UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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CISCO SYSTEMS INC.,

Petitioner

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U.S. Patent No. 7,420,952

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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 14
VI. OVERVIEW OF THE '952 PATENT 15
VII. CLAIM CONSTRUCTION 18
VIII. IDENTIFICATION OF HOW THE CLAIMS ARE UNPATENTABLE 19
IX. THE COMBINATION OF GANZ AND SRIKRISHNA RENDERS OBVIOUS CLAIMS 1-3, 5-10, 12-14, AND 16-20 19
A. Summary of Ganz 19
B. Summary of Srikrishna 23
C. Reasons to Combine Ganz with Srikrishna 24
D. Detailed Analysis of Claims 29
1. Claim 1 29
2. Claim 2 63
3. Claim 3 65
4. Claim 5 69
5. Claim 6 70
6. Claim 7 73
7. Claim 8 75
8. Claim 9 77
9. Claim 10 78
10. Claim 12 82
11. Claims 13, 14, and 16-20 86
X. THE COMBINATION OF GANZ, SRIKRISHNA, AND BISHOP RENDERS OBVIOUS CLAIMS 4 AND 15 86

A. Summary of Bishop....86
B. Reasons to combine Bishop with Ganz and Srikrishna....89
C. Detailed Analysis of Claims....93
1. Claim 4....93
2. Claim 15....96
XI. THE COMBINATION OF GANZ, SRIKRISHNA, AND IEEE 802.11 RENDERS OBVIOUS CLAIMS 11 AND 21....96
A. Summary of IEEE 802.11....96
B. Reasons to Combine Ganz, Srikrishna, and IEEE 802.11....97
C. Detailed Analysis of claims....98
1. Claim 11....98
2. Claim 21....102
XII. CONCLUSION....103

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

I. INTRODUCTION

1. I am making this declaration at the request of Cisco Systems, Inc. in the matter of the *Inter Partes* Review of U.S. Patent No. 7,420,952 ("the '952 patent") to Da Costa et al.

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 1-21 ("the Challenged Claims") of the '952 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 '952 patent, Ex. 1001;

b. the prosecution history of the '952 patent ("'952 File History"), Ex. 1002;

c. U.S. Patent No. 6,584,080 to Ganz et al. ("Ganz"), Ex. 1005;

d. U.S. Patent No. 7,031,293 to Srikrishna ("Srikrishna"), Ex. 1006;

e. ANSI/IEEE Std IEE 802.11, 1999 ed. ("IEEE 802.11"), Ex.1007; and

f. U.S. Patent No. 6,377,782 to Bishop et al. ("Bishop"), Ex.1020.

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. U.S. Patent No. 7,568,107, Ex.1008;

b. U.S. Patent Pub. No. 2002/0124036, Ex.1011;

c. U.S. Patent Pub. No. 2002/0110105, Ex.1013;

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

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

f. U.S. Patent No. 5,673,031 to Meier, Ex.1016;

g. U.S. Patent Publication No. 2002/0136170 to Struhsaker, Ex.1017;

h. U.S. Patent Publication No. 2003/0224750 to Sampath, Ex.1018; and

i. U.S. Provisional Patent Application No. 60/421,930, Ex.1019.

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 ("TGay") (responsible for 802.11ay) which led to

new mmWave features, Task Group M ("TGm") (responsible for the 802.11-2020 standard), and the Integrated mmWave Study Group ("IMW SG") (the precursor for TGbq). I received awards from the IEEE for my contributions to TGay and TGm.

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 '952 patent, as of its earliest possible priority date of October 28, 2002, would have had a working knowledge of the wireless networking art that is pertinent to the '952 patent, including familiarity with standards such as IEEE 802.11. Such a POSITA would have a bachelor's degree in computer science, computer engineering, electrical engineering, or equivalent training, and approximately two years of experience working in the field of network communications. Additional work experience could have been substituted for educational experience, and vice versa.

21. 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 ’952 patent.

IV. RELEVANT LEGAL STANDARDS

22. I am not an attorney. In preparing and expressing my opinions and considering the subject matter of the ’952 patent, I am relying on certain basic legal principles that Cisco’s counsel has explained to me.

23. I understand that prior art to the ’952 patent includes patents and printed publications in the relevant art that predate the priority date of the ’952 patent. The ’952 Patent issued from U.S. Patent Application No. 10/434,948 (“the ’948 Application”), filed by Mesh Dynamics Inc. on May 8, 2003. ’952 Patent, cover page. The ’952 Patent claims priority to U.S. Provisional Application No. 60/421,930 (“the ’930 Provisional Application”), filed a little over six months before the ’948 Application on October 28, 2002. ’952 Patent, cover page. Based on my review of the respective disclosures of the ’948 Application and the ’930 Provisional Application, it is my opinion that the priority date for all claims of the ’952 Patent is May 8, 2003, which is the filing date of the ’948 Application. The ’948 Application adds substantial disclosure related to multiple features in independent claims 1 and 12, as well as their dependents. The ’930 Provisional Application lacks that disclosure, or any other disclosure that would support each limitation in independent claims 1 and 12.

24. The provisional application does not expressly discuss the concept of selecting a different relay node "*prior to being dynamically selected … was a sibling node of the first relay node*." The provisional application only discusses dynamically reselecting different parent-child paths through the mesh network, such as a node "select[ing] alternative paths" in response to changes in connectivity cost or in the event of a node failure. '930 Provisional Application, 11, 12. Elsewhere, the provisional application discusses "siblings," but it is in the context of two child siblings communicating with a "direct communication link between siblings" as opposed to having to travel first to a shared parent node. '930 Provisional Application, 13-14.

25. These descriptions, even when combined together, are insufficient to support "*prior to being dynamically selected … was a sibling node of the first relay node*." Instead, at best a POSITA might be able to infer from the provisional application that (1) different parent-child relationships can be dynamically established selected from existing parent-child relationships, and (2) sibling nodes can bypass parent nodes entirely to communicate with each other when within range.

26. However, the prior art applied in this disclosure is prior art to the '952 patent under §102(a) and (e) even if the '952 Patent had the benefit of the '930 Provisional Application's priority date.

27. 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.

28. 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

29. 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.

30. 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.

31. 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.

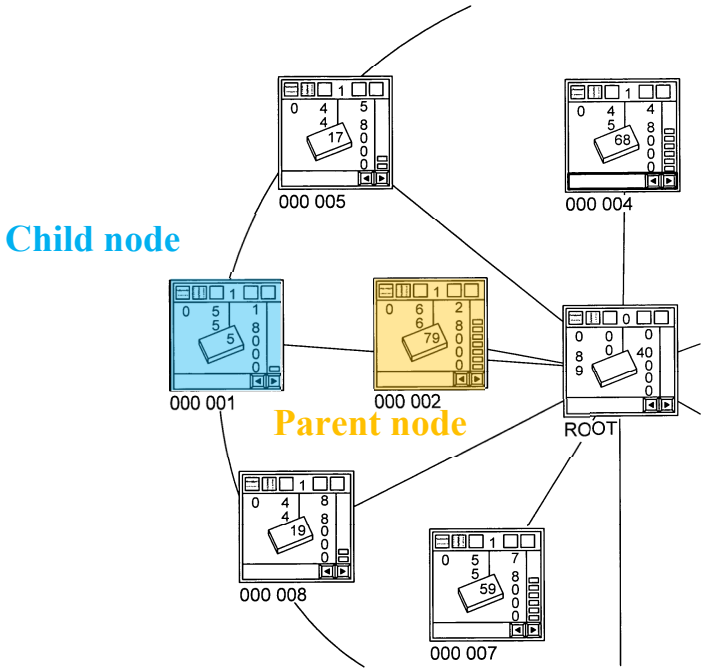
32. All of the features and functionality described in this section were well known in the early 2000s, and a POSITA would have been familiar with them.

VI. OVERVIEW OF THE '952 PATENT

33. The '952 Patent describes "an adaptive wireless network" that includes several interconnected wireless access points (APs) to support different

types of data communication services for clients. ’952 Patent, 2:58-59, 6:37-40, The ’952 Patent explains that the APs may support various functionalities for an adaptable network, including “fail over,” “load balancing,” and “asynchronous application requirements.” ’952 Patent, 5:58-6:7.

34. For instance, with respect to “fail over” functionality, the ’952 Patent explains “if one node dies, nodes connected to it automatically switch to another.” ’952 Patent, 5:64-65. Further, the ’952 Patent states that mesh networks allow “nodes to select alternate routes, in case one node fails or becomes congested.” ’952 Patent, 10:26-28. The ’952 Patent refers to nodes that “share the same parent in their routing paths” as “siblings.” ’952 Patent, 14:27-29. If a routing path from an end user toward a root node includes a hop from a first node to a second node, then those two nodes are described as “child” and “parent,” respectively. ’952 Patent, 7:63-37.



'952 Patent, FIG. 5 (annotated)

35. The '952 Patent describes mechanisms to "enable voice and data types of requirements" based on "application profiles" that include the "latency and throughput requirements" for different applications. '952 Patent, 6:25-28. The APs perform "dynamic channel allocation" to reduce interference with other nodes. '952 Patent, 11:53-59, 62-62. For instance, an AP uses an algorithm in order to "select a channel, from a list of available channels that does not conflict with channels selected by neighboring devices." '952 Patent, 12:7-10. This algorithm seeks "to define what the best channel allocations should be between devices and their parents." '952 Patent, 12:1-2.

36. The ’952 claims recite a “*method*” and a “*computer program product*” for a wireless mesh network having a “*plurality of relay nodes*.” The claims recite steps that include “*determining that a first one of the plurality of relay nodes in the wireless mesh network requires a channel selection change,…dynamically selecting a second one of the plurality of relay nodes in the wireless mesh network to form a parent-child relationship with the first relay node; and making a channel selection change…to meet a performance requirement*.”

37. As I will explain below, these concepts were well known as of the priority date of the ’952 patent.

VII. CLAIM CONSTRUCTION

38. It is my understanding that in order to properly evaluate the ’952 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. I have reviewed the entirety of the ’952 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

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

40. 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.

41. 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.

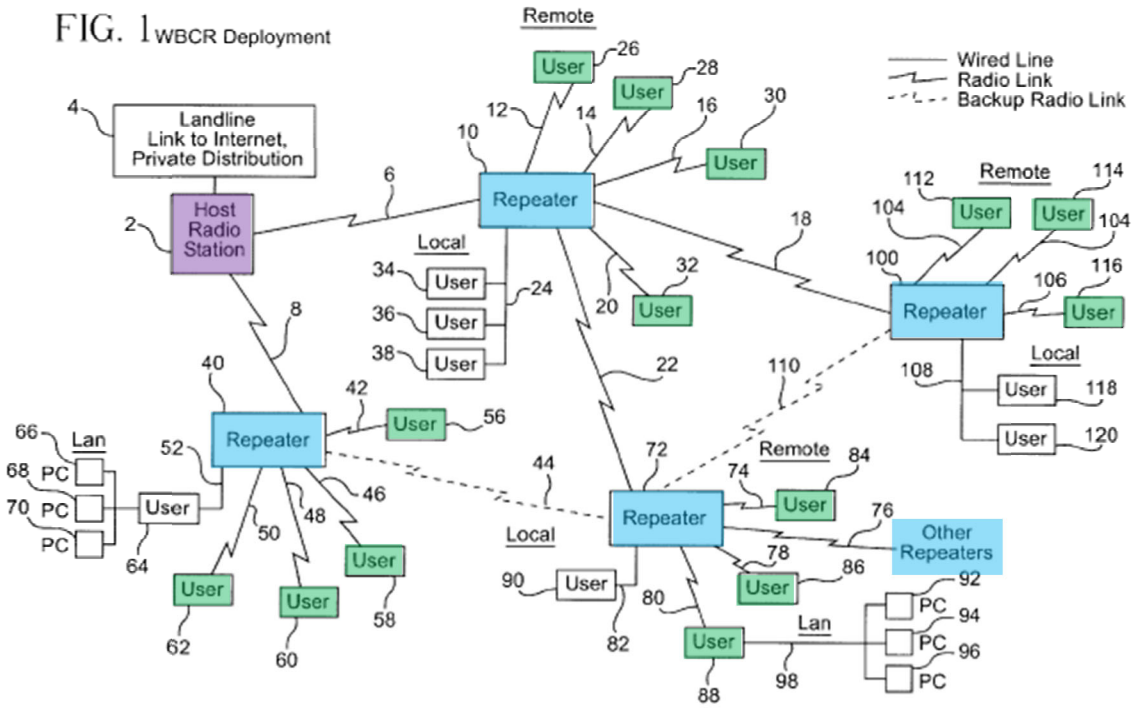
IX. THE COMBINATION OF GANZ AND SRIKRISHNA RENDERS OBVIOUS CLAIMS 1-3, 5-10, 12-14, AND 16-20

A. Summary of Ganz

42. U.S. Patent No. 6,584,080 to Ganz et al. (Ex. 1005, "Ganz") issued on June 24, 2003 from U.S. Patent Application No. 09/231,458, filed on January 14, 1999. Accordingly, I understand that Ganz is prior art to the '952 patent at least under pre-AIA USC §§ 102(a) and 102(e).

43. Ganz describes a "wireless high speed data communication system" that includes "numerous repeaters each of which is configured to communicate with each other within a light of sight," and with "users by…a line of sight

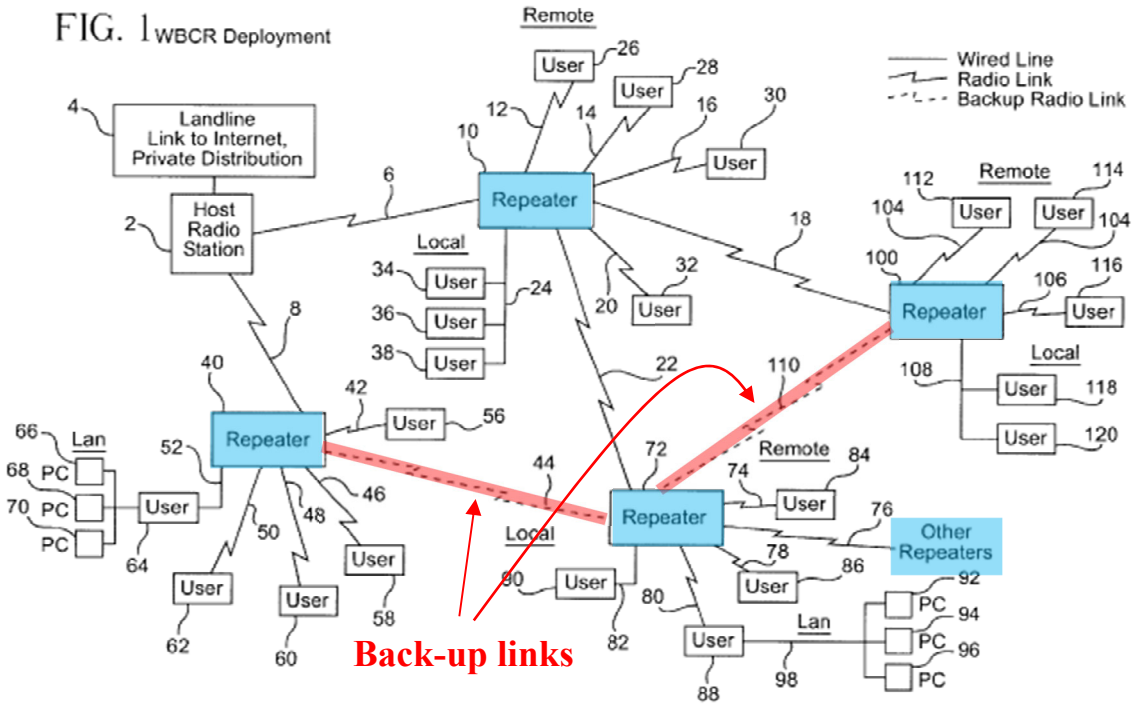
wireless connection." Ganz, Abstract. In FIG. 1 below, wireless connections are represented by zig-zag-style lines between the various nodes.



Ganz, FIG. 1 (annotated)

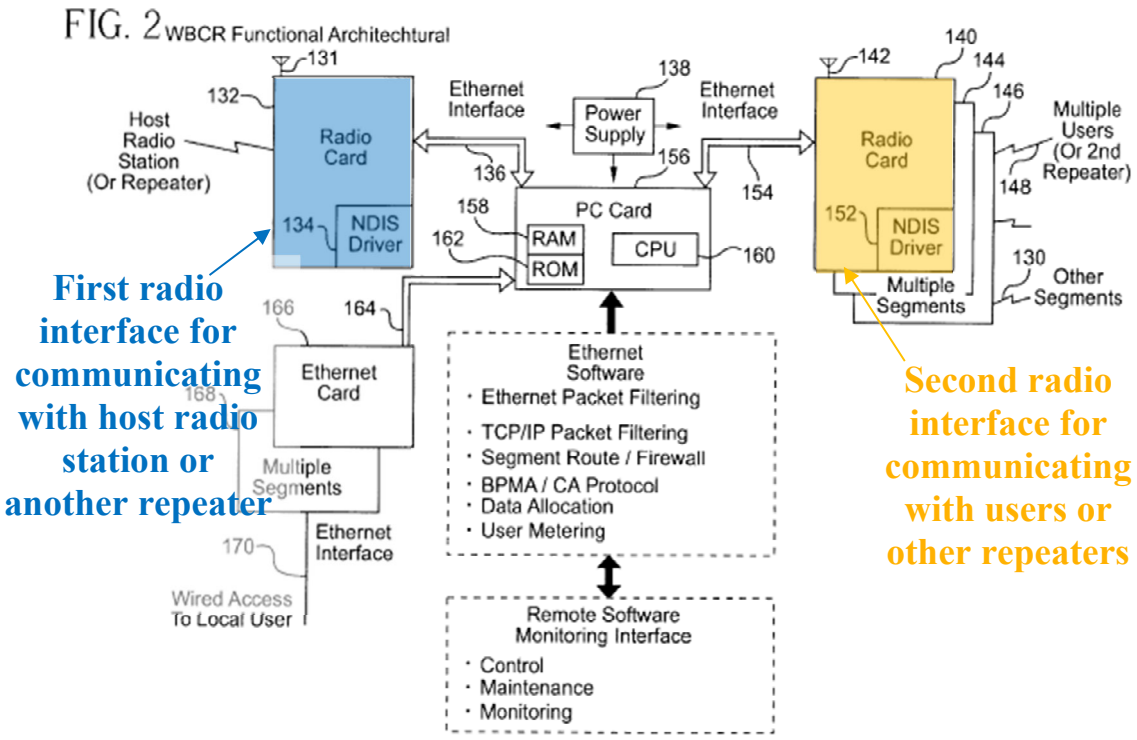
44. Ganz refers to the repeaters as "wireless burstable communications repeaters (WBCRs)." Ganz, 3:31-32 (cleaned up). As shown above, the repeaters (blue) are arranged at various levels or "hops" away from the host radio station 2 (purple), where some repeaters have a direct wireless connection with the host radio station (e.g., repeaters 10 and 40), and other repeaters (e.g., repeaters 72, 100) are connected to the host radio station through wireless connections with other repeaters.

45. The repeaters have back-up links 44, 110 with other repeaters that "can be established…in the event that one of the primary radio links 18, 22 were to fail." Ganz, 3:57-58. Further, repeaters can adapt to create new segments as traffic on that segment "approaches capacity." Ganz, 5:33-37. Ganz's network is also adaptable, allowing for "topology changes" and continually tests links to "steer traffic away from the problem links." Ganz, 11:10-11, 12:38-39.



Ganz, FIG. 1 (annotated)

46. Each repeater (WBCR) has memory and processing circuitry, and two radio transceiver circuits 132, 140. Ganz, FIG. 2, 3:64-4:7.



Ganz, FIG. 2 (annotated)

> The radio transceiver circuit 132, provides the radio frequency link to a host radio station and, optionally, to one or more repeaters. The second radio transceiver circuit 140, provides multiple radio frequency access to remotely distributed users and/or other WBCRs.

Ganz, 4:8-12.

47. Ganz uses a variety of mechanisms to monitor, maintain, and fix wireless links, including switching the channels or radio parameters. For instance, Ganz's repeaters perform "regular automatic tests" to "confirm the viability of [a] specific link" and to "reprogram[] wireless link parameters" to avoid interference. Ganz, 12:22-43. Additionally, Ganz discloses "frequency hopping" techniques to

switch or "hop" between up to "79 channels" to "decrease the chances of frequency jamming/interference." Ganz, 7:6-30.

48. Ganz discloses that frequency hops can be performed in light of "historical data on link behavior" to "automatically avoid RF frequencies susceptible to interference from various sources." Ganz, 12:45-49 (cleaned up).

B. Summary of Srikrishna

49. Srikrishna describes "a method of increasing the data throughput of a multi-hop wireless link." Srikrishna, Abstract. For instance, in a multi-hop wireless network, "source and destination wireless devices" can "route or relay their data transmission through intermediate wireless devices…generally referred to as routers, repeaters, or relays." Srikrishna, 1:30-34.

50. Srikrishna's relay nodes "can be equipped with two (half-duplex) wireless transceivers, one for the "uplink" and one for the 'downlink'. Srikrishna, 5:15-16. When two half-duplex receivers are used in this way, "one half-duplex transceiver can transmit, while the other one receives data." Srikrishna, 1:66-67. The two half-duplex transceivers "operate on distinct channels" to prevent one transceiver from interfering with the other. Srikrishna, 5:24-26.

51. The nodes periodically measure the link quality of several channels to determine which channel has the "best link quality:"

> For one embodiment, each node in the network has a software agent ("the Channel Manager") 1010 that communicates periodically, and on

> each available channel, with the corresponding software agents on neighboring downstream nodes and determines which channel corresponds to the best link quality. Having determined the best downlink channel, the Channel Manager 1010 instructs the Channel Managers on the neighboring downstream nodes to switch to that channel.

Srikrishna, 9:51-59.

52. Srikrishna explains that the "best channel" can be identified based on various metrics, including packet-error rate and throughput. Srikrishna, 11:19-46.

C. Reasons to Combine Ganz with Srikrishna

53. A POSITA would have combined Ganz with Srikrishna because they both relate to providing and maintaining wireless links in a way that increases throughput and reduces interference. Ganz, 12:23-24 ("Radio segments are automatically tested at regular intervals to confirm the viability of a specific link."), 12:38-40 ("Since the integrated WBCR spread spectrum techniques allow reprogramming of the wireless link parameters, the regular automatic tests also allow a more advanced scheme for avoiding interference."); Srikrishna, 4:33-35 ("By using different channels or spreading codes for the two transceivers, self-interference between the transceivers is reduced, or eliminated."), multiple channels that do not interfere with each other, interference between nodes is minimized."); 9:51-59 (identifying "which channel corresponds to the best link

quality," and instructing "the neighboring downstream nodes to switch to that channel."

54. Ganz and Srikrishna also addressed problems faced by the '952 patent related to sharing and allocating "finite communication channels" between many wireless communication nodes that experience changes in conditions due to mobility of at least some of the wireless devices. '952 Patent, 2:46-54. As explained above, Ganz addresses issues of sharing frequency resources and interference "automatic link testing … to confirm the viability of the specific link," enabling the system to isolate problem links, steer traffic away from them, and also avoiding interference. Ganz, 12:38-45.

55. Likewise, Srikrishna describes channel allocation protocols that increase throughput, in party by reducing or preventing interference by nearby nodes. For instance, Srikrishna states that its protocols "increase[] the capacity utilization of the network and renders the system robust to localized interferers and jammers," a desirable solution to the problem of sharing non-exclusive, finite channels. Srikrishna, 2:48-54.

56. A POSITA would have understood that Srikrishna simply provides implementation details that Ganz expects. For instance, Ganz discloses that repeaters perform "automatic link testing" to obtain link quality measurements such as "throughput speed" and packet error rates, and adjust radio frequency

parameters accordingly. Ganz, 12:22-49. Srikrishna provides further details concerning what the specific radio frequency parameters are, and how channel allocation decisions are made, including by switching channels based on link quality measurements and that channel allocation decisions are made to avoid interference and to switch to the "best" channel available. Srikrishna, 9:51-59. Srikrishna explains that the "channel" being used by a repeater is a radio frequency parameter that is adjusted based on link quality measurements. Srikrishna, 6:27-29, 9:57-59. Thus, a POSITA would have appreciated that Srikrishna's disclosure provides additional details for channel allocation and link quality testing.

57. A POSITA would have been motivated to combine Ganz with Srikrishna 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 (Srikrishna's channel allocation procedures for switching to "best" channel) to improve a similar method (Ganz's automatic link testing and radio parameter adjustment procedures) in the same way. Srikrishna's channel allocation procedures offer a straightforward channel selection approach using "uplink" and "downlink" transceivers, which are similar to Ganz's first and second radio transceiver circuits.

58. A POSITA would have been motivated to take advantage of Srikrishna's use of downlink channel selection and allocation procedures because

it would provide for ongoing, consistent channel maintenance by ensuring that the repeaters are also connected using the "best" channel for avoiding interference and optimizing throughput. In this way, if the conditions for a given channel degrade (e.g., increased interference, increased packet drop rates), the repeater can respond by identifying and switching to a channel that provides a better link quality.

59. The combination also would have been obvious because it is merely the application of a known technique (switching to a "best" channel determined based on link quality, per Srikrishna) to a known method (automatic link quality tests and reprogramming wireless parameters, per Ganz) ready for improvement to yield predictable results. Here, the improvement provided to Ganz's process by Srikrishna's "best" channel identification is ongoing monitoring and adjustment of channel allocations to ensure that wireless devices use links that reduce interference in the network. A POSITA would have been familiar with channel allocation and management to coordinate the use of frequency resources in the network and to reduce the chance of interference between neighboring nodes.

60. A POSITA would have had a reasonable expectation of success in combining the teachings of Ganz and Srikrishna. Notably, Srikrishna's relay nodes have a similar radio transceiver architecture to the architecture of Ganz's repeaters. Srikrishna, 5:14-16 ("Each relay node can be equipped with two (half-duplex) wireless transceivers, one for the 'uplink' and one for the 'downlink.'"); Ganz, 4:8-

12 ("The radio transceiver circuit 132, provides the radio frequency link to a host radio station and, optionally, to one or more repeaters. The second radio transceiver circuit 140 provides multiple radio frequency access to remotely distributed users and/or other WBCRs."). Further, both Srikrishna and Ganz disclose that their relay nodes have software modules for performing various network management and maintenance procedures, including link testing. Ganz, FIG. 3, 10:41-51; Srikrishna, 9:52-57 ("[E]ach node in the network has a software agent" that determines the best channel and instructs neighboring nodes to switch to that channel). Thus, a POSITA would have recognized how details provided for components in Srikrishna would be applied to the corresponding components in Ganz.

61. Further, both Srikrishna and Ganz contemplate using the same wireless standard to facilitate communications in their networks. *See* Srikrishna, 1:50-53 (half-duplex transceiver providing a IEEE 802.11 interface), 4:23-22-24 (using "MAC/PHY layer protocol standards such as IEEE 802.11b" to reduce interference); Ganz, 7:11-13 ("The radio/data link element circuits can incorporate an IEEE 802.11 specification…"). A POSITA would have appreciated the value of following an industry specification. It would promote interoperability among devices from different device manufacturers, so long as the devices are all

specification compliant. Indeed, device interoperability is a common and important goal in computer networking.

62. The analogous architectures of Ganz's and Srikrishna's systems, the fact that they propose using the same wireless standard (IEEE 802.11) to facilitate wireless connections and communications, and the fact that they both solve similar problems within the same field of channel allocation in multi-hop wireless networks and avoiding interference, would have provided a POSITA with a reasonable expectation of success in combining their disclosures.

63. The combination permits but does not require physical incorporation of elements from Srikrishna into Ganz. Nevertheless, the physical incorporation of Srikrishna's half-duplex transceivers and software modules for channel allocation (e.g., the Channel Manager 1010) would teach the claim limitations. As explained above, both Srikrishna and Ganz disclose that their relay nodes have software modules for performing various network management and maintenance procedures, including link testing.

D. Detailed Analysis of Claims

1. Claim 1

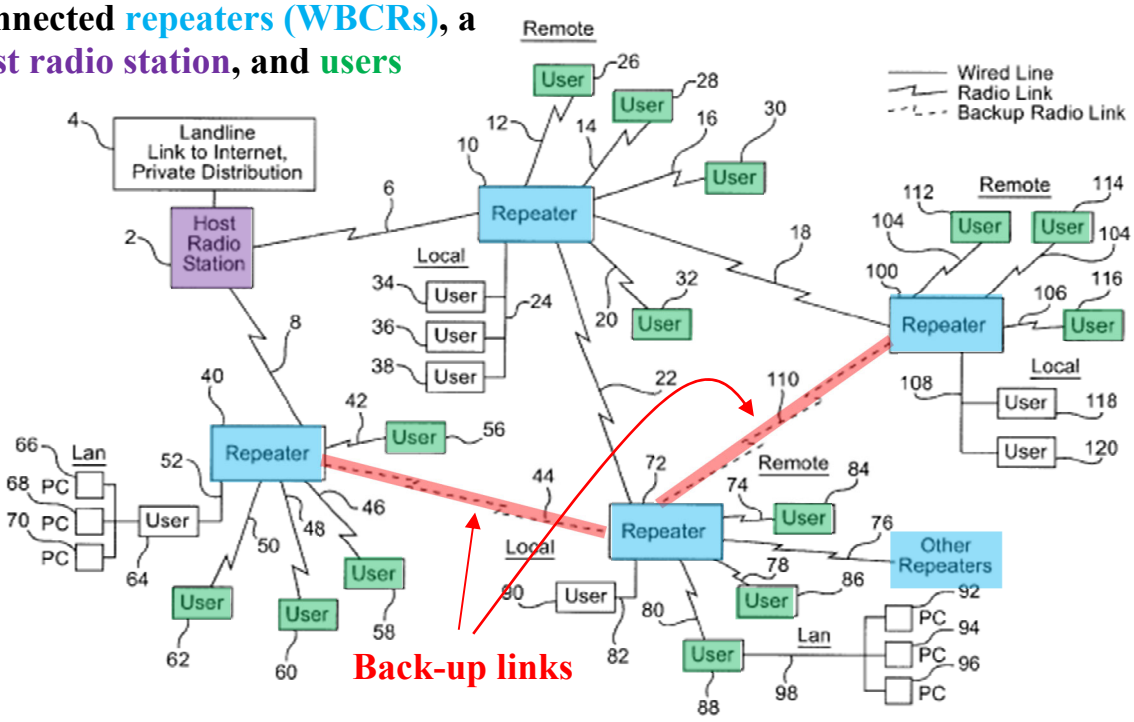
a. [1.0] *A method of controlling a wireless mesh network, comprising:*

64. To the extent that the preamble is limiting, Ganz discloses it.

65. Ganz discloses a "wireless high speed data communication system" including "numerous repeaters…configured to communicate with each other within a line of sight." Ganz, Abstract. The "repeaters are also configured to communicate with users by…a line of sight wireless connection." Ganz, Abstract. As explained above, Ganz describes the repeaters as "wireless burstable communications repeater[s] (WBCR[s])," but also occasionally refers to the WBCRs as simply "repeaters." Ganz, 3:31-32, 57-58. Thus, the quoted portions of Ganz below—and my analysis more generally—may refer to "WBCRs" and "repeaters" interchangeably.

66. The system includes a host radio station 2 that provides data communications "to users 26 remotely located from the host radio station 2, by a network of WBCRs 10, 100, 72, 40." Ganz, 3:40-43. Each WBCR can "provide[] local access to users 26-32 within light of sight," and "serves as a relay for WBCRs 100, 72, and 40, which serve further remote users…beyond the line-of-sight of both the host radio station 2 and WBCR 10." Ganz, 3:43-50.

"*wireless mesh network*" including interconnected repeaters (WBCRs), a host radio station, and users



Ganz, FIG. 1 (annotated)

67. Ganz's network, including the host station and Repeaters (WBCRs), is a "*wireless mesh network*."

68. Each WBCR includes a "computer circuit 156" that "performs the controlling functions within the WBCR." Ganz, 4:15-16. The controlling functions include "[c]ontrol of packet scheduling…to select users for a transmission and allocate data packet sizes and numbers for transfer to the users." Ganz, 5:11-14. The WBCRs include functionality for switching to "back-up links…in the event that one of the primary radio links…were to fail." Ganz, 3:57-58. Ganz's network of WBRCs facilitates "[a] method of routing data," which includes "using a

forwarding engine TCP/IP stack to route data packets via a packet exchange bus" and "monitoring data packets for the purpose of accounting." Ganz, 2:66-3:7.

69. The procedures for routing and relaying communications between WBCRs and user devices, controlling packet scheduling, and switching to backup channels disclose a "*method of controlling a wireless mesh network*."

b. [1.1] *a) configuring the wireless mesh network with a first configuration, the wireless mesh network comprising a plurality of relay nodes, each of the relay nodes being capable of relaying traffic from a child node associated with the relay node,*

70. Ganz discloses this limitation.

71. The '952 patent describes the "*configuration*" of the wireless network as the topology or overall structure of the network (e.g., "star configuration"), including how the nodes of the network are arranged for routing data between them:

> FIG. 1 illustrates a wireless network in **star configuration**, with low latency but poor throughput according to an embodiment of the present invention;

'952 Patent, 4:41-43.

> By controlling the latency cost factor, or the upper bound of the max hops, the access server can change **the configuration** of the network resulting in a higher redundancy of the system and less likelihood of load congestion hot spots.

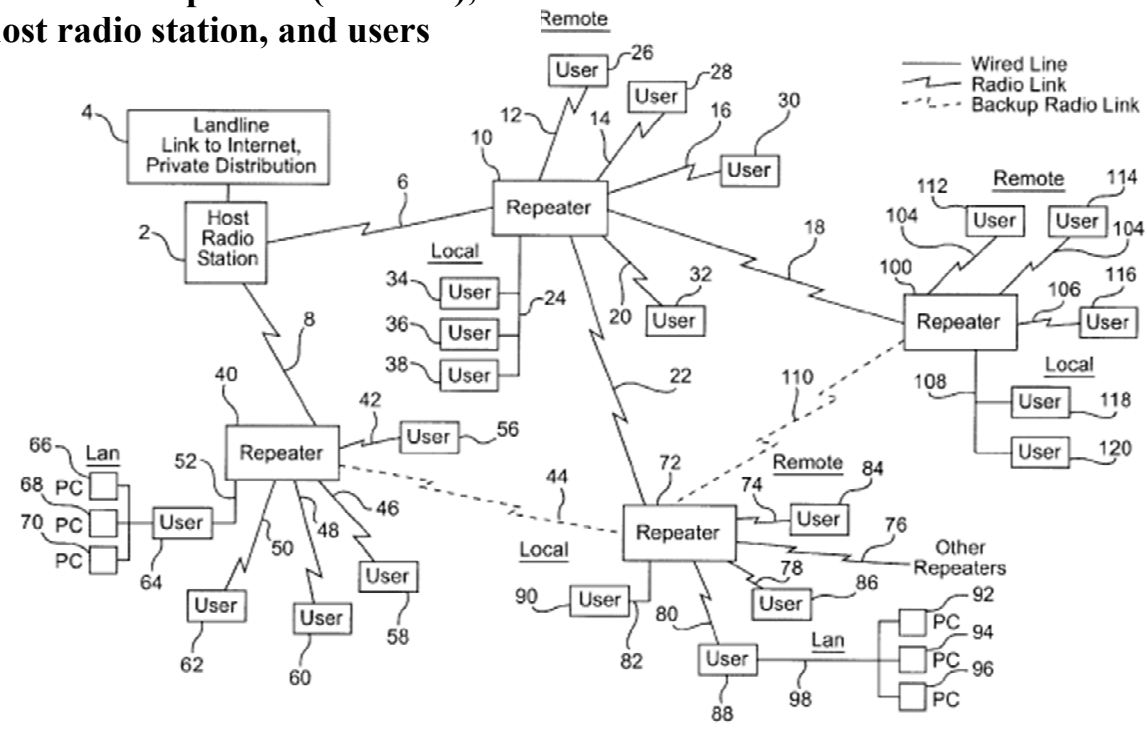
'952 Patent, 10:55-59.

> If it is assumed that, to ensure multiple routing paths, there are more nodes connected to the root, then the service cycle will be driven by the number of 1 hop nodes, in this case 5. Note that **the network configuration is set for high throughput**. In **this configuration** the worst service cycle is 5T. Ironically, the network configuration for a "low latency".

'952 Patent, 13:58-63.

72. Consistent with the '952 patent's disclosure of the "*configuration*" of a wireless mesh network, Ganz discloses a network of interconnected repeaters (WBCRs) that are arranged in multiple scalable segments to provide data communications between users and a host radio station.

"*wireless mesh network*" including interconnected repeaters (WBCRs), a host radio station, and users



Ganz, FIG. 1 (annotated)

73. Referring to FIG. 1, Ganz describes a "WBCR deployment scheme" that includes a network of WBCRs configured to facilitate wireless communications between remote users and a "land line link" (e.g., the Internet):

> Deployment of the WBCR scheme includes: a host radio station 2, a land line link 4, a WBCR 10, a remote user 26, a physical data line 24, and a local user 34.
>
> **The host radio station 2**, provides data communications from the land line link 4 (**i.e., Internet** or other private distribution data sources) **to users 26 remotely located from the host radio station 2, by a network of WBCRs 10, 100, 72, 40**. Each WBCR 10, 100, 72, 40 provides local access to users 26-32 within line-of-sight 12 of the

> WBCR 10, as well as local users 34-38 which are connected by a physical data line 24 to the WBCR 10.
>
> In addition, the WBCR 10 serves as a relay for WBCRs 100, 72, and 40, which serve further remote users 112-120 and 84-90 beyond the line-of-sight of both the host radio station 2 and WBCR 10. Other WBCR sites 76 can also be sequentially connected to WBCR 10,100,72,40 within the deployment scheme.

Ganz, 3:36-53.

74. Ganz's explains that the arrangement of the network is "constructed":

> A wireless high speed data communication system constructed in accordance with one form of the present invention includes a host radio station connected to a source of data. The host radio station transmits and receives data to and from at least one wireless communication repeater within line of sight of the host radio station. The repeater is configured to communicate with at least one end user by either a direct electrical connection or a wireless connection. The repeater may also transmit and receive data to another repeater within its line of sight yet beyond the line of sight of the host radio station. The data source, connected to the host radio station, can be private data or data accessed and/or delivered to the Internet.

Ganz, 2:43-55.

75. Ganz discloses that the repeaters have back-up links 44, 110 with other repeaters that "can be established…in the event that one of the primary radio

links 18, 22 were to fail." Ganz, 3:57-58. Establishing and/or switching to back-up links includes rearranging or reconfiguring a portion of the network.

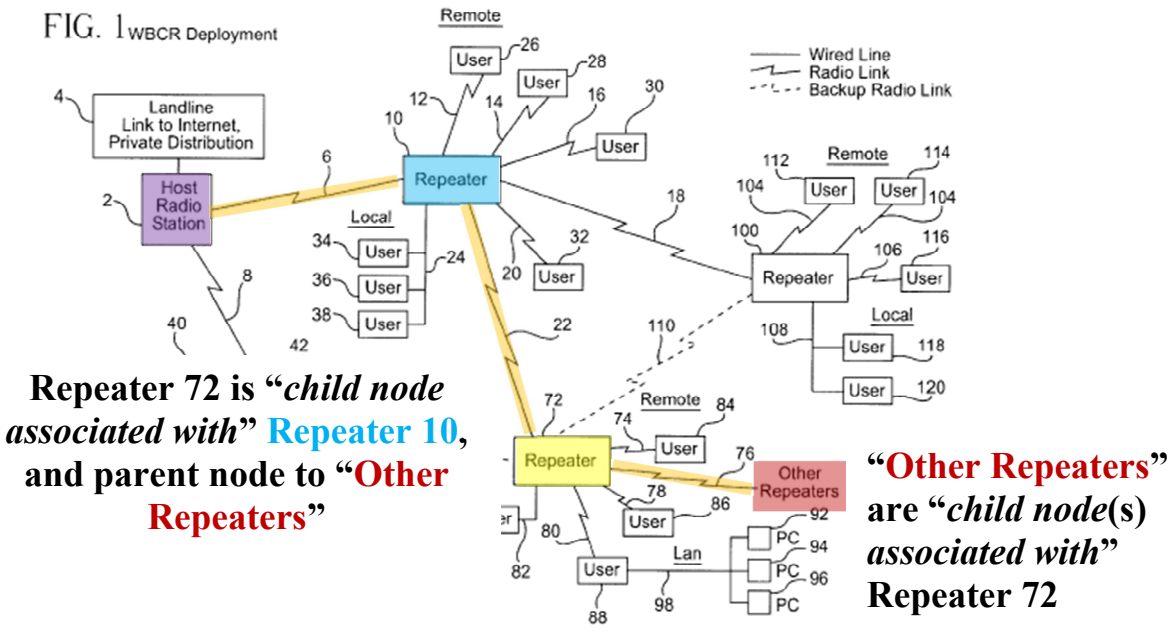
76. Thus, Ganz's construction of the wireless network, including deployment of repeaters facilitating wireless communications between remote users and the host radio station, and the establishment of back-up links in the event of a connection failure, discloses or renders obvious "*configuring the wireless mesh network with a first configuration*."

77. As explained above with respect to FIG. 1, Ganz's repeaters (WBCRs) 100, 72, 40 relay communications from remote users to the repeater 10, which is connected to the host radio station 2:

> The host radio station 2, provides data communications from the land line link 4 (i.e., Internet or other private distribution data sources) **to users 26 remotely located from the host radio station 2, by a network of WBCRs 10, 100, 72, 40. Each WBCR** 10, 100, 72, 40 **provides local access to users 26-32** within line-of-sight 12 of the WBCR 10, as well as local users 34-38 which are connected by a physical data line 24 to the WBCR 10.
>
> In addition, the WBCR 10 serves as a **relay** for WBCRs 100, 72, and 40, which **serve further remote users 112-120 and 84-90** beyond the line-of-sight of both the **host radio station 2** and WBCR 10. Other WBCR sites 76 can also be sequentially connected to WBCR 10,100,72,40 within the deployment scheme.

Ganz, 3:39-53.

78. As FIG. 1 shows, the repeater 72 is a "*child node*" of the repeater 10, because it communicates upstream to the host radio station through the repeater 10. Further, the repeater 72 may be a parent node to "Other Repeaters" that may be added downstream (further from host radio station 2).



Ganz, FIG. 1 (partial annotated)

79. Thus, Ganz discloses that each of the repeaters ("*relay nodes*") is "*capable of relaying traffic from a child node associated with the relay node.*"

80. Accordingly, Ganz discloses this limitation.

c. [1.2] *each of the relay nodes including a first radio interface configurable to relay traffic to a parent relay node and a second dual purpose radio interface*

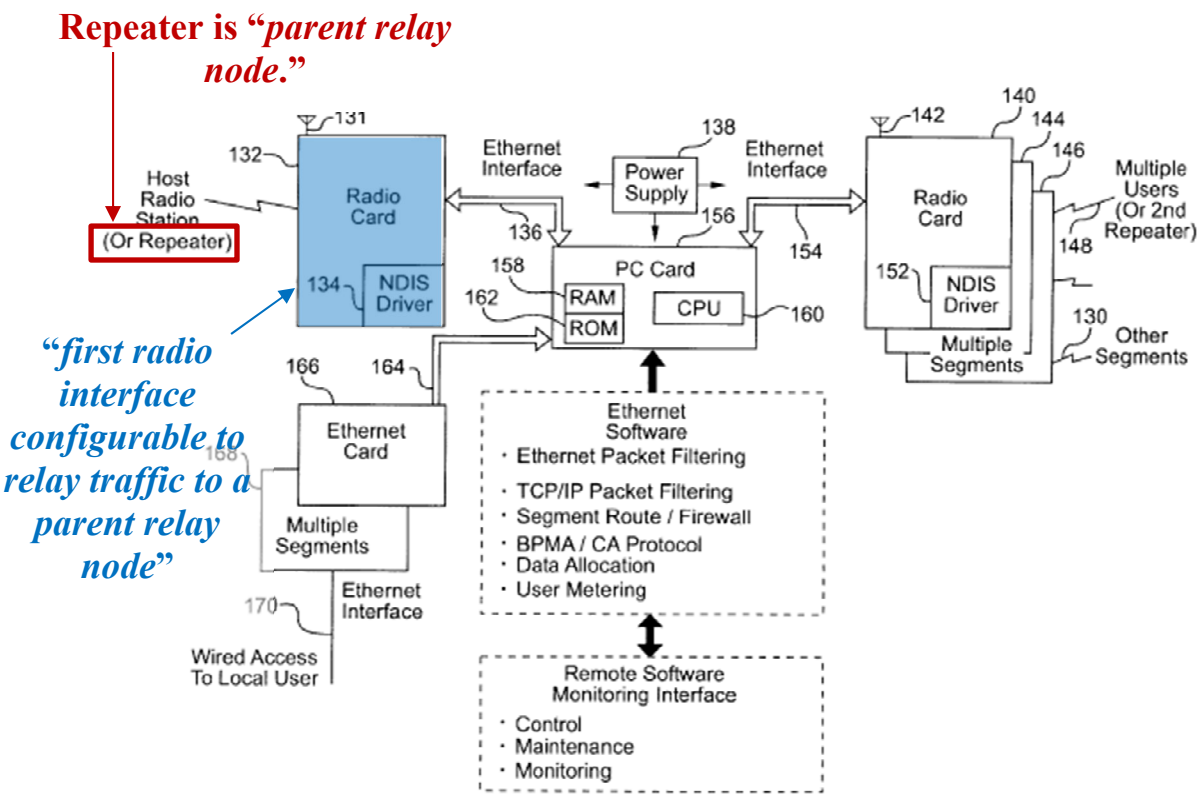
configurable to both relay traffic from the child relay node and to communicate with a client node that is not a relay node,

81. Ganz discloses this limitation.

82. Ganz explains that all WBCRs are configured with the same general radio architecture and software configuration shown in FIGS. 2-5. *See* Ganz, 3:64-66, 6:4-10, 10:41-43, 12:53-55. Thus, as further explained below, Ganz discloses "***each*** *of the relay nodes including a first radio interface…and a second dual purpose radio interface*."

i. "*a first radio interface configurable to relay traffic to a parent relay node*"

83. Ganz's FIG. 2 shows the architecture of each WBCR ("*each of the relay nodes*") with a radio transceiver circuit 132 ("*first radio interface*") for communicating with a "Host Radio Station (Or Repeater)" ("…*configurable to relay traffic to a parent relay node*").



Ganz, FIG. 2 (annotated)

84. Ganz explains that the radio transceiver circuit 132 ("*first radio interface*") "provides the radio frequency link to a host radio station and, optionally, to one or more repeaters." Ganz, 4:8-10. Further, Ganz makes clear that upstream communications (e.g., from repeater to host station) are made using the radio transceiver circuit 132 ("*first radio interface*"), and that downstream communications to the "user side" (e.g., from repeater to user) are made using the **second** radio transceiver circuit 140:

> The WBCR functions, such that the data packets **coming from the user side**, are received by the second radio transceiver circuit 140 and then

> temporarily buffered in the RAM circuit 158 before being retransmitted by the radio transceiver circuit 4 to the host radio station. Alternatively, when a data packet comes in from the host radio station, it can be directed to a local user at the WBCR site, by the local Ethernet card interface 170. The WBCR functions as a full data rate communications system. The full data stream transfer is accomplished by **receiving data packets from the host radio station, temporarily buffering the data packets in the RAM circuit 158 and <u>transferring the data packets to the second radio transceiver circuit 140 (user side),</u>** where the data packets are then transmitted to the user.
>
> The WBCR "reads" each data packet in transit and directs it to the appropriate segment (i.e., out to the user radio link side, or to a user local to the repeater site via the Ethernet card).

Ganz, 4:21-39.

85. Thus, Ganz discloses that the radio transceiver circuits 132, 140 are configured to communicate on different "sides" (i.e. upstream or downstream), and that each WBCR passes data from one radio transceiver circuit to the other to get the data to the next "hop" or segment.

86. A POSITA would have therefore understood that the radio transceiver circuit 132 is used for communicating in the upstream (or "uplink") direction toward the host radio station 2, or with one or more repeaters in the upstream direction toward the host radio station 2. Thus, Ganz discloses or at least renders obvious the radio transceiver circuit 132 being "*configurable to relay traffic to a*

parent relay node." For instance, because the repeater 72 in FIG. 1 does not have a direct connection with the host radio station 2, it would have been obvious for the repeater 72 to use the radio transceiver circuit 132 to relay traffic to the repeater 10 ("*to a parent relay node*"), which receives, then in turn forwards, the traffic to the host radio station 2 using its own radio transceiver circuit 132.

87. Further, it would have been obvious for the radio transceiver circuit 132 to be configured for upstream communications and for the second radio transceiver circuit 140 to be configured to for downstream communications in light of Srikrishna. Similar to Ganz's separate radio transceiver circuits 132, 140, Srikrishna discloses using separate "wireless transceivers" for uplink (toward the root) and downlink (toward the client) communications:

> **Each** relay node can be equipped with **two (half-duplex) wireless transceivers, one for the "uplink" and one for the "downlink".** Each half-duplex transceiver is capable of receiving and transmitting, though not at the same time.

Srikrishna, 5:11-5:18.

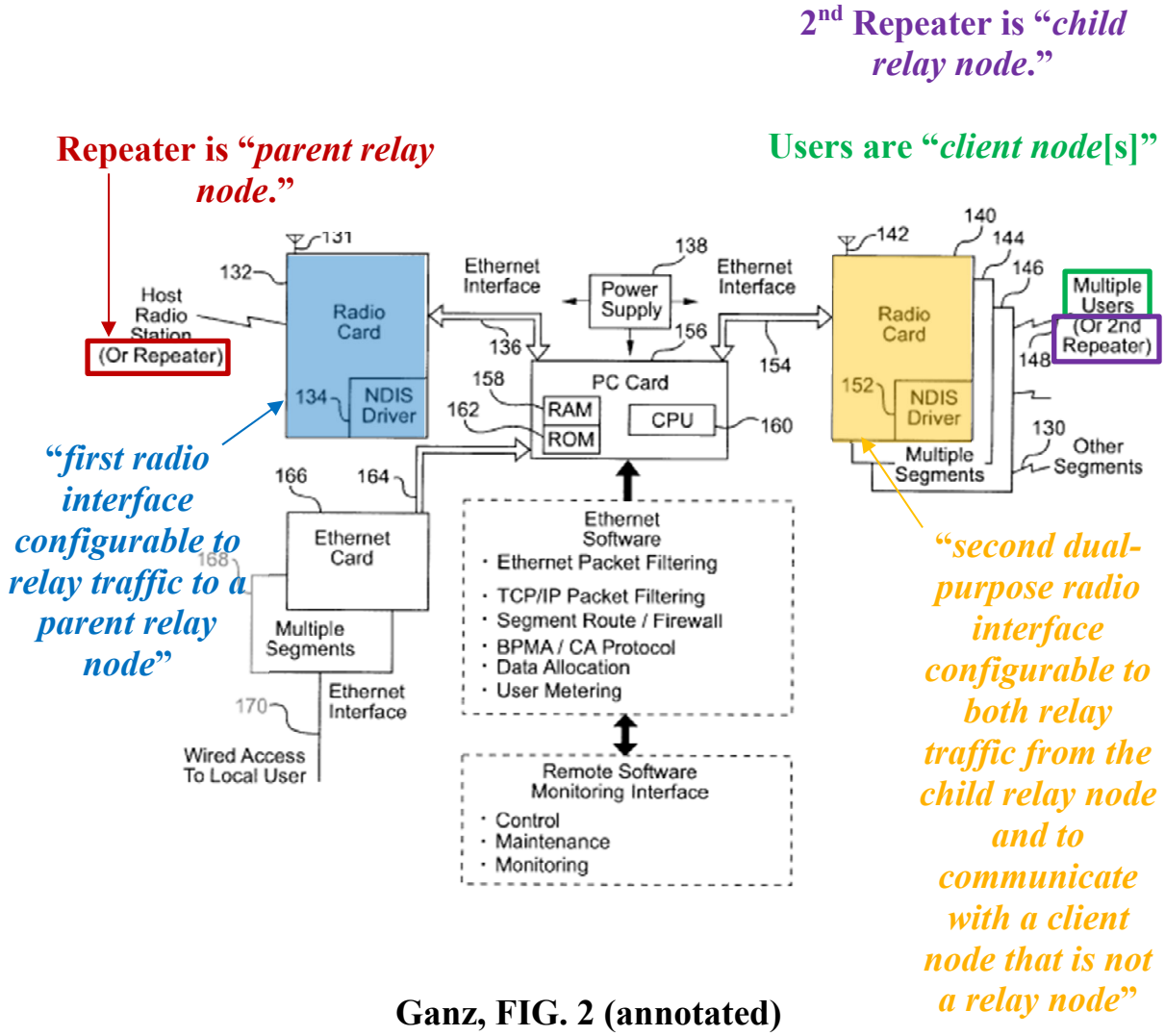
88. When two half-duplex receivers are used in this way, "one half-duplex transceiver can transmit, while the other one receives data." Srikrishna, 1:66-67. The two half-duplex transceivers "operate on distinct channels" to prevent one transceiver from interfering with the other. Srikrishna, 5:24-26.

89. Srikrishna explains that its channel allocation techniques using respective uplink and downlink transceivers reduce inter-node interference. *See* Srikrishna, 5:19-6:2 (explaining how half-duplex uplink and downlink transceivers address inter-node interference scenarios including the "one-third problem" and the "near-far problem").

90. Srikrishna provides additional implementation details for the radio transceiver configuration described in Ganz. It would have been obvious for Ganz's repeaters to use the "uplink" and "downlink" transceiver configuration disclosed by Srikrishna to allow for both transceivers to communicate at the same time, and to allow the "uplink" transceiver to maintain a stable and robust connection with its parent repeater, while allowing other downstream repeaters nodes and client nodes to access the repeater using the "downlink" transceiver. Srikrishna's uplink and downlink channel allocation details provide for effective reduction in several types of interference, including the "one-third problem" and the "near-far problem." A POSITA would have also appreciated that by reducing these types of interference, throughput can be increased, because there are fewer constraints on time resources than there would have been if devices on different "sides" of the repeater had to share the same channel.

ii. "*a second dual-purpose radio interface configurable to both relay traffic from the child relay node and to communicate with a client node that is not a relay node*"

91. As shown in FIG. 2, each WBCR also has a second radio transceiver circuit 140 ("*second dual-purpose radio interface*") that "provides multiple radio frequency access to remotely distributed **users and/or other WBCRs**" ("*configurable to both relay traffic from the child relay node and to communicate with a client node that is not a relay node*"). Ganz, 4:10-12.



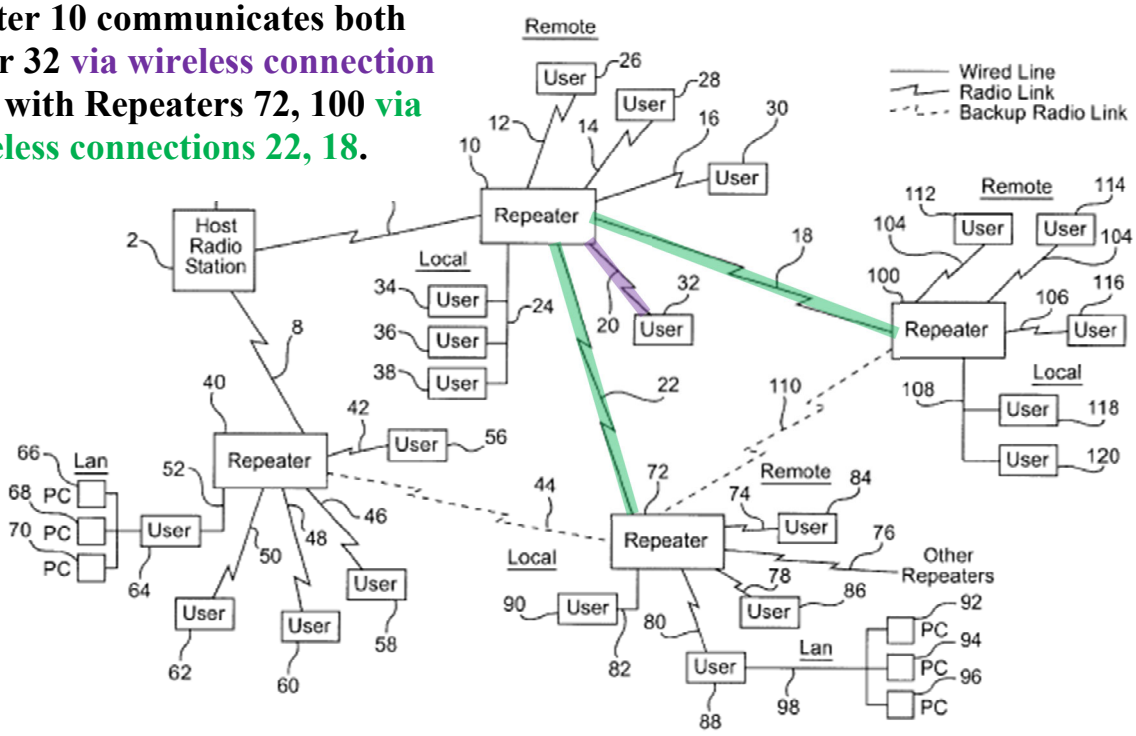
Ganz, FIG. 2 (annotated)

92. Because FIG. 2 shows the general architecture for all repeaters, regardless of their level in Ganz's network, it would have been obvious for the

"2nd Repeater" with which the second radio transceiver circuit 140 communicates to be a "*child relay node*." For instance, FIG. 1 shows that Repeaters 72, 100 are "*child relay node*[s]" to Repeater 10, and that "Other Repeaters" are "*child relay node*[s]" to Repeater 72.

93. Accordingly, Ganz discloses or at least renders obvious the repeater 10 having the architecture shown in FIG. 2, such that the second radio transceiver circuit 140 is a "*dual purpose radio interface*" configured for communications with the repeaters 72, 100, as well as the users (e.g., user 32).

Repeater 10 communicates both with user 32 via wireless connection 20, and with Repeaters 72, 100 via wireless connections 22, 18.



Ganz, FIG. 1 (annotated)

94. For the same reasons, it would have been obvious for the repeater 72, for instance, to include the second radio transceiver circuit 140 to communicate with users 74, 78, 80, and with the "Other Repeaters."

95. Thus, Ganz discloses or renders obvious "*each of the relay nodes including a first radio interface configurable to relay traffic to a parent relay node and a second dual purpose radio interface configurable to both relay traffic from the child relay node and to communicate with a client node that is not a relay node*."

d. [1.3] *and at least one of the relay nodes is configured in the first configuration to relay traffic from a child relay node to a parent relay node;*

96. Ganz discloses that the repeater 10 relays communications from the other repeaters (100, 72, 40) to the host radio station 2:

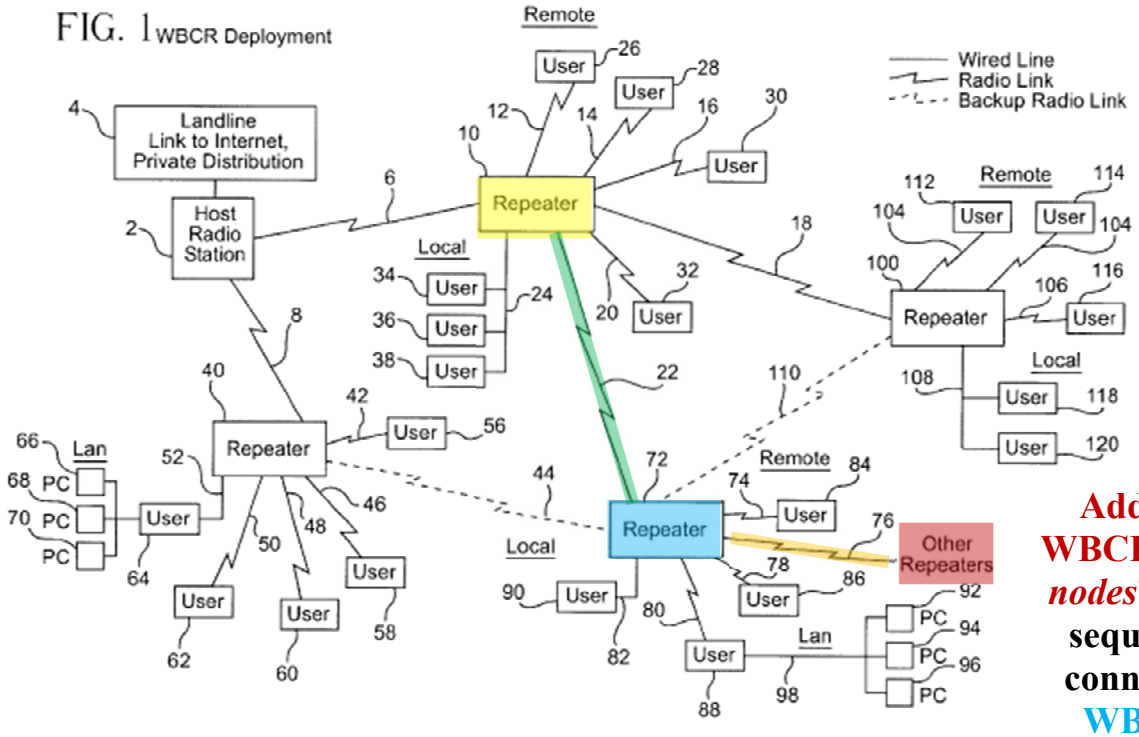
> the **WBCR 10** serves as **a relay for WBCRs 100, 72, and 40**, which serve further remote users 112-120 and 84-90 beyond the line-of-sight of both the host radio station 2 and WBCR 10.

Ganz, 3:47-50.

97. Ganz also teaches that the network is scalable such that additional repeaters can be "sequentially" added downstream of the repeaters 100, 72, and 40.

> **Other WBCR sites 76** can also be sequentially connected to WBCR 10,100,72,40 within the deployment scheme.

Ganz, 3:51-53.



Ganz, FIG. 1 (annotated)

98. In the network configuration shown in FIG. 1 ("*the first configuration*"), the "Other Repeaters" 76 are "*child relay nodes*[s]" to repeater 72, and the repeater 10 is a "*parent relay node*" to repeater 72. Accordingly, the repeater 72 is "*configured…to relay traffic from a child relay node*" via connection 76, and to relay the traffic to "*a parent relay node*" via connection 22.

99. Thus, Ganz discloses or at least renders obvious this limitation.

e. [1.4] *b) determining that a first one of the plurality of relay nodes in the wireless mesh network requires a channel selection change;*

100. Ganz alone, or Ganz in combination with Srikrishna, renders this limitation obvious.

101. Ganz's repeaters (WBCRs) are each configured to select and change their channels of communication. For instance, Ganz discloses that the each WBCR includes medium access control (MAC) circuitry to control "channel allocation procedures." Ganz, 6:29-31.

102. Ganz describes multiple scenarios that would lead a repeater to determine that a *channel selection change* is needed. For instance, Ganz discloses that when a primary wireless link fails, the repeater can use a back-up link with another repeater to continue communications:

> Because of a multiple access circuit within each WBCR, **back-up links 44 and 110 can be established between repeaters 40 and 72** in the event that one of the primary radio links 18, 22 were to fail.

Ganz, 3:55-58.

103. With respect to radio link "fail[ure]," Ganz's repeaters perform "regular automatic tests" to "confirm the **viability** of [a] specific link." Ganz, 12:22-25. When a link is determined to be non-viable, Ganz's techniques "allow reprogramming of the wireless link parameters." Ganz, 12:46-49. Ganz describes several well-known criteria for determining the viability of the link, including "lost packet percentages," "transmission times," and "throughput speeds." Ganz, 12:34-36, 5:51-54 (periodically measuring "[t]hroughput speeds and data packet drop rates" and "adjust[ing] the radio parameters" as appropriate).

104. It would have been obvious for the repeater, when switching to a back-up link with another repeater, to determine to change to the channel ("*channel selection change*") associated with that back-up link. A POSITA would have appreciated the obvious benefits and practicalities of configuring the back-up links to be on different channels than the channels used for the respective primary links. For instance, Ganz explains that different segments operated by a repeater use different frequencies to avoid interference:

> Overlapping and adjacent Segments can be accommodated by ensuring that **the center frequencies of each Segment are separated by at least 30 MHZ**. This requirement will enable only two overlapping or adjacent Segments to operate **with out interference**.

Ganz, 7:47-51; *see also*, 5:44 ("operating a new Segment on a different radio frequency").

105. Similarly, Ganz explains that full-duplex systems achieve simultaneous reception and transmission by using "one radio channel for reception and a second radio channel for transmission" to provide "necessary channel isolation." Ganz, 1:25-35. Thus, Ganz acknowledges what a POSITA would have well understood: that interference from neighboring nodes or segments can be easily prevented and reduced by using different radio channels for different links.

106. Additionally, the reason for the primary link failure would have likely been related to the conditions of that particular channel or frequency band, such as

interference. *See* Ganz, 12:45-49 (avoiding radio frequencies "susceptible to interference"). A POSITA would have chosen to use a different channel for the back-up link to avoid the same interference issues on the primary link. Using different frequency channels also simplifies the network management and troubleshooting processes to identify and correct connection issues. Further, using a different channel for the back-up link would have prevented the repeater of the primary link and the repeater of the backup link from competing for the same limited frequency resources. This also would have allowed for a simpler, faster transition to the back-up link, because the repeaters would not have to contend for access to the channel or reconfigure the channel parameters for use on the back-up link.

107. Additionally, Srikrishna's disclosure demonstrates why it would have been obvious to use different frequency channels for back-up links and primary links. Srikrishna discloses additional channel allocation details relevant to the channel allocation in Ganz. Srikrishna's channel allocation procedures assign—and subsequently maintain—different channels for a node's uplink and downlink connections to minimize interference between nodes:

> A channel assignment scheme for a node in a wireless network is described. The method includes assigning a first channel to an uplink for a node, and assigning a second channel for a downlink for a node. The method further maintains the first channel and the second channel

> distinct from an uplink channel of a default gateway for the node. **By maintaining multiple channels that do not interfere with each other, <u>interference between nodes is minimized</u>**.

Srikrishna, 3:37-44.

108. Further, Srikrishna's channel allocation procedures assign and distribute frequency resources that reduce or prevent various types of interference that would result from assigning the same frequency to the uplink and downlink of a given node. *See* Srikrishna, 5:19-6:2. These problems include:

- The "One-Third Problem," which allows only one node in a chain of three nodes to transmit at any given time if the middle node uses the same frequency for uplink and downlink communications; (Srikrishna, 4:58-64) and

- The "Near-Far Problem," in which a node's transmitting half-duplex transceiver interferes with a receiving half-duplex transceiver on the same node if the same or overlapping frequencies are used. (Srikrishna, 5:20-25).

109. Thus, Srikrishna's channel allocation procedures illustrate that inter-node interference and conflicts can be significantly reduced by allocating different channels for different links, and especially for those links used by the same device (e.g., uplink and downlink), and for links that are spatially close to one another.

110. A POSITA would have found it obvious to use different channels for the primary and back-up links to achieve a more effective use of frequency resources in a wireless network. As Srikrishna explains, allocating the frequency channels in this way addresses various problems of self-interference and inter-node interference, including the "one-third problem" and the "near-far problem." Thus, Ganz renders obvious "*determining that…a channel selection change*" is required.

111. Additionally, because Ganz's repeaters are all similarly configured to perform channel allocation, link fail-over, automatic link testing, and to reprogram their respective wireless link parameters as a result, it would have been obvious for each and any one of Ganz's repeaters ("*a first one of the plurality of relay nodes*") to perform those procedures.

112. Thus, Ganz renders obvious any of the repeaters ("*a first one of the plurality of relay nodes*") "*determining*" that it "*requires a channel selection change*" to switch to the back-up link with another repeater. For instance, it would have been obvious for Ganz's repeater 100 to reprogram its wireless link parameters to switch to the back-up link 110 upon determining that its primary link 18 is not viable (e.g., based on packet loss rate or interference). As explained above, switching to the back-up link would have included "*determining*" to switch to the channel associated with the back-up link. *See* Ganz, 12:46-49.

113. Thus, this limitation is rendered obvious by Ganz alone, or by Ganz in view of Srikrishna.

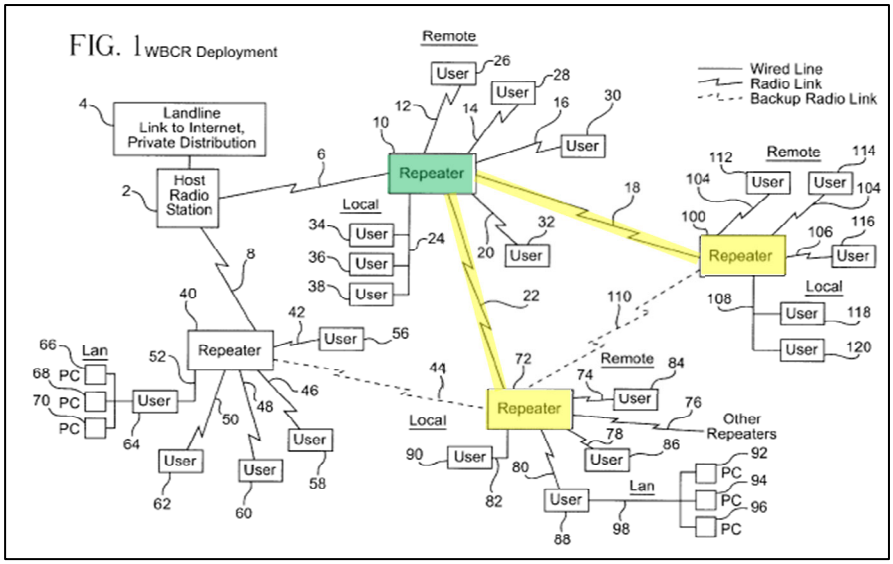
f. [1.5] *c) dynamically selecting a second one of the plurality of relay nodes in the wireless mesh network* to *form a parent-child relationship with the first relay node;*

114. As explained above, Ganz's repeaters are configured with "back-up links" that can allow the repeaters to continue communication in a different topology in the event of a failure of a primary radio link:

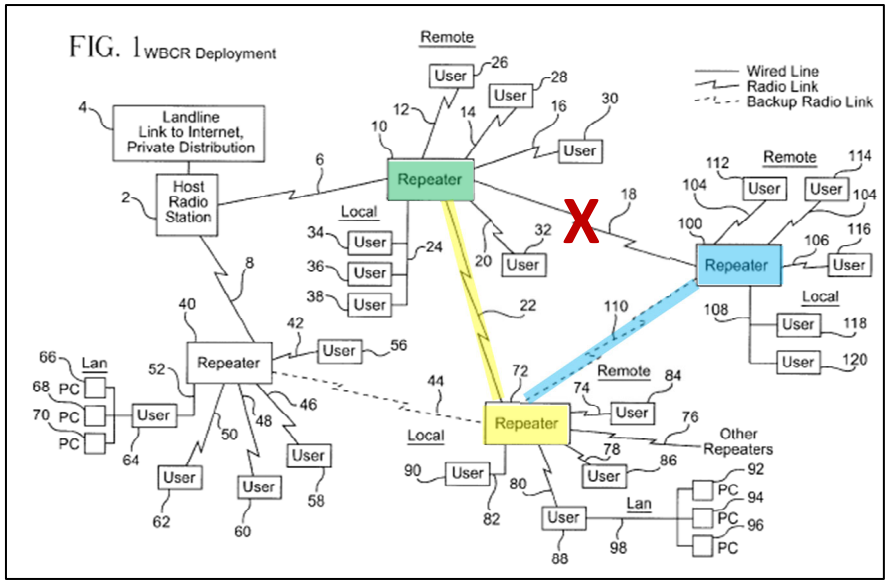
> Because of a multiple access circuit within each WBCR, **back-up links 44 and 110 can be established between repeaters 40 and 72** in the event that one of the primary radio links 18, 22 were to fail.

Ganz, 3:55-58.

115. As shown in FIG. 1 below, reestablishing communications using back-up link 110 *dynamically* changes repeaters 72 and 100 from a "sibling" relationship (both directly connected to repeater 10) to a "*parent-child relationship*," because communications to/from Repeater 72 must be relayed through Repeater 100.



Repeaters 72, 100 are "siblings" via connections 22, 18 to Repeater 10



Repeater 100 becomes "*child*" of Repeater 72 when connection 18 fails

Ganz, FIG. 1 (annotated)

116. In the scenario above, either of the repeaters 72, 100 may be mapped to the "*first relay node*" or the "*second relay node*," respectively.[1] In the quote

[1] I understand the term "*a first one of the plurality of relay nodes*" in limitation [1.4] (step "b") to provide antecedent basis for "*the first relay node*" recited in

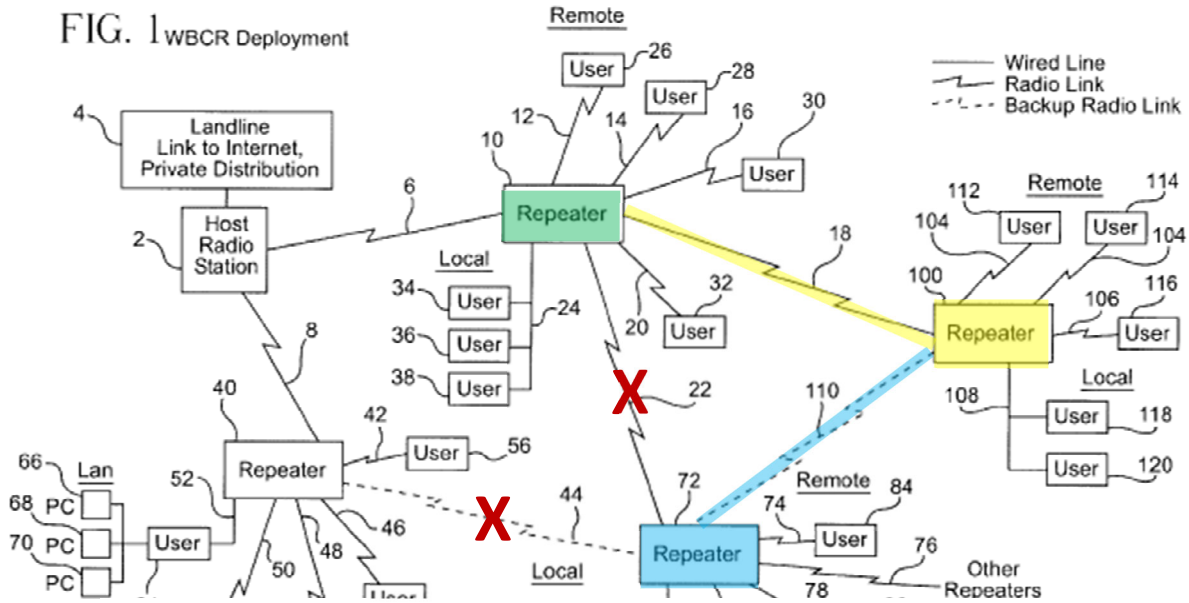
above, Ganz explains that "each WBCR" has this back-up link functionality. Therefore, the WBCRs (repeaters) switching to a back-up link between them includes "*selecting*" one of the WBCRs to be the "*parent*" and the other WBCR to be the "*child*."

117. In another example, it would have been obvious for the repeater 72 to select between multiple back-up link options when its connection with repeater 10 fails. As illustrated below, repeater 72 has two different back-up link options in the event that its primary link 22 with repeater 10 fails: link 44 and link 110. The repeater 72 may first attempt to switch to the backup link 44, as that link has fewer hops back to the host radio station. However, a POSITA would have understood that network conditions may vary and the viability or availability of a link is not a given. If the back-up link 44 for some reason is not available, was never established, or a connection request was unsuccessful, it would have been obvious for the repeater 72 to select the other back-up link 110, instead of back-up link 44. At the very least, this would have been obvious to try because there are only two options for backup links. A POSITA would have appreciated that having multiple

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limitation [1.5] (step "c"). However, as all of Ganz's repeaters are similarly configured, different repeaters (e.g., 72, 100) may be mapped to the "*first relay node*."

back-up link options provides additional redundancy to address the types of link failures that Ganz's fail-over procedures are meant to facilitate.



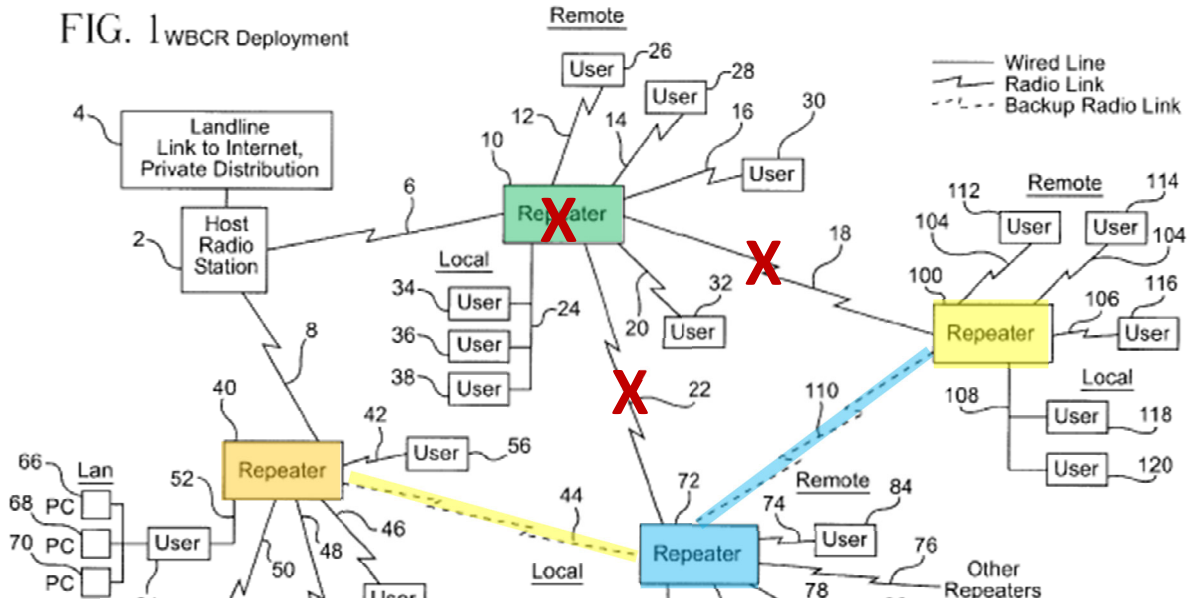
Repeater 72 selects back-up link 110 and becomes "*child*" of Repeater 100 when connection 22 fails and back-up connection 44 is unavailable

Ganz, FIG. 1 (annotated)

The change in relationship is made "*dynamically*" because it is made "**in the event that** one of the primary radio links 18, 22, were to fail." Ganz, 3:57-59.

118. In yet another example, shown in the figure below, the repeater 10 (green) may become non-operational or unavailable entirely. For instance, the repeater 10 may lose power and/or its link 6 with the host 2. In this example, both the repeaters 72 (blue) and 100 (yellow), while initially siblings, may each

establish their back-up links 44, 110 to connect to the host 2 via the repeater 40 (orange).



Repeater 72 switches to back-up link 44, and Repeater 100 switches to back-up link 110 to become "*child*" of Repeater 72 when Repeater 10 goes down

Ganz, FIG. 1 (annotated)

119. In the scenario above, the Repeater 100 dynamically becomes the "*child*" node of the repeater 72 when it switches to the back-up link 110.

120. Thus, Ganz discloses or renders obvious "*dynamically selecting a second one of the plurality of relay nodes in the wireless mesh network to form a parent-child relationship with the first relay node*."

g. [1.6] *d) making a channel selection change;*

121. As explained above with respect to limitation [1.4], Ganz, or Ganz in combination with Srikrishna, disclose or render obvious "*determining that a first one of the plurality of relay nodes in the wireless mesh network requires a channel selection change.*"

122. For the same or similar reasons Ganz, or Ganz and Srikrishna, render obvious "*making a channel selection change*." Each of the channel change procedures that Ganz and Srikrishna describe include "*making a channel selection change*" after *determining* that a repeater requires a change.

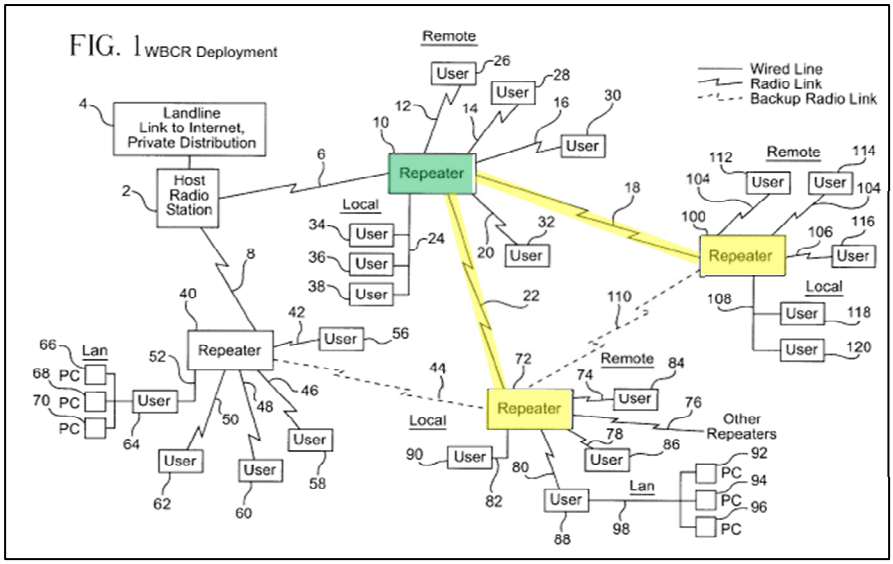
123. For example, Ganz discloses that the each WBCR includes medium access control (MAC) circuitry to control "reprogramming of the wireless link parameters" when a wireless link is determined to be non-viable. Ganz, 12:38-44, 5:51-54. Further, Ganz discloses that each repeater can establish a back-up link with another repeater if its primary radio link fails (and is therefore not viable). Ganz, 3:55-58. As explained above with respect to limitation [1.4], it would have been obvious for the back-up link to be on a different channel than the primary link. Thus, it would have been obvious for Ganz's repeater, upon failure of the primary link to determine to change to the channel of the back-up link, and then "*mak*[*e*] *a channel selection change*" to establish the back-up link.

124. In other words, switching to the back-up link, as explained by Ganz, would have included both "*determining that*" a repeater "*requires a channel selection change*," and then "*making a channel selection change*."

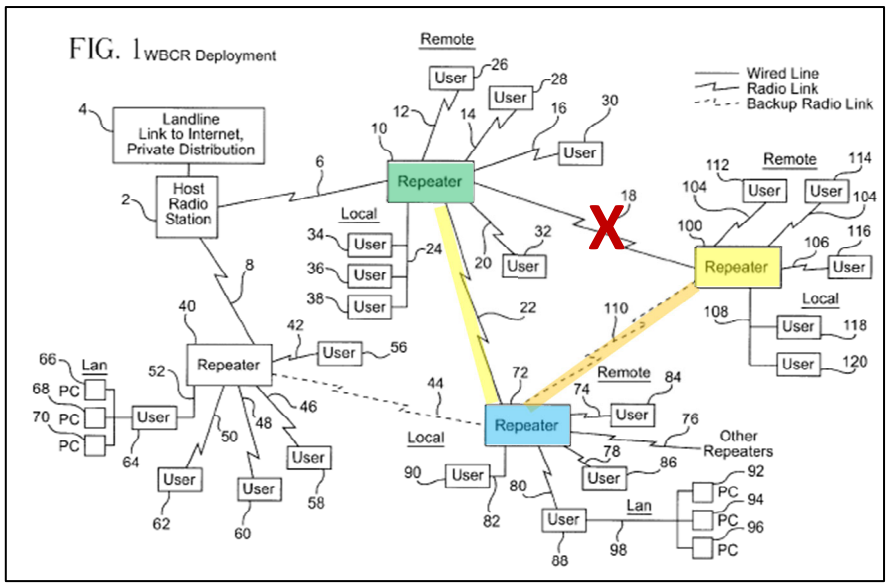
125. Thus, Ganz alone, or Ganz in combination with Srikrishna, renders obvious this limitation.

h. [1.7] *wherein prior to being dynamically selected, the second relay node was a sibling node of the first relay node;*

126. As explained above at [1.5], reestablishing communications using back-up link 110 and/or back-up link 44 changes Repeaters 72 and 100 from a "*sibling*" relationship (both directly connected to Repeater 10) to a "*parent-child relationship,*" because communications to/from Repeater 72 must be relayed through Repeater 100.



Repeaters 72, 100 are "*siblings*" via connections 22, 18 to Repeater 10



When connection 18 fails, Repeater 100 becomes "*child*" of Repeater 72 via back-up connection 110

Ganz, FIG. 1 (annotated)

i. [1.8] *and making a channel selection includes making a channel selection change to meet a performance requirement.*

127. Ganz, or Ganz in combination with Srikrishna, renders this limitation obvious.

128. I note that the first part of this limitation omits the word "*change*" ("*making a* ***channel selection*** *includes*…"), but the second part of the limitation adds the word "*change*" back in ("…*includes making a channel selection* ***change***…"). I understand limitation [1.8] to refer to the "*channel selection change*" features of limitations [1.4] and [1.6] discussed above, because it is a "wherein" clause that does not add a new step, and appears to recite additional details of a previously-recited step. My analysis of this limitation is not affected by this variation in wording, as the portions of Ganz and Srikrishna I cite to disclose both "*channel selection*" and "*channel selection change*."

129. As explained above with respect to limitation [1.6], Ganz's channel allocation, automatic link testing, and back-up link establishment procedures, as well as Srikrishna's channel allocation details, disclose or render obvious "*making a channel selection change*." As explained below, Ganz's "*channel selection change*" includes changing channels "*to meet a performance requirement*."

130. For instance, for automatic link testing, Ganz discloses that the repeaters perform automatic tests and take corrective measures when the "**viability** of the specific link" has failed. Ganz, 12:22-24. Ganz further explains that a repeater may respond to a link failure with its uplink node by establishing a back-up link.

> Because of a multiple access circuit within each WBCR, **back-up links 44 and 110 can be established between repeaters 40 and 72** in the event that one of the primary radio links 18, 22 were to fail.

Ganz, 3:55-57.

131. Link viability is a *performance requirement*. A POSITA would have understood that the most fundamental and obvious requirement of a wireless link is that it is usable and meets some minimum threshold of reliability or performance. For instance, Ganz explains that link viability may be tested using various metrics and corresponding thresholds including throughput and packet loss percentages, and throughput. Ganz, 8:24-25 (threshold throughput for performance is "at least 1.5 Mb/s"), 12:31-38 ("Lost packet percentages of up to 10 percent will provide adequate performance"). Thus, Ganz provides multiple examples of criteria for assessing link viability, but a POSITA would have appreciated that additional criteria are available. For instance, Srikrishna explains that "link quality is estimated by the **latency** observed on the link." Srikrishna, 14:43-44. A POSITA would have appreciated that a combination of criteria may be used to determine link viability, which would have been particularly helpful to support different traffic types having different needs and susceptibility to failure. For instance, Ganz contemplates that data applications like voice require real time service that would be significantly degraded by increased latency. Ganz, 11:14-20 ("**real-time** applications such as voice and video" requires a "specific QoS," including

"maximum end-to-end delay"). A POSITA would have appreciated that link quality (or degradation thereof) manifests in different ways, and that some metrics are more relevant than others depending on the type of data traffic being communicated.

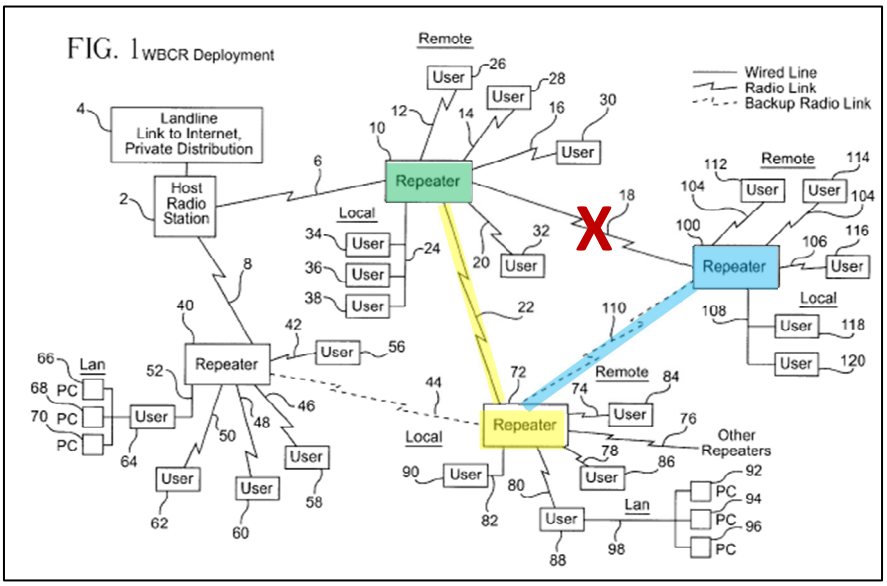
132. It would have been obvious for a repeater to identify a link failure using any of the criteria disclosed by Ganz and/or Srikrishna (e.g., throughput, latency, lost packet rates), and to take "corrective steps" by switching to the back-up link on a different channel. Thus, Ganz discloses or at least renders obvious switching to the back-up link selectively, that is, only when the network performance failed to meet a *performance requirement* (e.g., the "viability of the specific link" has failed). Ganz, 12:22-24. In other words, when the network performance meets needs or expectations when a repeater is using the primary link, and therefore the primary link is viable, there would be no need for establishing a back-up link, or for taking other "corrective action," such as adjusting radio parameters.

133. Thus, switching to a back-up link in response to identifying a link failure, as measured by any of Ganz's link testing criteria, discloses or renders obvious "*making a channel selection change to meet a performance requirement*."

2. Claim 2

a. [2.0] *A method as recited in claim 1, wherein the second node is selected to be a parent node of the first node.*

134. As explained above, either of Ganz's repeaters 100, 72 can be mapped to the "*first node*," or the "*second node*." A first example is shown below, where the Repeater 72 is the "*second node*" and the Repeater 100 is the "*first node*.".



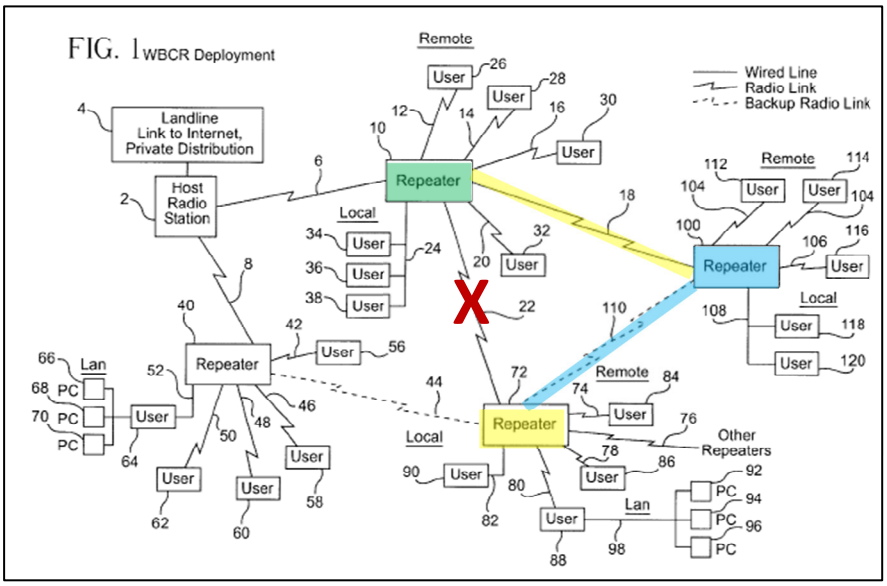
Repeater 72 ("*second node*") becomes "*parent node*" of Repeater 100 ("*first node*") when connection 18 fails

Ganz, FIG. 1 (annotated)

135. In the example above, the primary link 18 fails, and the backup connection 110 is established. Thus, Ganz discloses or renders obvious the repeater 72 ("*second node*") being "*selected to be a parent node*" of the repeater 100 ("*first node*").

136. In another example shown below, primary link 22 may fail, and the repeater 72 may establish the backup connection 110 with the repeater 100. For

instance, as explained above, the repeater 72 may first attempt to establish the back-up link 44, but the back-up link 44 may not be available. *See* Ganz, 12:22-24, 38-39 (repeaters perform regular automatic testing of radio links to confirm their viabilities, "problem links" are avoided). In this example (shown below), the repeater 100 is the "*second node*" and the repeater 72 is the "*first node*."



Repeater 100 ("*second node*") becomes "*parent node*" of Repeater 72 ("*first node*") when connection 22 fails

Ganz, FIG. 1 (annotated)

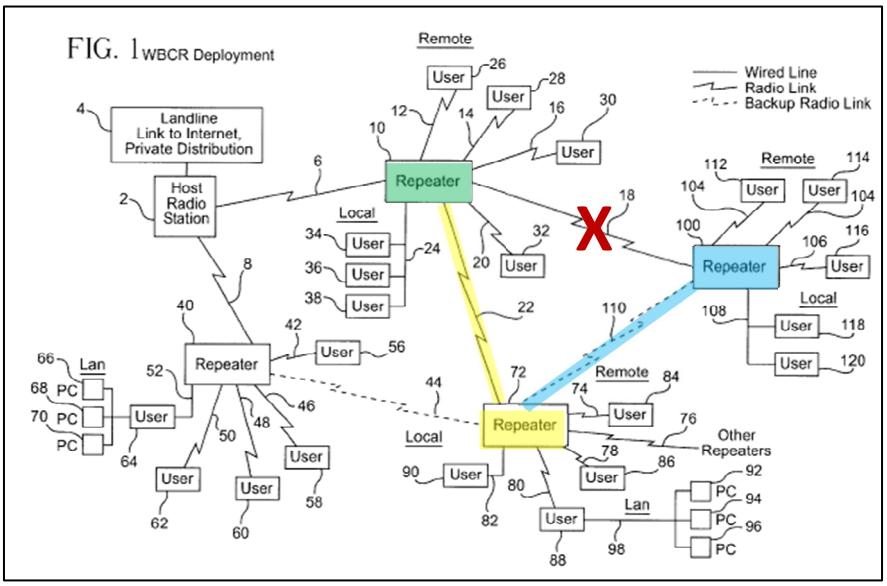
137. It would have been obvious for the repeater 72 to try the second back-up link 110 if the first back-up link 44 is unavailable, or if the second back-up link 110 provides a superior link quality than the first back-up link.

138. Thus, Ganz discloses or renders obvious this limitation.

3. Claim 3

a. [3.0] *A method as recited in claim 1, wherein the second node is selected to be a child node of the first node.*

139. As explained above, either of Ganz's repeaters 100, 72 can be mapped to the "*first node*," or the "*second node*." A first example is shown below, where the Repeater 100 is the "*second node*" and the Repeater 72 is the "*first node*."



Repeater 100 ("*second node*") becomes "*child node*" of Repeater 72 ("*first node*") when connection 18 fails

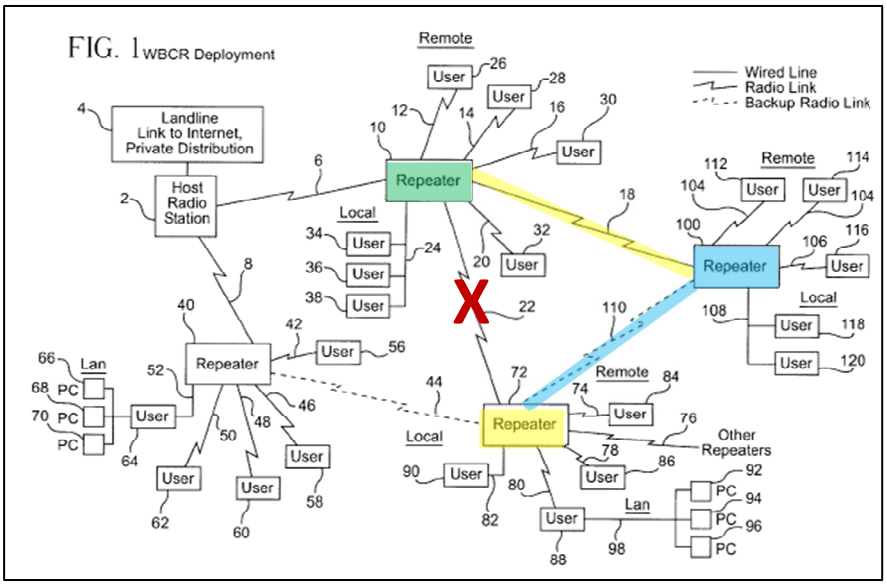
Ganz, FIG. 1 (annotated)

140. In the example above, the primary link 18 fails, and the backup connection 110 is established. Thus, Ganz discloses or renders obvious the repeater

100 ("*second node*") being "*selected to be a parent node*" of the repeater 72 ("*first node*"). [2]

141. In another example, primary link 22 may fail, and the repeater 72 may establish the backup connection 110 with the repeater 100. For instance, as explained above, the repeater 72 may first attempt to establish the back-up link 44, but the back-up link 44 may not be available *See* Ganz, 12:22-24, 38-39 (repeaters perform regular automatic testing of radio links to confirm their viabilities, "problem links" are avoided). In the example shown below, the repeater 72 is the "*second node*" and the repeater 100 is the "*first node*."

[2] I note that Ganz, or Ganz in combination with Srikrishna, renders obvious the limitations of claim 1 and its dependents whether or not there is a causal relationship between the step of "*determining that a first one of the plurality of relay nodes in the wireless mesh network requires a channel selection change*," and the step of "*dynamically selecting a second one of the plurality of relay nodes in the wireless mesh network* to *form a parent-child relationship with the first relay node*." For instance, if the claims are interpreted to include scenarios where there is no causal relationship between those steps, claim 3 is obvious at least because Ganz discloses that repeater 100 and repeater 72 may switch to their respective back-up links at any time if their primary links fail.



Repeater 72 (“*second node*”) becomes “*child node*” of Repeater 100 (“*first node*”) when connection 22 fails

Ganz, FIG. 1 (annotated)

142. Thus, Ganz discloses or renders obvious the repeater 100 (“*second node*”) being “*selected to be a parent node*” of the repeater 72 (“*first node*”).

143. Further, claim 3 is obvious for an additional reason. A POSITA would have appreciated, in the first example scenario illustrated above, that the repeaters 10 and 72 would have experienced an increase in data traffic on the link 22, as the repeater 72 would now be sending its own traffic in addition to the uplink traffic of Repeater 100 on the link 22 (via back-up link 110). A POSITA would have appreciated that such a sudden increase in traffic and supported users may render a link that was previously suitable, unsuitable, because the increased traffic would resulted in a more substantial user of the link’s “capacity” or similar capabilities. Ganz discloses multiple contexts and mechanisms by which a repeater may

respond when one of its links faces an increase in connected devices and/or an amount of data traffic.

144. First, Ganz discloses that an increase in data traffic that approaches or exceeds its "capacity" requires the repeater to offload some of the traffic onto a different segment, which may be performed by creating "new segment[s]" (e.g., with a different radio transceiver circuit). Ganz, 5:33-39. For instance, Ganz's repeaters make a new segment when an existing segment has "a high volume of users that significantly exceed a 2-5% loading factor." Ganz, 5:33-35. The new segment "operat[es]…on a **different radio frequency**." Ganz, 5:43-44.

145. Second, Ganz also teaches that the repeaters' "controlling functions…provide for remote dynamic **load balancing** among the users" based on those results. Ganz, 5:54-56. The "load balancing mechanism is used for optimizing the total system throughput," including creating "bandwidth on demand, by routing **excess traffic** through links that would otherwise be underutilized." Ganz, 12:12-22.

146. It would have been obvious for the repeater 72, due to the increased traffic and/or volume of users when the repeater 100 ("*second node*") is *selected to be a child node of* the repeater 72 ("*first node*"), to determine to switch to the back-up link 44 ("*channel selection change*"). Ganz, 5:33-37. For instance, it would have been obvious for the repeater 72 to identify the back-up link 44 based on the

link being "underutilized," using or allowing "aggregated bands," or having excess capacity to take on the additional traffic.

147. Thus, Ganz discloses or renders obvious this limitation.

4. Claim 5

a. [5.0] *A method as recited in claim 1, wherein making a channel selection includes making a channel selection change to meet a throughput requirement.*

148. Ganz discloses or renders obvious this limitation.

149. As explained above with respect to limitation [1.8], Ganz renders obvious switching to a back-up link on another channel ("*making a channel selection change*") based on throughput measurements. As explained above with respect to limitation [1.8] and claim 4, it would have been obvious for Ganz to use criteria like throughput or latency to determine whether a link is not "viable," and has therefore "failed." Ganz's repeaters may have specific throughput targets (e.g., "at least 1.5 Mb/s"). Ganz, 12:18-19. Various modes of link failure (e.g., equipment failure, interference on channel, out of range) would have been observable by, for instance, a significant drop in throughput. Ganz explicitly states that throughput is a target criteria for network performance, and provides mechanisms for "optimizing the total system throughput," and assessing link quality based on specific throughput thresholds (e.g., "at least 1.5 Mb/s"). Ganz, 8:24-25, 12:18-19.

150. Additionally, as explained above with respect to limitation [1.4], switching to a different channel for the back-up link avoids interference and unnecessary competitions for frequency resources that would occur if the same frequency channel were used. Srikrishna explains that throughput can drop if another wireless node interferes with communications on a channel:

> The throughput of a chain of wireless links is limited at least by the…interference of the data transfer taking place between a pair of wireless devices.

Srikrishna, 3:55-64.

151. Further, "Self-interference" "prevents the bandwidth of communication in a chain of links from reaching the rate of a single link." Srikrishna, 3:65-4:3. Thus, the establishment of back-up links on different channels than their respective primary links facilitates the objectives of high throughput. *See, e.g.*, Ganz, 8:24-25 (throughput target of 1.5 Mb/s). Thus, changing to a different channel in order to switch to the back-up link is done "*to meet a throughput requirement*."

152. Accordingly, Ganz, or Ganz in combination with Srikrishna, renders obvious "*making a channel selection change to meet a throughput requirement*."

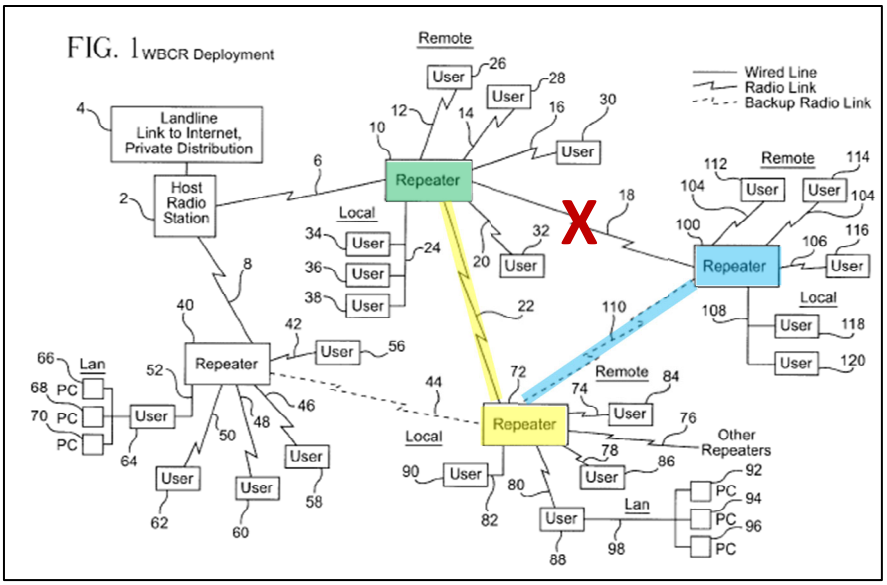
5. Claim 6

a. [6.0] *A method as recited in claim 1, wherein determining that the first node requires a channel selection change includes determining that the channel*

selection change is required due to a performance requirement change.

153. Ganz discloses or renders obvious this limitation.

154. A POSITA would have understood that an increase in traffic and connected devices in a segment of the network increases the throughput required by the WBCR at the top of the segment. For instance, if the repeater 72 becomes the parent node of repeater 100, as explained with respect to limitation [1.5] above, the repeater 72 would have significantly greater demands for throughput on link 22, because that link must now also handle the traffic that was previously communicated on link 18.



When connection 18 fails, repeater 72 becomes "*parent*" of repeater 100, and now supports the traffic of repeater 100's users

Ganz, FIG. 1 (annotated)

155. Thus, the increased throughput that repeater 72 needs to support is a "*performance requirement change.*" Ganz acknowledges that performance

requirements of a segment of the network (a link) can change, or vary from link to link. For instance, Gan explains that "the information throughput in each segment is preferably at least 1.5 Mb/s." Ganz, 8:24-25. However, Ganz also acknowledges that a "higher data transfer rate" may be needed, and that "data bandwidth can be increased beyond 1.5 Mb/s," or that "bands can be aggregated to provide much wider data transfer bandwidth within the WBCR." Ganz, 8:41-43. A POSITA would have appreciated that increased traffic on a link due to a topology change (e.g., repeater 72 switching to a back-up link), would be one such scenario that would have changed the *performance requirement* of the upstream link(s) going toward the host.

156. Ganz also acknowledges that different frequency bands can offer greater levels of bandwidth, which would have increased the amount of throughput supported on that link. For instance, Ganz explains that some frequency bands "can be aggregated to provide much wider data transfer bandwidth within the WBCR." Ganz, 8:36-43. Further, Ganz explains that some links are "underutilized," and therefore would have effectively offered better throughput, as fewer devices are competing for that link's resources. Ganz, 12:19-21

157. It would have been obvious for the repeater 72 to make "*a channel selection change*" for the link 22 to a channel that provides greater bandwidth. For

instance, Ganz explains that some frequency bands provide greater data bandwidth, and that frequency bands can be added to further increase data bandwidth:

> Additionally, the FCC allocates five overlapping frequency bands for spread spectrum radio operation, so that up to fifty different segments can coexist at the same time. Within a given FCC allocated band, **data bandwidth can be increased beyond 1.5 Mb/s** for higher data transfer rate, with fewer segments used. Additionally, **bands can be aggregated to provide much wider data transfer bandwidth within the WBCR**.

Ganz, 8:36-43.

158. It would have been obvious for the repeater to select an "underutilized" channel, a channel with aggregated bands, or to add additional bands (each of which includes "*making a channel selection change*") to achieve increased throughput. Thus, it would have been obvious for the repeater 72 to change to a channel ("*making a channel selection change*") to support the increased throughput requirements ("*due to a performance requirement change*") resulting from the establishing of backup link 110.

159. Thus, Ganz renders this limitation obvious.

6. Claim 7

a. [7.0] *A method as recited in claim 1, wherein determining that the first node requires a channel*

selection change includes determining that the channel selection change is required due to congestion.

160. As explained above for claim 6, Ganz's repeaters can make "new segment[s]" when one of its segments has "a high volume of users that significantly exceed a 2-5% loading factor." Ganz, 5:33-40; *see also*, 2:28-31. When Ganz creates a new segment, the new segment "operat[es]…on a **different** radio frequency." Ganz, 5:43-44. Thus, Ganz's creation of a new segment also includes making a "*channel selection change*."

161. A POSITA would have understood that a repeater's segment having a "high volume of users" that approaches or exceeds its capacity is at risk for "*congestion*," because the high volume of users and traffic may cause collisions, queueing, dropping of packets, or other network behaviors that adversely impact network performance. Thus, Ganz's creation of a new segment when traffic on one of its segments approaches capacity also discloses or renders obvious a repeater "*determining that the channel selection change is required due to congestion.*"

162. Additionally, Ganz describes periodically measuring "[t]**hroughput** speeds and data packet drop rates," and "adjust[ing] the radio parameters" based on those results. Ganz, 5:51-54. Based on the results of the "throughput" tests, Ganz also explains that the "controlling functions implemented as part of the BPMA/CA protocol provide for remote dynamic **load balancing** among the users." Ganz,

5:54-56. Ganz explains that the "load balancing mechanism is used for optimizing the total system **throughput**," including creating "bandwidth on demand, by routing **excess traffic** through links that would otherwise be underutilized." Ganz, 12:12-22. Similar to the "high volume of users" on a segment explained above, "excess traffic" on a link that has a greater load than other links discloses or renders obvious that the link would experience "*congestion*."

163. It would have been obvious for Ganz's ongoing channel allocation and load balancing features to include adjusting radio parameters, including the channel, to correct for unbalanced loads created by "*congestion*" on a segment of the network. Thus, Ganz's load balancing features also render obvious "*determining that the channel selection change is required due to congestion*."

7. Claim 8

a. [8.0] *A method as recited in claim 1, wherein the channel selection change is made to avoid channel interference.*

164. Ganz discloses or renders obvious this limitation.

165. As explained above with respect to limitations [1.4] and [1.6], Ganz's repeaters perform "regular automatic tests" and "reprogram[] wireless link parameters" to avoid interference. Ganz, 12:22-24, 42-43. As Ganz explains, some "RF frequencies [are] susceptible to interference from various sources," and "the

regular automatic tests also allow a more advanced scheme **for avoiding interference**." Ganz, 12:41-49.

166. A POSITA would have understood that interference on a link would have likely resulted in dropped packets and retransmission delays, which would have required retransmission of the data packets and increased delays. *See* Ganz, 4:46-49; §X.C.1 (discussing claim 4).

167. Srikrishna's disclosure further illustrates this point, and provides additional implementation details about channel allocation. Srikrishna discloses allocating different channels to adjacent links (uplink and downlink) minimizes interference between nodes:

> A channel assignment scheme for a node in a wireless network is described. The method includes assigning a first channel to an uplink for a node, and assigning a second channel for a downlink for a node. The method further maintains the first channel and the second channel distinct from an uplink channel of a default gateway for the node. **By maintaining multiple channels that do not interfere with each other, <u>interference between nodes is minimized</u>**.

Srikrishna, 3:37-44.

168. A POSITA would have understood that interference can further be avoided by configuring wireless links on nearby nodes, including nearby siblings, parent, and child nodes, to use different frequencies. Thus, switching to a different

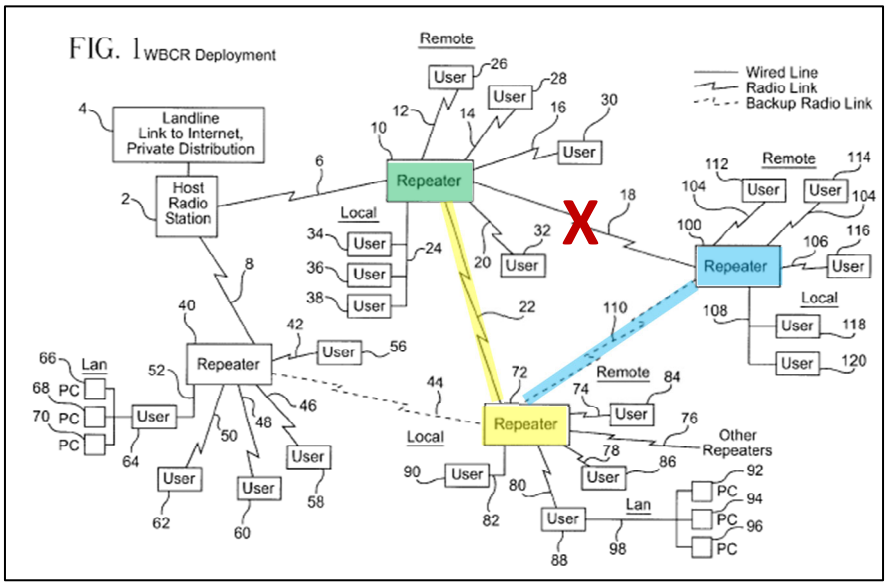
channel for an adjacent link (e.g., back-up links) would have avoided those problems because they "*avoid channel interference*."

169. Accordingly, Ganz, or Ganz in combination with Srikrishna, discloses or renders obvious "*wherein the channel selection change is made to avoid channel interference*."

8. Claim 9

a. [9.0] *A method as recited in claim 1, wherein the channel selection change is made based on a change to network topology.*

170. As explained above with respect to claim 1, Ganz's establishment of back-up links discloses or renders obvious "*making a channel selection change*" when a second repeater switches its uplink connection to a back-up link with the first repeater. *See* [1.4]-[1.6]. For instance, if the repeater 72 becomes the "parent node" of repeater 100, the repeater 100 switches its upstream channel from the primary link 18's channel with the repeater 10 to the back-up link 110's channel with the repeater 72. *See, e.g.*, Ganz, Fig. 1:



There is a "topology change" when repeaters 100, 72 establish back-up link 110. repeater 100's users

Ganz, FIG. 1 (annotated)

171. Switching to the back-up link 110 includes a "*change in network topology*" because the repeater 100 is now a child node of repeater 72, rather than the repeater 10. Further, switching to the back-up link 110 would have included making "*a channel selection change*" to the repeater 72's downlink channel for the link 110. Thus, Ganz discloses or renders obvious that the "*channel selection change is made based on a change to network topology*."

172. Thus, Ganz discloses or renders obvious "*wherein the channel selection change is made based on a change to network topology*."

9. Claim 10

a. [10.0] *A method as recited in claim 1, further comprising repeating b)-d).*

173. This limitation is disclosed by Ganz.

174. Steps (b)-(d) correspond to limitations [1.4]-[1.8] discussed above, and include:

> b) determining that a first one of the plurality of relay nodes in the wireless mesh network requires a channel selection change;
>
> c) dynamically selecting a second one of the plurality of relay nodes in the wireless mesh network to form a parent-child relationship with the first relay node; and
>
> d) making a channel selection change;

'952 Patent, claim 1.

175. As I explain above with respect to limitations [1.4]-[1.8], steps (b)-(d) are disclosed or rendered obvious by Ganz's disclosure of reprogramming wireless communication parameters based on "regular automatic tests" and switching to backup links when a primary link fails.

176. Ganz alone, or Ganz in combination with Srikrishna, either discloses or renders obvious "*repeating*" each of the procedures corresponding to steps b)-d).

177. **First**, Ganz discloses performing "**regular** automatic tests" to "confirm the viability" of a link. Ganz, 12:22-24, 38-49. Further, as explained above with respect to claim 7, Ganz discloses measuring throughput speeds "**periodically**" and "adjust[ing] the radio parameters," if necessary. Ganz, 5:51-54. Performing those procedures "regular[ly]" or "periodically" discloses or renders

obvious "*repeating*" those procedures. Thus, Ganz renders obvious "*repeating*" step (b).

178. Additionally, repeating step (b) is rendered obvious by Ganz in view of Srikrishna. Srikrishna further explains that a node will initiate a Downlink Channel Discovery Protocol "if **at any time** one or more of the channels allocated to its downlink does not satisfy" the conditions for efficient channel allocation (e.g., downlink channel must be different from uplink channel). Srikrishna, 12:10-14.

179. Thus, Ganz and/or Srikrishna disclose or render obvious repeating steps "*b) determining that a first one of the plurality of relay nodes in the wireless mesh network requires a channel selection change*" and "*d) making a channel selection change*."

180. **Second**, Ganz renders obvious repeating step (c). As explained above for limitation [1.5], Ganz's activation of back-up links 44, 110 due to a failed primary link (e.g., 18, 22) between nodes discloses the claimed step "*c) dynamically selecting a second one of the plurality of relay nodes in the wireless mesh network to form a parent-child relationship with the first relay node*"). *See* Ganz, 3:55-58.

181. Ganz further discloses that its "[r]adio segments are automatically tested **at regular intervals** to confirm the viability of the specific link." Ganz, 12:23-24.

182. Thus, Ganz at least renders obvious "*repeating*" (e.g., "at regular intervals") the step of "*dynamically selecting*" one of the repeaters "*to form a parent-child relationship with the first relay node*" based on regular or periodic radio link tests. A POSITA would have appreciated that radio link failures and backups are not single-use procedures, and that ongoing monitoring is necessary to ensure that communication failures are corrected. It would have been obvious for Ganz's repeaters to periodically monitor the primary radio links 18, 22 to determine whether the back-up links 44 or 100 need to be established. For instance, after a primary radio link (e.g., 18, 22) has been reestablished, a POSITA would have understood that additional failures would have been likely. It would have been obvious to use the same back-up links in the event of a second failure of the radio links 18, 22. This would be a "*repeat*" of step c.

183. **Third**, Ganz, alone and combined with Srikrishna, teaches repeating step (d). This follows from the evidence above described for step (b). In this regard, Ganz teaches performing "**regular** automatic tests" to "confirm the viability" of a link (Ganz, 12:22-24, 42-43), and switching to back-up links every time a link is no longer viable. Thus, it would have been obvious that the channel

selection changes taught by Ganz are repeated, because actually performing or executing the channel selection change would follow from the determination to make a channel selection change.

184. Moreover, since Srikrishna further teaches the channel manager instructing other channel managers to switch to a best channel, and the recipient channel manager makes the switch to the best channel—"periodically"—the combination with Srikrishna's additional teachings further renders obvious repeating step (d). *See* Srikrishna, 9:51-59, 11:61-67.

185. Thus, Ganz, or Ganz and Srikrishna, disclose or render obvious this limitation.

10. Claim 12

186. Claim 12 is an independent claim that recites a "*computer program product for controlling a wireless mesh network, the computer program product being embodied in a computer readable medium and comprising computer instructions for*" performing steps a)-d), which correspond to steps a)-d) of claim 1. Accordingly, claim 12 generally mirrors claim 1, but also specifies that steps a)-d) are performed as instructions of a "*computer program product being embodied in a computer readable medium*." As explained below, Ganz discloses, or at the very least renders obvious, that steps a)-d) are performed by executing instructions

of a "*computer program product being embodied in a computer readable medium*."

187. Ganz's Repeaters each include a "network control module" having computer processing circuitry that run instructions (embodied in firmware and software) stored on flash memory:

> The network control module (NCM) 202 is electrically coupled to the packet exchange bus (Xbus) circuit 200. The NCM circuit 202 includes the processor 204, the DRAM circuit 208, and the flash memory circuit 206. The processor 204 performs per-packet processing and is responsible for examining data packets from incoming ports, looking up a destination address and queuing the data packets to an appropriate port for transmission. The processor 204 also collects and maintains WBCR statistics…. **[T]he flash memory 206 stores firmware**, configuration data and statistics. The flash memory circuit 206 is partitioned into three areas and **stores WBCR software image**, configuration data, and boot sector data. Most of the flash memory circuit 206 is used to store the WBCR software image.

Ganz, 9:1-15.

188. The Repeaters use software to control communications between the Repeaters, and between the Repeaters and the host radio station:

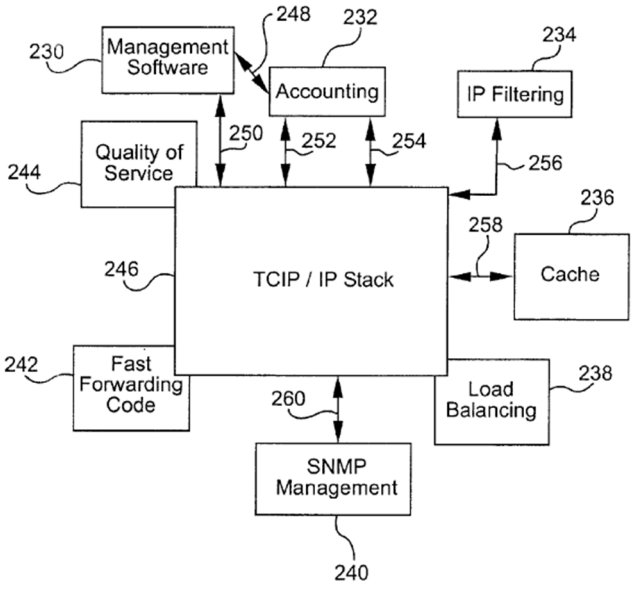
> Monitoring and control of the WBCR is achieved by **software** controlled radio/data communications, between a host radio station and the WBCR. This provides for radio link tests to be remotely conducted for each segment using a unique radio code assigned at a data link level.

Ganz, 5:47-51.

189. Ganz's FIG. 4 is a diagram of the various "software modules" that are used by the WBCRs for various networking functions, including QoS, network management, and load balancing:

> To further understand the present invention, FIG. 4 illustrates principal **software modules** and their inter-relationships. A central transmission control protocol/internet protocol (TCP/IP) stack 246, which provides software management features for appending software modules. The appended software modules are: quality of service (QoS)244, bandwidth accounting 232, IP filtering 234, fast forwarding 242, cache 236, management software 230, simple network management protocol (SNMP) 240, and load balancing 238.

Ganz, 10:42-51; *see also* 3:64-4:7 (FIG. 2 illustrates functional WBCR architecture including "a computer circuit 156 having a random access memory (RAM) circuit 158, a read only memory (ROM) circuit 162 and a processor 160."), 6:4-20 (FIG. 3 illustrates alternative WBCR architecture "using a combination of ASIC (application specific integrated circuit) and RISC (reduced instruction set computer)").



Ganz, FIG. 4

190. Thus, Ganz discloses that each repeater includes memory storing "software modules" that facilitate the various procedures correspond to the claimed steps b)-d), as explained above with respect to limitations [1.1]-[1.8]. This software is a "*computer program product for controlling a wireless mesh network, the computer program product being embodied in a computer readable medium and comprising computer instructions*."

191. With respect to claimed step a), each repeater includes the same architecture and software to coordinate with the other repeaters and to provide communication links between the users and the internet. Accordingly, the repeaters each include the same "*computer program product*," and individually and collectively facilitate the functions of step a), including "*configuring the wireless mesh network with a first configuration*."

192. Thus, for the reasons explained above, and for the reasons explained with respect to limitations [1.0]-[1.8], Ganz discloses all limitations of claim 12.

11. Claims 13, 14, and 16-20

193. Claims 13, 14, and 16-20 mirror the limitations of claims 2, 3, 5-7, 9, and 10. Other than the preamble, which I address above for claim 12, the steps or functional limitations of claims 13, 14, and 16-20 are disclosed or rendered obvious by Ganz, or by Ganz and Srikrishna, for the same reasons explained above with respect to claims 2, 3, 5-7, 9, and 10.

X. THE COMBINATION OF GANZ, SRIKRISHNA, AND BISHOP RENDERS OBVIOUS CLAIMS 4 AND 15

A. Summary of Bishop

194. U.S. Patent No. 6,377,782 to Bishop et al. ("Bishop") describes a "method of upstream communication over a linear broadband network," which includes wireless access interface devices in a wireless Local Area Network (LAN). Bishop, Abstract, 7:31-38. Bishop explains that a "subscriber access interface device" (SAID) on the subscriber premises is connected to a "network access interface device" (NAID) that serves as a gateway between a Wide Area Network (WAN) and the wireless LAN. Bishop, 7:33-39.

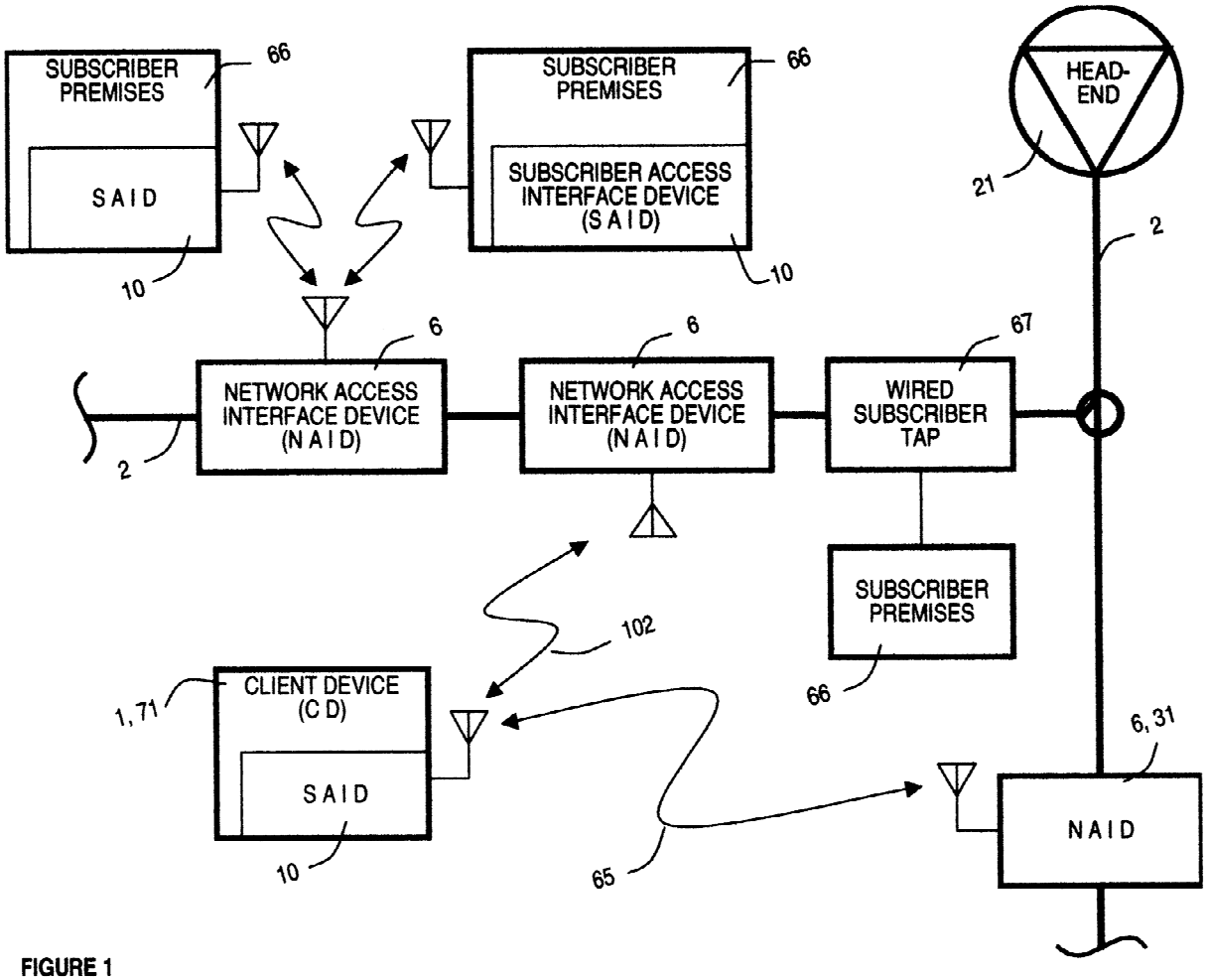


FIGURE 1

Bishop, FIG. 1

195. The SAID "receives upstream information from an initiating client device 1 and wirelessly relays it to the network access interface device 6." Bishop, 7:62-65. Bishop explains that the connection between the SAID and the NAID preferably follow the IEEE 802.11 wireless networking standard. Bishop, 12:58-61, 22:66-23:2, FIG. 3.

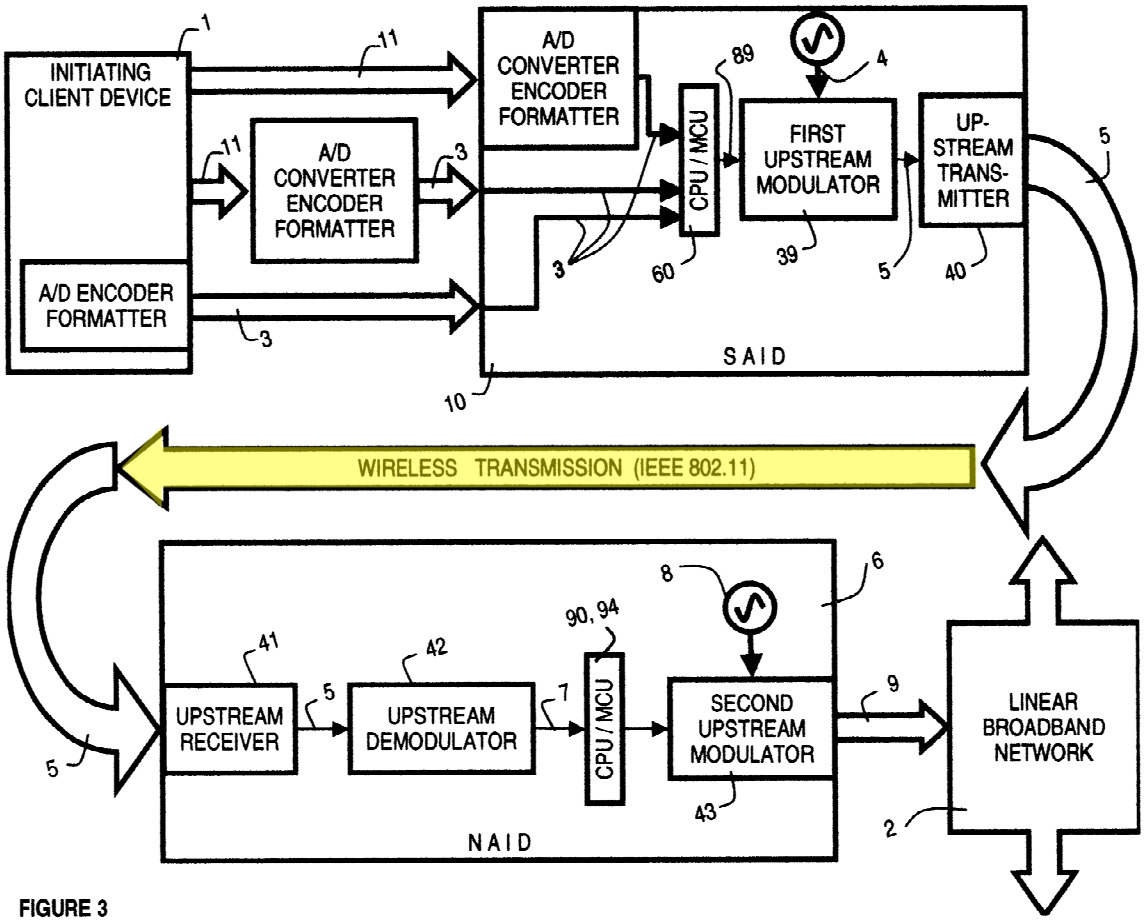


FIGURE 3

Bishop, FIG. 3 (annotated)

196. Bishop explains that the SAIDs use a "predetermined threshold," such as a "bit error rate, latency of upstream data packet transmission, signal strength, or a combination thereof" to determine "whether an existing communication link is adequate." Bishop, 23:23-28. Bishop further explains that "[i]n the event that the communications link falls below the predetermined threshold, the subscriber access interface device 10 seeks and establishes an alternate communications link 65 with an alternate network access interface device 31." Bishop, 23:29-33.

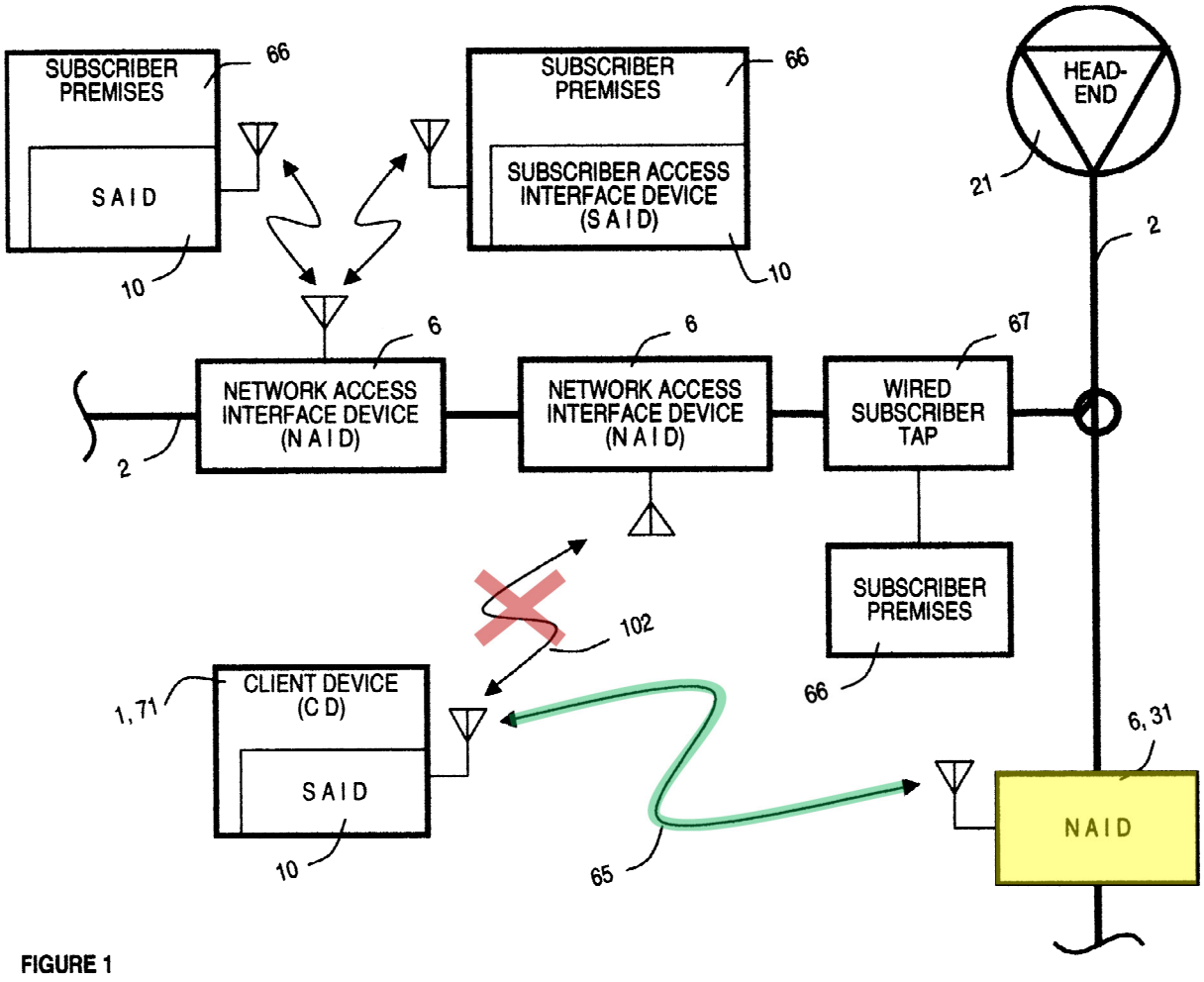


FIGURE 1

Bishop, FIG. 1 (annotated)

B. Reasons to combine Bishop with Ganz and Srikrishna

197. A POSITA would have appreciated the relevance of Bishop, particularly in its disclosure of implementation details that would have offered a straightforward and obvious way to achieve the back-up link switching and channel viability assessment processes disclosed by Ganz and Srikrishna.

198. Bishop is in the same field of endeavor as the ’952 patent, Ganz, and Srikrishna. Each of these references relates to monitoring link quality between nodes and taking corrective action in an ongoing fashion to ensure that wireless links satisfy a set of criteria. *See, e.g.*, Bishop, 23:23-32. Bishop is clearly relevant to the same problems discussed in the ’952 patent. Those problems include maintaining acceptable link quality in a dynamically changing environment. ’952 Patent, 2:46-54. Bishop’s disclosure provides a straightforward solution for assessing channel quality and making adjustments to ensure acceptable performance, including comparing channel measurements to a “predetermined threshold” to determine “whether an existing communication link is adequate.” Bishop, 23:23-25.

199. Ganz discloses that repeaters perform “automatic link testing” to obtain link quality measurements such as “transmission times,” and adjust radio frequency parameters accordingly. Ganz, 12:35-36. Srikrishna additionally discloses that “link quality is estimated by the **latency** observed on the link.” Srikrishna, 14:43-44. Ganz and Srikrishna leave some of the implementation details up to a POSITA, including what criteria to use to determine whether a link is adequate or viable, and how that information is used in determining whether to switch to an alternate link. Bishop provides additional details about determining link adequacy based on “latency,” including comparing latency measurements to a

predetermined threshold to determine whether the link is adequate. Bishop, 23:23-28. Bishop also provides implementation details for switching to a back-up (or alternate) link "[w]hen the primary communications link 102 degrades to a predetermined threshold." Bishop, 8:18-22. In that way, as mentioned above, Bishop simply provides additional implementation details that Ganz and Srikrishna expects.

200. Bishop's link adequacy testing and alternate link selection is simply a known technique that would have facilitated and improved Ganz's automatic link testing and back-up link selection in the same way. In that regard, as network communications are ongoing and persistent, a POSITA would have understood that decision-making criteria would be needed to automate channel assessment and to allow the repeaters to determine whether and when to switch to a back-up link. A POSITA would have appreciated that Bishop's link adequacy determination, including its latency metrics and latency thresholds, would provide for a standardized, consistent way to automate decision-making in Ganz's repeaters about whether the current link and/or back-up link are viable. In this way, if the conditions for a given channel degrade (e.g., increased interference, increased latency), Ganz's repeater would respond by identifying and switching to a channel that provides lower latency, which is important for time-sensitive applications like voice. *See* Ganz, 11:14-17 (providing information for "real-time applications" like

voice); Bishop, 11:11-14 ("As one of ordinary skill in the art will appreciate, the upstream data packets 24 from a voice or a video communications signal must be reliably and consistently delivered in real time…").

201. Further, using Bishop's known link adequacy assessment based on latency measurements and a corresponding threshold for Ganz's automatic link quality tests would have predictably improved on Ganz's system by using latency as the criteria for determining whether a link is viable, which is particularly relevant for time-sensitive "real-time" applications like voice. In other words, Bishop's channel monitoring and selection would have beneficially provided for ongoing link monitoring and link switching to ensure that wireless devices – especially those requiring real-time applications – use links that satisfy a latency threshold.

202. Finally, a POSITA would have had a reasonable expectation of success in combining the teachings of Bishop with Ganz and Srikrishna. Bishop, like Srikrishna and Ganz, contemplates using the IEEE 802.11 wireless standard to facilitate communications in their networks. *See* Bishop, 10:46-50, 12:40-43, 58-62, FIG. 3; Srikrishna, 1:50-53; Ganz, 7:11-13. As explained above for ground 1, it was well known that following an industry specification promotes interoperability among specification-compliant devices, and using the same

communication protocols would have further bolstered a POSITA's expectation of success with the combination.

C. Detailed Analysis of Claims

1. Claim 4

a. [4.0] *A method as recited in claim 1, wherein making a channel selection includes making a channel selection change to meet a latency requirement.*

203. As explained above, Ganz and Srikrishna render obvious "*making a channel selection change to meet a performance requirement*." *See* §IX.D.1.e, g, I ([1.4], [1.6], [1.8]). Further, as explained above for limitation [1.8], Ganz discloses measuring "data packet drop rates," "throughput speeds," and "transmission times" to assess link viability. Ganz, 5:51-54, 12:31-38 ("Lost packet percentages of up to 10 percent will provide adequate performance"). Ganz explains that the transmission errors that cause lost packets will result in "retransmission" of the affected data packets:

> If an error occurs within a data packet during RF transit, it is detected by the Reed-Solomon decoding and a request for a retransmission of the data packet is effected [sic].

Ganz, 4:46-49.

204. Ganz further explains that "[i]n the uni-cast mode, lost data packets are retransmitted," and that "[t]ransmission times are measured based on the number of retries that were conducted, to achieve error-free transfer of the packet sequence." Ganz, 12:34-37. Thus, Ganz discloses that dropped packets increase the

"transmission time," and therefore increase the "*latency*," because the lost packets have to be retransmitted.

205. Ganz provides multiple examples for performance thresholds, including "information throughput" of "at least 1.5 Mb/s" and "[l]ost packet percentages of up to 10 percent." Ganz, 8:24-25, 12:37-38. Ganz further notes that "**real-time** applications such as voice and video" require a "specific QoS," including "maximum end-to-end delay." Ganz, 11:14-20. Additionally, Srikrishna explains that "link quality is estimated by the **latency** observed on the link." Srikrishna, 14:43-44. Ganz and Srikrishna therefore acknowledge that poor channel quality is often reflected by an increase in latency, and that latency is a relevant and useful metric to determine link quality—especially for time-sensitive data traffic types, like voice or video.

206. It would have been obvious for Ganz's repeaters to switch to a back-up link on another channel based on transmission times, or latency, of the primary link failing to satisfy a corresponding latency threshold ("*latency requirement*"). For instance, Bishop discloses additional implementation details for assessing a link's adequacy using performance thresholds. Bishop explains that an interface device uses a "predetermined threshold" to determine "whether an existing communication link is adequate." Bishop, 23:24-25. Bishop explains that the threshold may be a "latency of upstream data packet transmission" ("*latency*

requirement"). Bishop, 23:25-27. Similar to Ganz, Bishop notes the importance of low latency for voice data, which must be "consistently delivered in real time." Bishop, 11:11-14

207. Bishop explains that those performance metrics and thresholds are used to determine when to switch to an alternate link. For instance, Bishop further explains that a wireless device "establishes an **alternate communications link 65 with an alternate network access interface device 31**" when "the communications link falls below the predetermined threshold." Bishop, 23:29-32.

208. A POSITA familiar with channel-selection schemes based on throughput or loss would have also found it predictable and obvious to use latency as an alternative (or additional) indicator of quality. Ganz discloses identifying non-viable links, and switching to back-up links, but leaves implementation details up to a POSITA. Bishop provides those implementation details. It would have been obvious to use Bishop's latency threshold to provide for automatic link switching to maintain acceptable network performance to support time-sensitive data applications.

209. Thus, Bishop's disclosure of switching to an alternate link based on a latency threshold ("*latency requirement*"), in combination with Srikrishna's disclosure of assessing link quality based on "*latency*," and Ganz's disclosure of

switching links based on link "viability," renders obvious "*making a channel selection change to meet a latency requirement*."

2. Claim 15

210. Claim 15 mirrors the limitations of claim 4. Other than the preamble, which was addressed above for claim 12, the limitations of claim 15 are taught by Ganz, Srikrishna, and Bishop for the same reasons explained above with respect to claim 4.

XI. THE COMBINATION OF GANZ, SRIKRISHNA, AND IEEE 802.11 RENDERS OBVIOUS CLAIMS 11 AND 21

A. Summary of IEEE 802.11

211. As I explain above, IEEE 802.11 was a well-known wireless networking standard and would have been part of the background knowledge of a POSITA. *See* Ganz, 7:11-13; Srikrishna, 1:50-53, 4:23-22-24; Bishop, 10:46-50, 12:40-43, 58-62, FIG. 3; *supra*, § V.

212. ANSI/IEEE Std IEE 802.11, 1999 ed. ("IEEE 802.11") is the 1999 revision of the IEEE's 802.11 standard. The 1999 edition was published on August 20, 1999, which is a revision of the original standard published in 1997. IEEE 802.11, vi. The IEEE 802.11 standard was developed (and continues to develop) based on the contributions and collaborations of various partners in industry. Its protocols "represent a consensus of the broad expertise on the subject within the

Institute as well as those activities outside of IEEE that have expressed an interest in participating in the development of the standard." IEEE 802.11, iv.

213. One aspect of the IEEE 802.11 standard protocols is the use of "management messages" or "management frames" that "are used to support the IEEE 802.11 services." IEEE 802.11, 17. Examples of management frames include Beacons, Probe Requests, and Probe Responses. IEEE 802.11, 46-49. Management frames have a "format" that includes a header and a body containing various fields. For instance, a Beacon frame includes "Capability information," "Supported rates," and the SSID of the transmitting node. IEEE 802.11, 46.

B. Reasons to Combine Ganz, Srikrishna, and IEEE 802.11

214. The IEEE 802.11 standard was a well-known communications standard for broadband wireless communications. A POSITA would have been familiar with the IEEE 802.11 standard and its protocols. A POSITA would have appreciated the benefits of adhering to an industry standard to provide for enhanced cross-compatibility between different device manufacturers. The "IEEE 802.11" reference of this ground is the 1999 edition of the IEEE 802.11 standard. Thus, a POSITA would have been motivated to consult and incorporate the IEEE protocols in order to comply with the standard, which would have provided robust protocols for establishing and maintaining wireless connections, and for allocating limited frequency resources. IEEE 802.11, p. 1.

215. Indeed, Ganz expressly incorporates by reference the IEEE 802.11 standard. Ganz, 7:11-13. Srikrishna also refers to the 802.11 standard for its procedures. Srikrishna, 1:50-53, 4:23-22-24. A POSITA would have been motivated to combine IEEE 802.11 with Ganz and Srikrishna simply because both Ganz and Srikrishna suggest using IEEE 802.11 protocols.

216. Additionally, a POSITA would have appreciated that the IEEE 802.11 standard provides additional details for the procedures and functions that Ganz and Srikrishna disclose. A POSITA would have appreciated the benefits of adhering to developed standards to provide increased cross-compatibility in a diverse network. Indeed, device interoperability is a common and important goal in computer networking. Additionally, the IEEE 802.11 standard includes a robust framework for managing and maintaining wireless networks, and for supporting different types of services, including wireless broadband for mobile devices.

217. The fact that both Ganz and Srikrishna propose using the IEEE 802.11 standard to facilitate wireless connections and communications would have provided a POSITA with a reasonable expectation of success in combining the IEEE 802.11 disclosures with Ganz and Srikrishna.

C. Detailed Analysis of claims

1. Claim 11

a. [11.0] *A method as recited in claim 1, further comprising receiving a monitoring signal that includes*

information about available nodes from which the second node is selected.

218. Ganz explains that the repeaters can establish back-up links in the event of a network failure. Ganz, 3:55-58. Although Ganz provides limited details about how the repeaters learn about the other repeaters or connections in their vicinity, Ganz also incorporates by reference the IEEE 802.11 standard, similar to the '952 patent. Ganz, 7:11-13; '952 patent, 12:35-37.

219. The IEEE 802.11 standard provides other mechanisms for wireless devices in a wireless LAN network to signal their presence, and for devices to monitor for those signals, including beacon frames and probe response. For instance,

> At the nominal beginning of each CFP, the PC shall sense the medium. When the medium is determined to be idle for one PIFS period, **the PC shall transmit a Beacon frame containing the CF Parameter Set element and a DTIM element**.

IEEE 802.11, p. 88.

220. IEEE 802.11 explains that other nodes "shall scan" for beacon frames for the purpose of synchronization:

> STA **shall scan for Beacon frames** containing that ESS's SSID, returning all Beacon frames matching the desired SSID in the BSSDescriptionSet parameter of the corresponding MLME-SCAN.confirm primitive with the appropriate bits in the Capabilities

> Information field indicating whether the beacon came from an Infrastructure BSS or IBSS.

IEEE 802.11, p. 125.

221. The word "shall" in the IEEE 802.11 connotes a mandatory feature in all implementations. Thus, according to IEEE 802.11, all wireless nodes must have the ability to scan for beacon frames as part of the process of initiating and maintaining wireless connections in the network.

222. The Beacon frames include "Capability information," "Supported rates," and the SSID of the transmitting node. IEEE 802.11, p. 46. Other devices that receive the beacon frames use the information included in them to update their configuration information:

> STAs shall use information from the CF Parameter Set element of all received Beacon frames to update their NAV as specified in 9.3.2.2.

IEEE 802.11, p. 124.

223. Thus, the beacon is a "*monitoring signal that includes information about available nodes*." It would have been obvious for all of Ganz's repeaters to use the IEEE 802.11 mechanisms for beacon transmission and scanning to identify the potential back-up links that are available to it if a failure occurs. *See* Ganz, 3:57-58 (back-up links). The IEEE 802.11 standard provides additional details for the procedures and functions that Ganz discloses. A POSITA would have appreciated the benefits of adhering to developed standards to provide increased

cross-compatibility in a diverse network. Thus, it would have been obvious for every node, including the repeater 100 or 72 (the "*first relay node*") to scan for and receive beacon frames from the other repeaters, including from the repeater 72 or 100 (the "*second relay node*") to keep their configuration information updated and to identify potential back-up links.

224. Moreover, it would have been obvious for the repeater receiving the beacon frame to establish new links, or back-up links, based on the information indicated in the beacon signals. As explained above, the beacon frames indicate the addresses, capabilities, and communication parameters of other wireless nodes. These beacon frames are periodically broadcast by wireless nodes and were routinely used within the network to discover, assess, and maintain wireless connections with neighboring nodes. *See, e.g.*, U.S. Patent Pub. No. 2002/0110105, [0008], [0076], [0077], [0081] (describing use of beacon frames in IEEE 802.11 standard); IEEE 802.11, pp. 88, 125 (beacon frame protocols are mandatory part of IEEE 802.11 standard ("shall")). The information about other repeaters' presence and connection characteristics is relevant when establishing or re-establishing a wireless link with those repeaters. It would have therefore been straightforward, logical, and obvious to employ such information when a repeater seeks to identify and establish an alternative wireless connection path or a back-up link, including the back-up link 110, for instance.

225. Specifically, upon the disruption or failure of repeater 100's primary uplink connection 18 with repeater 10, the repeater 100 would logically rely on previously received beacon frames, which provide up-to-date information on other repeaters within wireless range, including information about repeater 72. This would allow identification and selection of an alternate communication path (back-up link 110) based on relevant criteria, such as signal strength, link quality, and node availability, all indicated in the beacon frame. Leveraging beacon frames for this purpose represents merely a predictable use of standard IEEE 802.11 functionality, which was well-known, and which Ganz and Srikrishna promote. Consequently, applying beacon frame information ("*information about available nodes*") to establish the back-up link 110 with repeater 72 ("*from which the second node is selected*"), upon failure of the primary link 18, would have been obvious to one skilled in the art.

226. Thus, Ganz, Srikrishna, and IEEE 802.11 render obvious this limitation.

2. Claim 21

227. Claim 21 mirrors the limitations of claim 11. Other than the preamble, which I address above for claim 12, the limitations of claim 21 are disclosed or rendered obvious by Ganz, Srikrishna, and IEEE 802.11 for the same reasons explained above with respect to claim 11.

XII. CONCLUSION

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

Dated: September 6, 2025

Christopher Hansen, Ph.D.