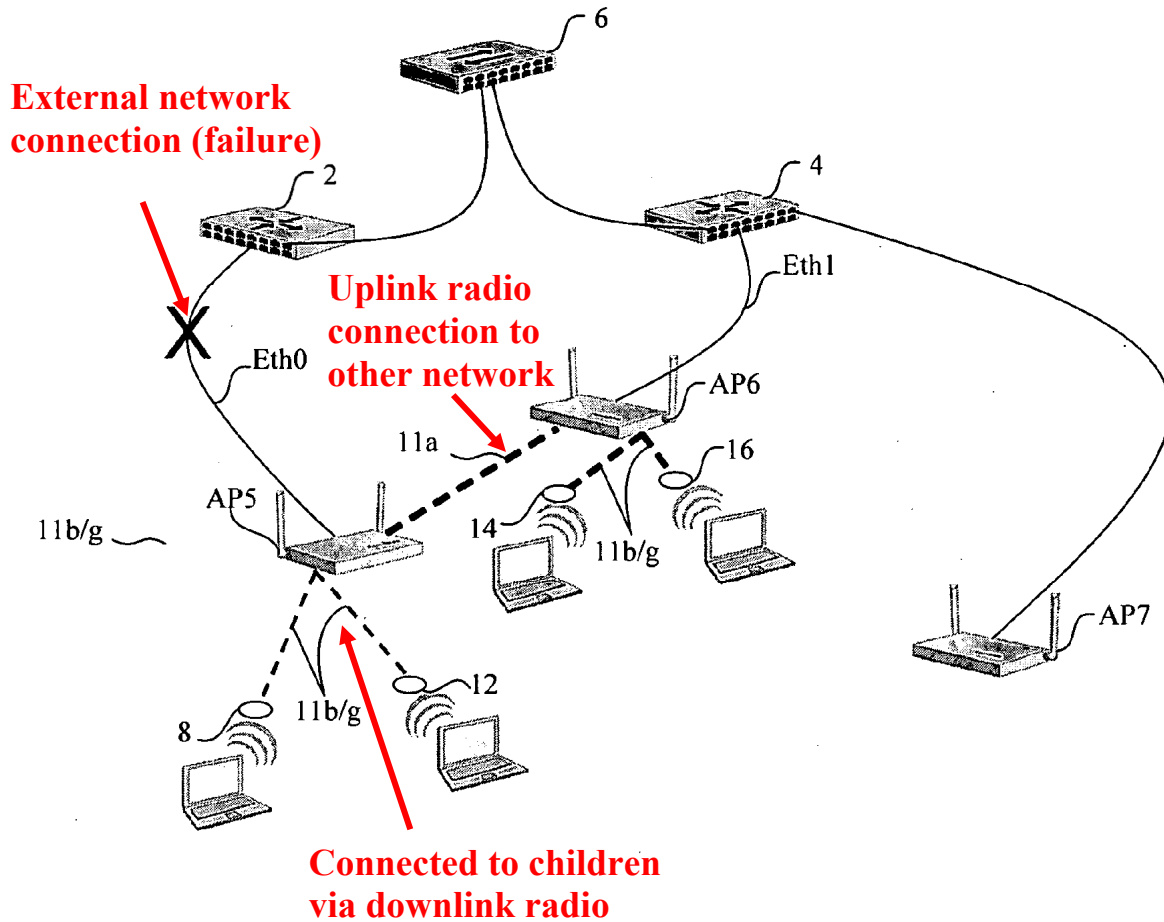
Figure 1 above, Zeng's Figure 4 below shows multiple networks—a first network with root access point 5 (left side), a second network with root access point 6 (middle), and a third network with root access point 7 (right side).



Ex.1007, Fig. 4 (annotated).

155. Zeng provides further details regarding the reacquisition of an external network connection following the failure of a wired link. Ex.1007, Abstract (“A method and corresponding system for providing for recovering from a failure of a wired link used for communication between the first access point and a wired

network.”). Zeng teaches that the status of an access point’s wired link is monitored, and “a determination is made whether the wired link is lost, indicating there may be failure.” Ex.1007, [0027]. If a failure is detected, one of the access point’s radios “is reconfigured in a backhaul mode in response to the detection of the loss of the wired link” and the access point “broadcast[s] a request for backhaul connectivity to neighboring APs.” Ex.1007, [0028], [0030]. When an acceptable neighboring access point is found, the radio establishes a wireless link between the two access points, where “[t]he wireless link enables AP5 to detect the wired network connected to AP6.” Ex.1007, [0035]. As reflected in Figure 5 below, connection 11a between AP5 and neighboring AP6 allows for a communication path from AP5 and its children to the wired network, despite the failure of AP5’s wired link Eth0. Ex.1007, [0035]-[0036].



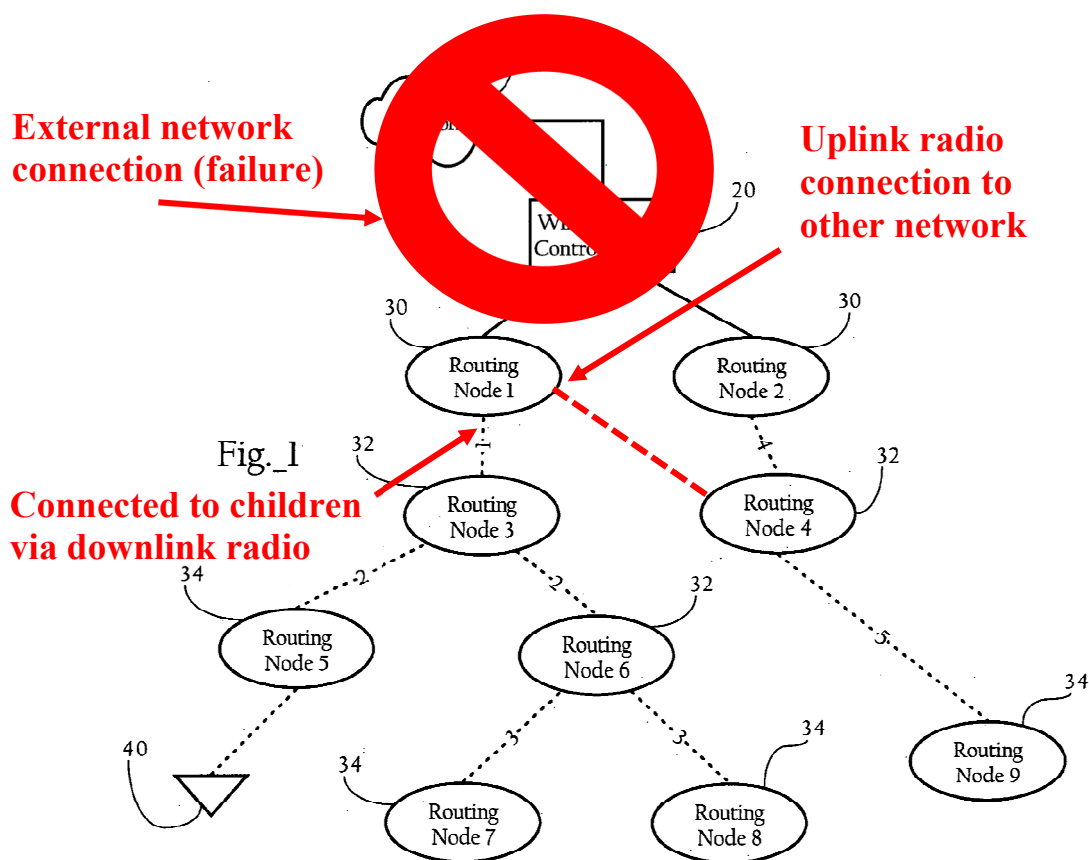
Ex.1007, Fig. 5 (annotated).

156. While Zeng specifically contemplates the loss of a wired connection, as discussed above in Section VIII.B.2, a POSITA would have been motivated to implement Zeng's teachings in scenarios where a root node loses its connection to an external network, regardless of whether the connection is wired or wireless.

157. In the combination, Castagnoli implements Zeng's teaching of enabling an uplink radio to search for and connect to other networks when a node's connection to an external network is lost. Indeed, Castagnoli explains that root routing nodes

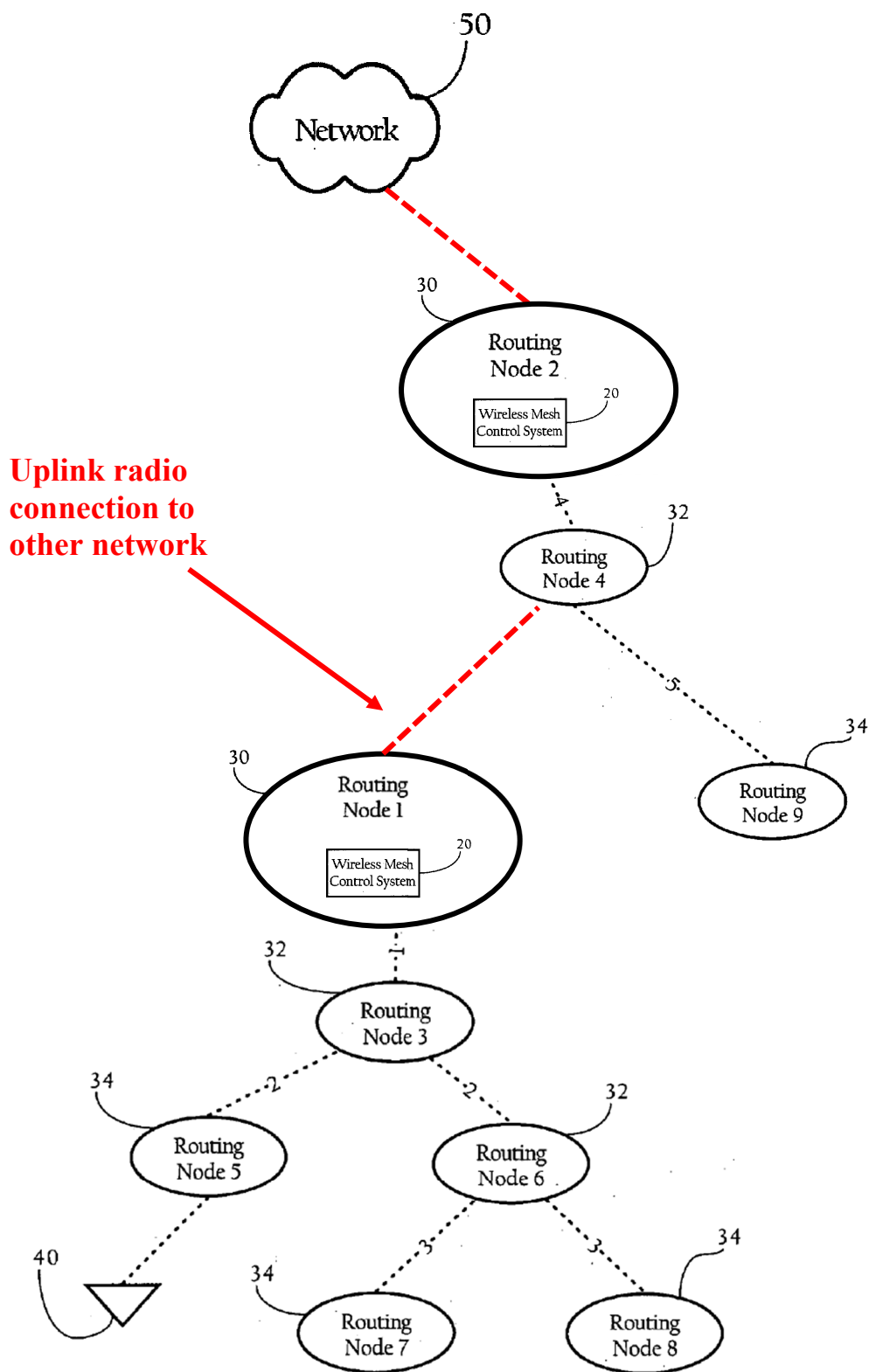
“include all the essential physical functionality discussed” with respect to each of the routing nodes in the network. Ex.1005, [0045]. However, when a node is configured to operate in a root mode, the “upstream synchronization functionality is disabled,” such that the uplink radio for that node is unused. Ex.1005, [0045]. Accordingly, such nodes include the capability of being used for backhaul purposes, such as Zeng contemplates, in situations where the root node loses its connection to network 50. By connecting with another network (e.g., the first mesh network with root routing node 1 connects to the second mesh network with root routing node 2, as reflected in annotated Figure 1³ of Castagnoli, below), the hierarchical wireless mesh network *form[s] the connected configuration* because it is connected to the network 50 via the backhaul connection to routing node 4, which is in turn connected to root node 2 and network 50:

³ While annotated Figure 1 below shows wireless mesh control system 20 under the crossed out connection to the external network, as discussed above in [1.0], the wireless mesh control system would be integrated into each routing node. Figure 1 is presented below in an unmodified form for purposes of clarity regarding the relationship between the two hierarchical wireless mesh networks.



Ex.1005, Fig. 1 (annotated).

158. Modified Figure 1 of Castagnoli, below, provides a logical representation of the combined hierarchical wireless mesh network after such a transition takes place. As reflected below, root routing node 1 connects to a routing node within the second hierarchical wireless mesh network, such as routing node 4.



Ex.1005, Fig. 1 (modified, annotated).

159. As discussed above in [1.4], Castagnoli renders obvious that *the connectivity logic contained by the nodes* determines the connections between the nodes because each node's routing node control processor controls the operation of its routing node. *See also* Ex.1005, [0036], Claims 10-11, 14. By implementing Zeng's teachings to search for (*detection of an external network connection*) and connect to another hierarchical wireless mesh network (*to form the connected configuration*), the routing node control processor of the root routing node *realigns connections between the nodes*.

160. Thus, Castagnoli in view of Bauer, Gil, and Zeng renders obvious claim 9.

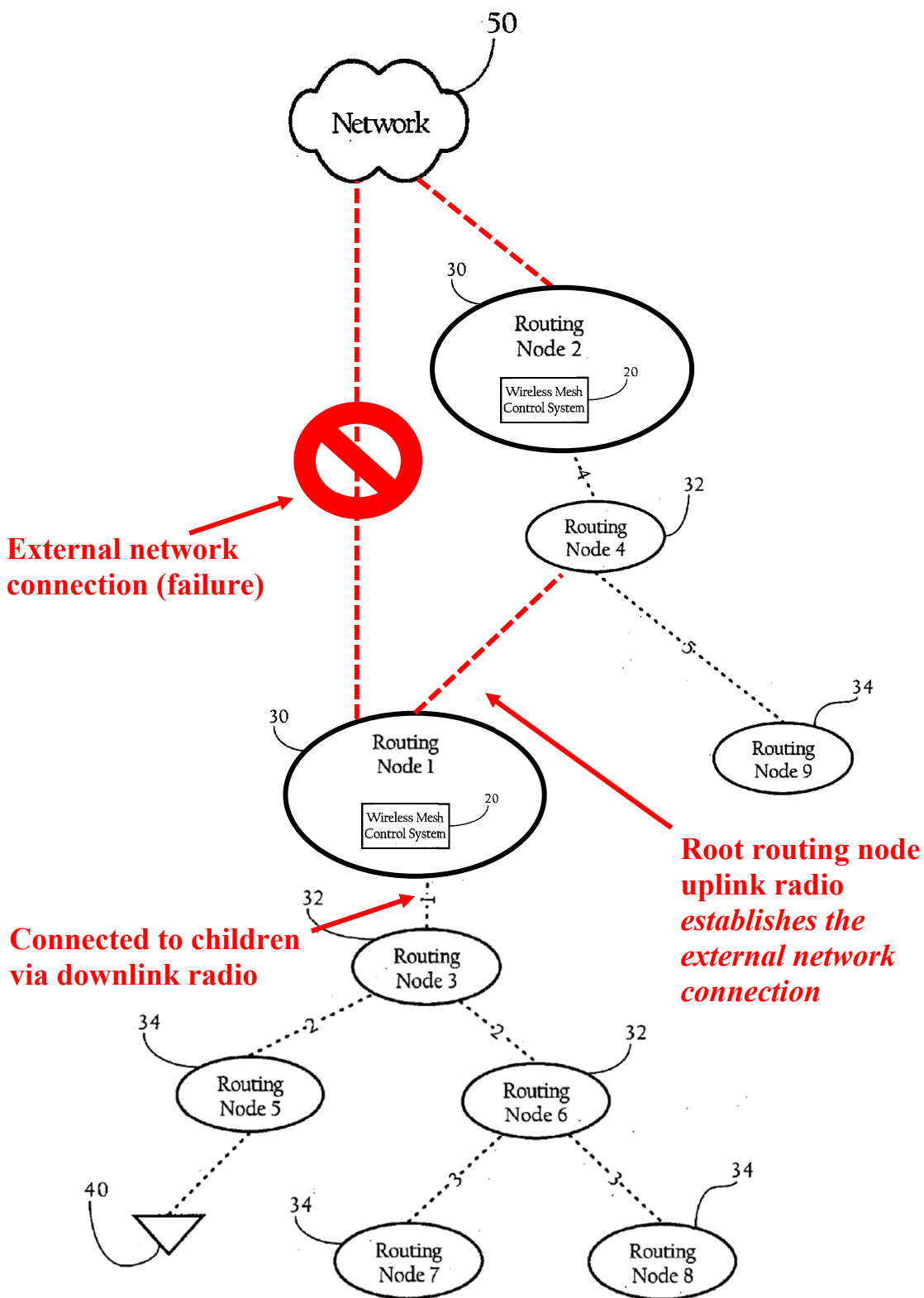
4. Claim 10

- a.** **[10.0]** *The structured mesh network of claim 9 wherein solely the isolated network root node logic searches for the external network connection and establishes the external network connection.*

161. Castagnoli in view of Bauer, Gil, and Zeng renders obvious claim 10.

162. As discussed above, the combination of Castagnoli, Bauer, and Zeng renders obvious *the structured mesh network of claim 9*. Further, it would have been obvious that in the combination, *solely the isolated network root node logic searches for the external network connection* because Zeng teaches that the node which loses its connection to the external network is the node that *searches for the external network connection*. More specifically, Zeng explains that when a node loses its

external network link, it configures a radio for backhaul and broadcasts requests for backhaul connectivity to neighboring nodes. Ex.1007, [0027]-[0030]. Because only one node within the wireless network is connected to an external network (i.e., root routing node 1 for Castagnoli's first hierarchical wireless mesh network discussed in claim 9, above), and Zeng teaches that the node that loses its external network link searches for another network, the combination renders obvious that *solely the isolated network root node logic searches for the external network connection*. And as discussed above in claim 9, the root routing node further *establishes the external network connection* by connecting to another network using its uplink radio:



Ex.1005, Fig. 1 (modified, annotated).

163. Thus, Castagnoli in view of Bauer, Gil, and Zeng renders obvious claim 10.

5. Claim 11

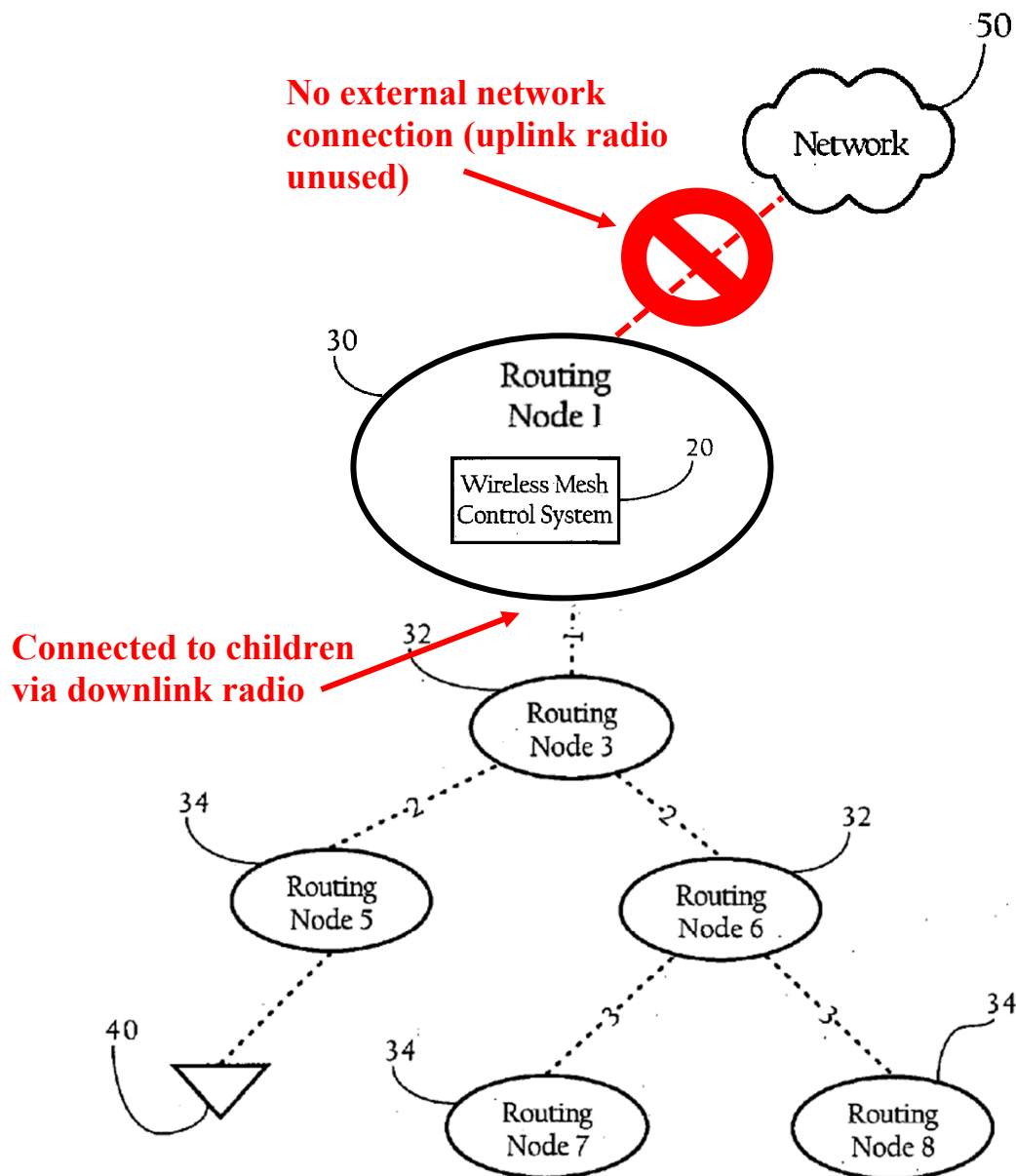
- a. [11.0] *The structured mesh network of claim 10 wherein the previously unused uplink radio of the isolated network root node is used to connect to the external network.*

164. Castagnoli in view of Bauer and Zeng renders obvious claim 11.

165. As discussed above, the combination of Castagnoli, Bauer, and Zeng renders obvious *the structured mesh network of claim 10*. More specifically, in the combination, a first mesh network with root routing node 1 connects to a second mesh network with root routing node 2 using the uplink radio of root routing node 1.

166. Castagnoli further renders obvious that the uplink radio of root routing node 1 is a *previously unused uplink radio of the isolated network root node*. More specifically, when operating in the isolated configuration (as discussed in [1.7] above), Castagnoli's root routing node is not connected to an external network and the hierarchical wireless mesh network is instead providing IP services locally, per Bauer. Ex.1006, Abstract, [0023], Fig. 1; *see also* Ex.1005, [0010], [0033]; Ex.1006, [0002]. Instead, as reflected in Castagnoli's modified Figure 1, the root routing node is connected to children via its downlink radio, while the uplink radio is *unused*

because it does not have a connection to the external network or other APs. Ex.1005, Fig. 1.



Ex.1005, Fig. 1 (modified, annotated).

167. Further, Zeng teaches enabling an uplink radio and using it for backhaul to connect to another network when an external network connection fails. Ex.1007, [0028], [0030].

168. Accordingly, in the combination, Castagnoli's root routing node 1 (*the isolated network root node*) would enable its unused uplink radio (*the previously unused uplink radio*) and search for and connect to a second hierarchical wireless mesh network, per Zeng (*is used to connect to the external network*).

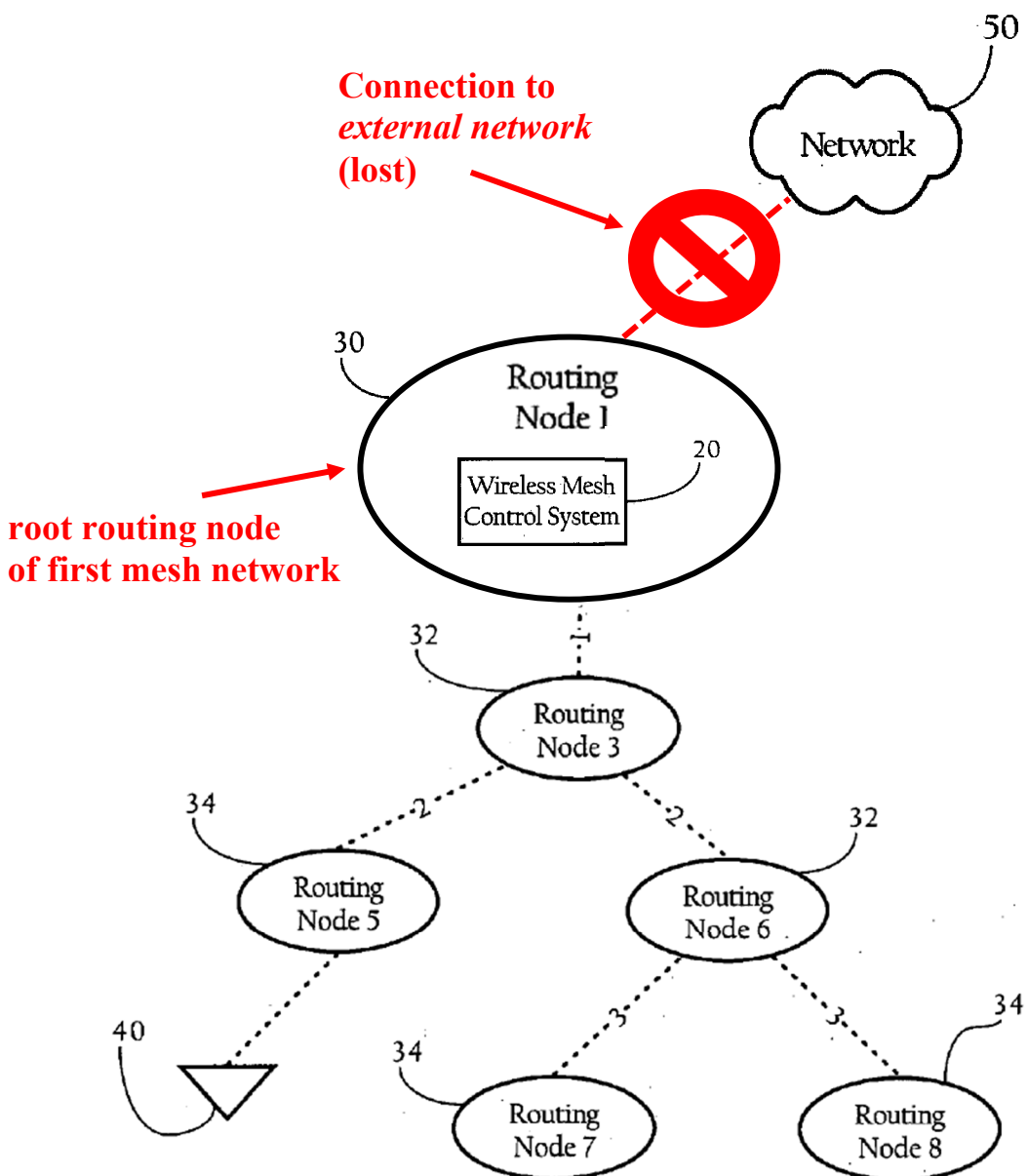
169. Thus, Castagnoli in view of Bauer and Zeng renders obvious claim 11.

6. **Claim 15**

- a. **[15.0] *The structured mesh network of claim 1 wherein a first mesh network in the isolated configuration comprises an isolated root node and one or more isolated children nodes and***

170. Castagnoli in view of Bauer renders obvious limitation [15.0].

171. As discussed above in [1.7], Castagnoli in view of Bauer renders obvious *a first mesh network* (Castagnoli's hierarchical wireless mesh network with root routing node 1) *in the isolated configuration* (operating where the connection is interrupted between root routing node 1 and network 50) *comprises an isolated root node* (root routing node 1) *and one or more isolated children nodes* (e.g., routing nodes 3 and 5-8):



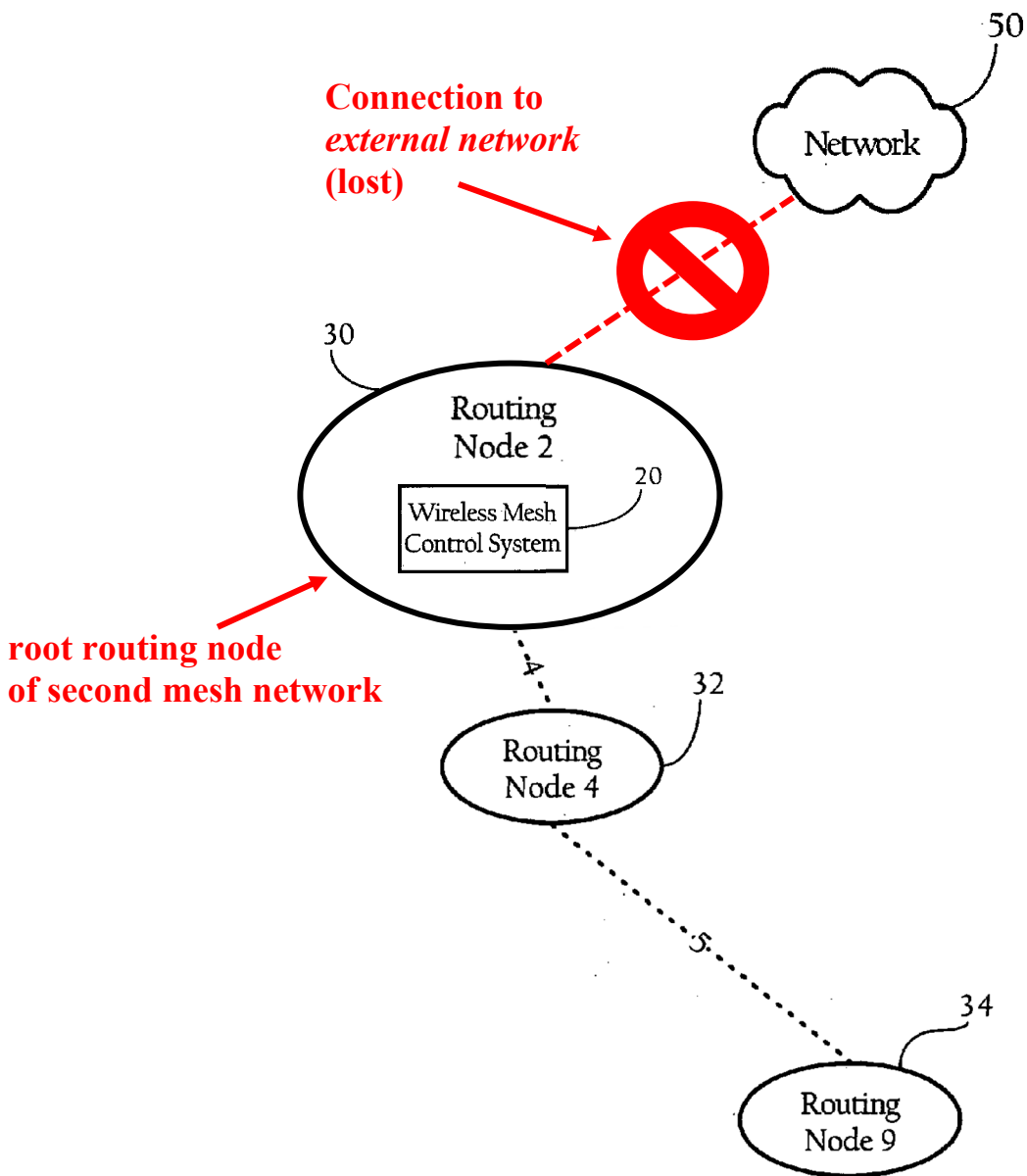
Ex.1005, Fig. 1 (modified, annotated).

172. Thus, Castagnoli in view of Bauer and Zeng renders obvious this limitation.

- b. [15.1] *a second mesh network in the isolated configuration comprises an isolated root node and at least one or more isolated children nodes and*

173. Castagnoli in view of Bauer renders obvious limitation [15.1].

174. Castagnoli contemplates multiple hierarchical wireless mesh networks. For instance, as discussed with respect to claim 9 above, in Figure 1 Castagnoli shows a first hierarchical wireless mesh network with root routing node 1 and a second hierarchical wireless mesh network with root routing node 2, where each mesh network is connected to network 50. Accordingly, for the same reasons as discussed in [1.7] and [15.0], Castagnoli in view of Bauer renders obvious *a second mesh network* (Castagnoli's hierarchical wireless mesh network with root routing node 2) *in the isolated configuration* (operating where the connection is interrupted between root routing node 2 and network 50) *comprises an isolated root node* (root routing node 2) *and at least one or more isolated children nodes* (e.g., routing nodes 4 and 9):



Ex.1005, Fig. 1 (modified, annotated).

175. Thus, Castagnoli in view of Bauer and Zeng renders obvious this limitation.

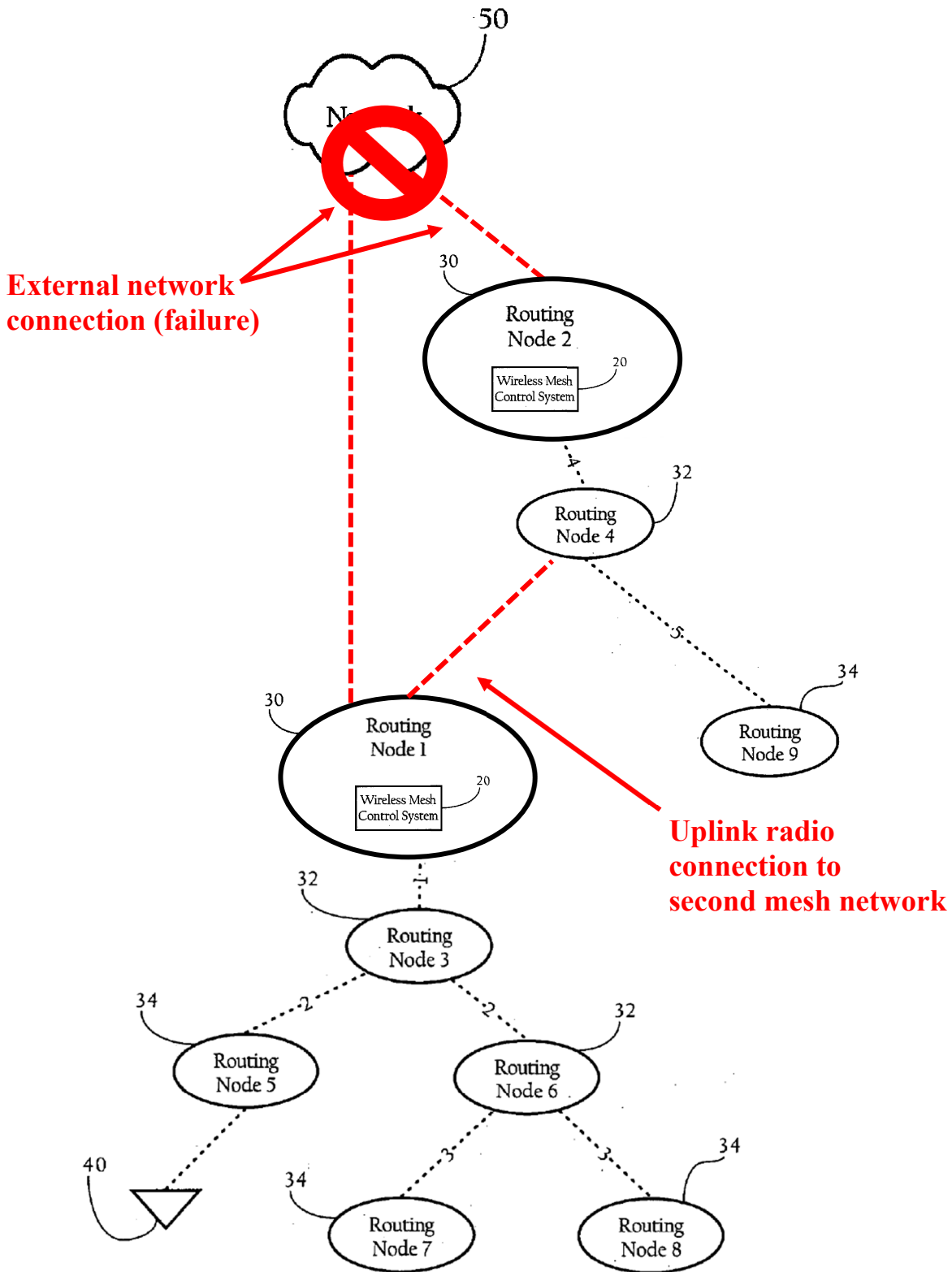
- c. [15.2] *the root node of the first network establishes communication with a child node of the second*

network, thereby the root node of the first network becomes a child node of the second network.

176. Castagnoli in view of Bauer and Zeng renders obvious *the root node of the first network establishes communication with a child node of the second network* because in the combination, Castagnoli's root routing node 1 searches for and connects to a node in the second hierarchical wireless mesh network.

177. As discussed above with respect to claim 9, in the combination, Castagnoli implements Zeng's teaching of using an uplink radio to search for and connect to other networks when a node's external network connection is lost. Accordingly, when the connection between root routing node 1 and network 50 is lost, root routing node 1 would use its uplink radio to "broadcast a request for backhaul connectivity to neighboring APs," per Zeng. Ex.1007, [0030]. Zeng explains that the node "detects whether any neighboring AP responds to the backhaul connectivity request" and "selects a responding neighboring AP based on at least one predetermined criteria." Ex.1007, [0031]-[0032]. Accordingly, it would have been obvious in the combination to locate various access points within wireless communication range of one another, as taught by Zeng, to facilitate using Zeng's technique for recovering from a failed external network link, based on factors such as "signal power...to ensure that the transmission between the two access points meets a predetermined threshold." Ex.1007, [0034]. Further, Castagnoli's Figure 1 is "a functional block diagram that illustrates a hierarchical wireless mesh network

according to an implementation of the present invention,” and thus a POSITA would have appreciated that it does not depict the relative positions of the nodes with respect to one another, and thus each of routing nodes 2, 4, and 9 would be understood to be viable candidates for neighbor selection. Ex.1005, [0012], [0033].



Ex.1005, Fig. 1 (modified, annotated).

178. Thus, Castagnoli in view of Bauer and Zeng renders obvious this limitation.

7. Claim 16

- a. [16.0] *The structured mesh network of claim 15 wherein the unused uplink radio on the root node of the first network is used to connect to the child node of the second network.*

179. Castagnoli in view of Bauer and Zeng renders obvious claim 16.

180. As discussed above for limitation [15.2], Castagnoli's root routing node 1 (*root node of the first network*) connects to a node in the second hierarchical wireless mesh network (*connect to the child node of the second network*). And as discussed above with respect to claim 11, Castagnoli further renders obvious that the uplink radio of root routing node 1 is an *unused uplink radio on the root node of the first network* because it is not connected to an external network (and as the root is not connected to another AP) when providing IP services locally, per Bauer. Ex.1006, Abstract, [0023], Fig. 1; *see also* Ex.1005, [0010], [0033]; Ex.1006, [0002]

181. Accordingly, Castagnoli in view of Bauer and Zeng renders obvious claim 16.

C. Ground 3: Claim 19 would have been Obvious over Castagnoli in view of Bauer, Gil, and Papadoglou.

1. Summary of Papadoglou

182. Papadoglou provides further details regarding the relationship between an access point and a client device. More specifically, Papadoglou "relates to a

method of and apparatus for transmitting data between devices.” Ex.1009. [0001]. Papadoglou describes “[a] communications device (1) communicates with an access point (7) to gateway (21) and local area network (13) by a wired or wireless communications link (9).” Ex.1009, Abstract. Communications devices include “mobile (cellular) telephones, personal digital assistance (PDAs), laptop computers or the like.” Ex.1009, [0014]. Papadoglou explains that when a device “has been connected to the access point 7 it is assigned a random IP address by the Dynamic Host Configuration Protocol (DHCP) server 11 of the local area network (LAN) 13[.]” Ex.1009, [0016].

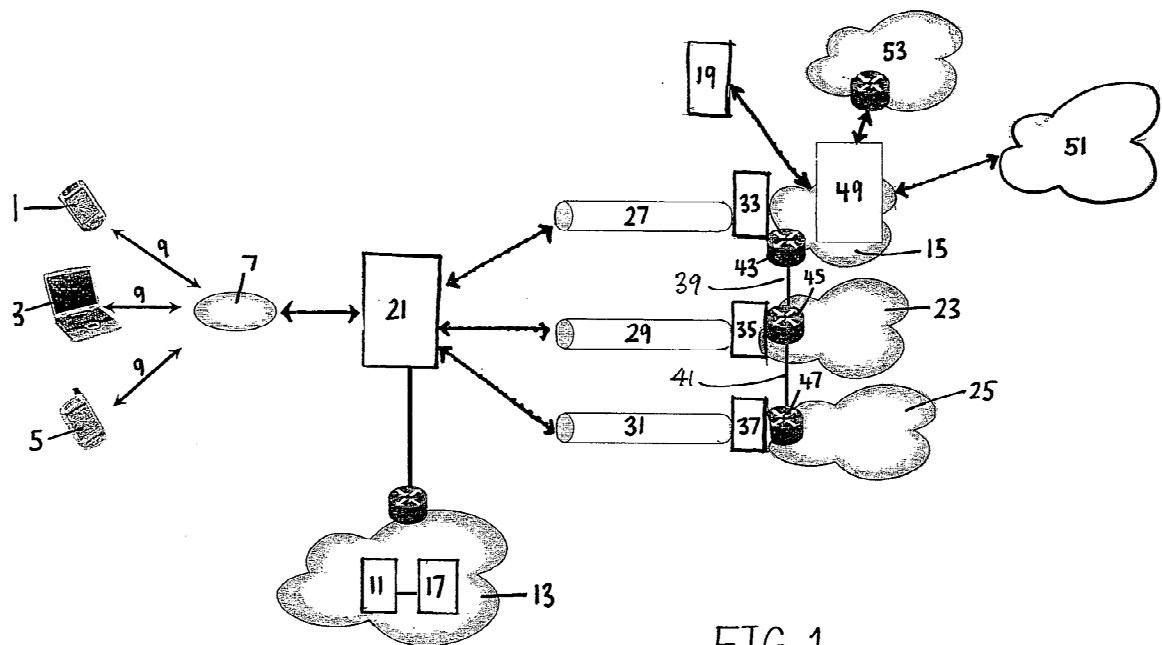


FIG. 1

Ex.1009, Fig. 1.

2. Reasons to Combine Castagnoli, Bauer, Gil, and Papadoglou

183. A POSITA would have combined Papadoglou with Castagnoli, Bauer, and Gil because Papadoglou merely provides additional details regarding conventional implementation of the connection of client devices to an access point. As discussed above in [18.0], Bauer describes how a mesh network operating without an external network connection provides DHCP services, and confirms that IP addresses would be assigned to clients. Ex.1006, [0056], [0002]-[0003], [0055]. Papadoglou provides additional implementation regarding such IP address assignment. More specifically, Papadoglou teaches that “a random IP address” is assigned “by the Dynamic Host Configuration Protocol (DHCP) server” when a client device connects to an access point, such as a routing node in Castagnoli’s hierarchical wireless mesh network. Ex.1009, [0016].

184. A POSITA would have been motivated to combine the teachings of Castagnoli, Bauer, and Gil with Papadoglou and doing so would have been within the POSITA’s skillset. The combination would have been obvious because it represents merely the use of a known technique (random IP address assignment) to improve similar devices (Castagnoli’s hierarchical wireless mesh network, using DHCP to assign IP addresses per Bauer) in the same way (assigning **random** IP addresses to client devices using DHCP, per Papadoglou) to yield predictable results. In the combination, each routing node, acting as DHCP servers per Bauer (Ex.1006,

[0056]), would assign random IP addresses to client devices as taught by Papadoglou. A POSITA would have had a reasonable expectation of success in the combination because Papadoglou merely teaches conventional IP address assignment practices (i.e., random IP address assignment to client devices) that was well known in the art. *See*, e.g., Ex.1016, [0005]; Ex.1017, [0130]; Ex.1018, [0002]; [19.0] (discussing same). And Papadoglou, like Bauer, teaches assigning IP addresses using a DHCP server. Ex.1009, [0016]; Ex.1005, [0056], [0002]-[0003]; *see* [18.0].

3. Claim 19

- a. ***[19.] The structured mesh network of claim 18 wherein the DHCP server within each node assigns IP addresses to client devices containing one or more random numbers within the IP addresses.***

185. Castagnoli in view of Bauer and Papadoglou renders obvious claim 19.

186. As discussed in [18.0], Bauer renders obvious *wherein the DHCP server within each node assigns IP addresses to client devices*. Further, it would have been obvious that *each node assigns IP addresses...containing one or more random numbers*, as taught by Papadoglou.

187. Papadoglou teaches that when a user terminal—e.g., a mobile phone, PDA, laptop computer, or the like—connects to an access point, “it is **assigned a random IP address by the Dynamic Host Configuration Protocol (DHCP) server** 11 of the local area network[.]” Ex.1009, [0016], [0014]. This is consistent

with Bauer, which similarly teaches the assignment of IP address using DHCP servers, as discussed above in [18.0]. Ex.1006, [0056], [0002]-[0003]. Indeed, it was well-known in the art for a DHCP server to assign random IP addresses to clients and for the IP addresses to be composed of numerals.

Once a terminal 1, 3, 5 has been connected to the access point 7 it is **assigned a random IP address by the Dynamic Host Configuration Protocol (DHCP) server 11** of the local area network (LAN) 13 that may be provided in the specific environment (for example, on board a train, at a train station or at an airport) of the access point 7.

Ex.1009, [0016].

This Invention solves that problem by using ODIPA (Outernet Dynamic IP Allocation). ODIPA allocates IP addresses in a two stage approach; where first stage uses **standard DHCP to allocate a random IP Address** from a large Private Address Space for a very short period of time (after which they are released and available for use).

Ex.1016, [0005].

DHCP and DNS can accomplish provisioning based on location. **The DHCP server could return a "random" address** from a pool of addresses and also could return a specific host name to the RFID reader.

Ex.1017, [0130].

Alternatively, **dynamic host configuration protocol (DHCP)** could be used to get a random address, but this requires that the proper subnet mask be preset.

Ex.1018, [0002].

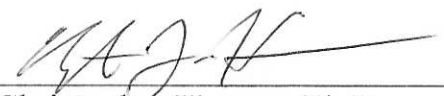
188. IP addresses are numeric. For example, it was well-known that a IPv4 address is a 32-bit value that is often written as four decimal numbers (each in the range of 0 to 255) separated by periods, such as 192.16.0.253. Ex.1019, [0035] (“the term ‘**Internet Protocol (IP) address**’ refers to a layer 3 address, and can be a **number** which identifies each sender or receiver of information packets across the Internet.”); Ex.1020, [0008] (“The current IP standard is IP version 4 (or IPv4). An **IP address** in IPv4 is a four-byte (32-bit) **number combination** in the format of AAA.BBB.CCC.DDD. For example, 64.236.16.20 is the IPv4 address for CNN.com.”). Since IP addresses are numeric, it would have been obvious to a POSITA for a random IP address to contain *one or more random numbers*.

189. Thus, Castagnoli in view of Bauer renders obvious claim 19.

IX. CONCLUSION

190. 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: October 10, 2025



Christopher Hansen, Ph.D.