IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

SMARTSKY NETWORKS, LLC, Plaintiff, v. GOGO BUSINESS AVIATION, LLC and GOGO INC., Defendants.	))))))))))	C.A. No. 22-266 (UNA) **PUBLIC VERSION**

DECLARATION OF DR. STEVEN GOLDBERG IN SUPPORT OF PLAINTIFF SMARTSKY NETWORKS, LLC MOTION FOR PRELIMINARY INJUNCTION

MORRIS, NICHOLS, ARSHT & TUNNELL LLP
Jack B. Blumenfeld (#1014)
Rodger D. Smith II (#3778)
Sarah E. Simonetti (#6698)
1201 North Market Street
P.O. Box 1347
Wilmington, DE 19899
(302) 658-9200
jblumenfeld@morrisnichols.com
rsmith@morrisnichols.com
ssimonetti@morrisnichols.com

Attorneys for Plaintiff SmartSky Networks, LLC

OF COUNSEL:

Ryan M. Corbett
BURR & FORMAN LLP
201 North Franklin Street, Suite 3200
Tampa, FL 33602
(813) 221-2626

Lance A. Lawson
BURR & FORMAN LLP
101 South Tryon Street, Suite 2610
Charlotte, NC 28280
(704) 347-1170

Confidential Version Filed: February 28, 2022

Public Version Filed: March 2, 2022

IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF DELAWARE

SMARTSKY NETWORKS, LLC
a Delaware limited liability company,

Plaintiff, C.A. No. _____

v.

GOGO BUSINESS AVIATION, LLC
a Delaware limited liability company, and

GOGO INC.
a Delaware corporation,

Defendants.
____/

DECLARATION OF DR. STEVEN GOLDBERG IN SUPPORT OF PLAINTIFF SMARTSKY NETWORKS, LLC MOTION FOR PRELIMINARY INJUNCTION

TABLE OF CONTENTS

I, Steven Goldberg, hereby declare the following:

I. INTRODUCTION

1. My name is Dr. Steven Goldberg. I have been retained by counsel for SmartSky Networks, LLC ("SmartSky") as a technical expert in the above-named matter. I submit this declaration in support of SmartSky's Motion for Preliminary Injunction.

2. I understand that SmartSky is seeking a preliminary injunction against Gogo Business Aviation, LLC ("Gogo BA") and Gogo Inc. (collectively "Gogo"), and in particular against Gogo's 5G air-to-ground (ATG) network that Gogo is currently testing and intends to commercially launch in mid-2022 ("the Gogo 5G network"). In connection with SmartSky's preliminary injunction request, I have been asked to offer my opinions regarding whether the Gogo 5G network infringes U.S. Patent Nos. 9,312,947 (the "'947 Patent"), 11,223,417 (the "'417 Patent"), 10,257,717 (the "'717 Patent") and 9,730,077 (the "'077 Patent") (collectively, "the Asserted Patents"), as well as technological advantages provided by the Asserted Patents.

II. BACKGROUND AND QUALIFICATIONS

A. Academic and Industrial Background

3. I am currently a Partner at Finistere Ventures, an early-stage venture capital firm. Additionally, I am the sole proprietor of a consulting business, dba Air Access, where I provide engineering, technical and management services. In that role, I direct and advise a number of high-tech start-up companies and provide litigation technical consulting and support services. My current curriculum vitae (CV) is attached at Exhibit A and some highlights follow.

4. My forty-year career in the technology industry includes employment as an RF engineer, algorithm engineer, digital design engineer, engineering manager, business general manager, CEO, and board member. The vast majority of these positions were at companies

involved in wireless communications, telematics, radar technology, communications technology, and/or embedded systems (those that include hardware, software, and algorithms).

5. I received a B.S.E.E. degree and M.S.E.E. degree from Washington University, St. Louis, Missouri in 1975 and 1980, respectively. I also received a Ph.D. in Electrical Engineering from the University of California, Santa Barbara in 1988.

6. My graduate education focused on digital and analog communications and related algorithms. My Ph.D. doctoral thesis focused on direct sequence spread spectrum communications and wireless technology, which includes technology related to the Global Positioning System (GPS), a technology based on direct sequence spread spectrum technology.

7. I was twice employed at Trimble Navigation, Sunnyvale, CA, a global leader in GPS technology. In my first position at Trimble, from 1991 to 1995, I was an Engineering Manager with the Vehicle Tracking Division of the company and a Senior Engineer in the Differential Corrections Group in the Survey Division. My group within the Vehicle Tracking Division—which was composed of hardware, software, and algorithm engineers—designed, developed, and manufactured tracking systems for cars, trucks, first responders, and public transportation systems. My second period of employment with Trimble Navigation was from September 2008 to September 2009. During this time, I was the Program Manager for the Trimble Military Division where I led approximately 20 hardware, software, algorithm, mechanical, and RF engineers in the design of the next generation M-Code GPS system for military aircraft.

8. My software and programming experience includes programming activity through undergraduate, graduate, Ph.D. programs in Fortran and Matlab (1971-1988). As a Systems Engineer at Applied Signal Technology (1988-1991), my job was to create algorithms to help the National Security Agency and the CIA to receive and decode wireless messages from entities of

interest internationally (known as Signal Intelligence). I designed and tested my algorithms in MATLAB, a programming language used by systems engineers. From 1991-2009, I had hundreds of software engineers reporting to me in my roles as Engineering Manager, VP Engineering, and CEO, including over 250 software engineers as part of my role of VP of Engineering at Nokia. I regularly reviewed product software architectures and validated, at a system and algorithmic level, the functionality and the potential performance of a wide variety of products, from GPS receivers and wireless/microwave radios to Internet Security products.

9. Additionally, earlier in my career I was an engineer with California Microwave, Inc., Emerson Electric Co., and an engineer at the Hewlett Packard Company where I regularly had responsibility for radar component design and/or radar system measurements.

10. Notably, I was also a founder and engineering leader at DataRunway, a startup company focused on the design, manufacture, and sale of a system that would provide high-speed data to aircraft in flight.

11. Throughout my more than 40 years of professional activities, I was very close to "product" and "product development." As an engineer, engineering manager, VP of engineering, General Manager, CEO, and corporate board member, I have been directly involved in product definition, market validation, product development, testing, manufacturing, pricing, sales, and support. My product management experience includes the creation and oversight of Market Requirements Documents (MRD; created by Marketing Dept), Product Requirements Documents (PRD; created by Product Managers), and System Specification Documents (SSD; created by engineering departments). These documents are tied to a detailed process that guides and enables the creation of a product by assessing and responding to the market and customer needs.

12. Additionally, at Trimble Navigation, Cylink, Applied Signal Technology, Nokia, DataRunway, and Vidient, I was involved with the generation of intellectual property, specifically patents, related to the products planned for current and future development in the fields of GPS, RF and microwave communications, communications signal processing, receiver design, and RF and microwave components.

13. My professional experience also includes the comparative analysis of competing products and features in a given marketplace as a mechanism for product valuation and unit pricing. This analysis typically involves leveraging a multidisciplinary evaluation of the product that requires an understanding of the hardware, software, algorithmic, user interface, and aesthetic design, and a valuation of the intellectual property associated with these aspects of the product.

14. My experience of nearly 40 years in academic and practical situations as well as my hands-on experience, has given me a detailed appreciation of the technology involved with the Asserted Patents.

B. Expert Experience and Compensation

15. A complete list of my expert cases is included within my CV, attached as Exhibit A.

16. My compensation in this matter is not based on the substance of my opinions or the outcome of this matter. I have no financial interest in SmartSky Networks, LLC or any other related party. I am being compensated at an hourly rate of $350 for my analysis and testimony in this case.

C. Materials Considered

17. In writing this Declaration, I have considered the following: my own knowledge and experience, including my work experience in the above fields; my experience in teaching those

subjects; and my experience in working with others involved in those fields. I have also reviewed the following references as well as the background materials referenced below in my analyses:

(a) U.S. Patent No. 9,312,947
(b) U.S. Patent No. 11,223,417
(c) U.S. Patent No. 10,257,717
(d) U.S. Patent No. 9,730,077
(e) SmartSky Patent Infringement Complaint
(f) Gogo website; www.gogoair.com
(g) https://www.facebook.com/watch/live/?ref=watch_permalink&v=130134005981785
(h) IEEE Std 802.16 -2004
(i) IPR2020-00709, Patent 9,312,947 B2; U.S. PTO Decision Denying Institution of *Inter Partes* Review
(j) IPR2020-00709; Patent 9,312,947 B2; Patent Owner's Preliminary Response
(k) U.S. Patent No. 9,312,947 Prosecution History
(l) U.S. Patent No. 11,223,417 Prosecution History
(m) U.S. Patent No. 10,257,717 Prosecution History
(n) U.S. Patent No. 9,730,077 Prosecution History
(o) All of the remaining exhibits and references cited herein

18. I reserve the right to add or modify my opinions based on any new information and/or art that is made available to me after the submission of this declaration.

III. SUMMARY OF OPINIONS

19. Based on my analysis of publicly available information regarding the Gogo 5G network, it is my opinion that the Gogo 5G network infringes at least claims 1 and 11 of the '947 Patent, claims 1, 2, 5, 8, 11, 12, 15, and 18 of the '417 Patent, claims 1 and 12 of the '717 Patent, and claims 1 and 2 of the '077 Patent.

20. I understand that SmartSky intends to seek documents and other information from Gogo regarding the Gogo 5G network. To the extent that additional information from Gogo becomes available to me during the preliminary injunction proceedings, I reserve the right to supplement or amend my opinions as appropriate.

IV. LEGAL FRAMEWORK

21. I am a technical expert and do not offer any legal opinions. However, counsel has informed me as to certain legal principles regarding patent infringement and related matters under United States patent law, as described below, which I have applied in performing my analysis and arriving at my technical opinions in this matter.

22. I understand that a U.S. patent includes a specification that describes examples of the invention(s) invented by the inventor(s), and one or more claims that define the scope of the subject matter protected by the patent, and over which the patentee has exclusive property rights. I understand that any person or entity that makes, uses, or sells within the United States and without SmartSky Networks, LLC permission any process and/or apparatus covered by at least one claim of the '947,'077,'417, or '717 Patents, or imports, sells for importation, or sells within the United States after importation, articles covered by the claims of any of these patents, or articles that are made, produced, or processed by means of a process covered by the claims of any of these patents, infringes the corresponding patent(s).

23. I understand that the patent infringement analysis includes two steps. First, the proper meaning and scope of the claims is determined. I understand that to define the scope of the claims, one must first look at the words of the claims themselves. I further understand that words in the claim are generally given their plain and ordinary meaning. "Plain and ordinary" relates to the meaning understood by one of ordinary skill in the art at the time of the invention. I further understand the plain and ordinary meaning of claim language as understood by a person of skill in the art may be readily apparent and involve little more than the application of widely accepted meanings of commonly understood words. Guidance for the "plain and ordinary meaning" is provided in the context of the claims, specification, prosecution history and, when appropriate, reference to extrinsic sources such as dictionaries and expert testimony. In properly construing

claims I understand that claims must be read in view of the specification, of which they are a part. During the course of the prosecution history, the applicant may have made express representations regarding the scope of the invention, so the prosecution history may be significant in determining the meaning of the claims.

24. I understand that the second step of the infringement analysis includes comparing each of the claims to the product or process accused of infringement to determine whether each element of a claim is present in the accused product or process. When considering whether a person or entity infringes the patents, each of the asserted claims must be considered individually against an accused product or process. To establish infringement, all of the limitations of at least one of the asserted claims must be present in the accused product or process.

25. I understand that a patent may include both independent and dependent claims. An independent claim sets forth all the elements covered by that claim. A dependent claim does not by itself recite all of the elements of the claim, but instead refers to another claim for some of its requirements, and in that way "depends" on another claim. I understand that a dependent claim is considered to incorporate all of the elements of the claim from which it depends. I understand that for infringement of a dependent claim, the accused product or process must include every limitation of the dependent claim itself, as well as all other claims from which it depends.

26. I understand that a patent claim is literally infringed if the accused product or method includes each and every element or method step in that patent claim. I also understand that, if an alleged infringer's product or method does not literally infringe an asserted patent claim, that product or method may still infringe the asserted claim under the "Doctrine of Equivalents." Under this doctrine, the accused product or method infringes an asserted patent claim if it includes a structure or a step that is equivalent to a requirement of the claim.

27. A structure or step of an accused product or method is equivalent to a requirement of an asserted claim if a person of ordinary skill in the art would think that the differences between the structure or step and the requirement were not substantial as of the time of the alleged infringement. One way to decide whether any difference between a requirement of an asserted claim and a structure or step of the accused product or method is not substantial is to consider whether, as of the time of the alleged infringement, the structure or step of the product or method performed substantially the same function, in substantially the same way, to achieve substantially the same result as the requirement in the patent claim.

28. In deciding whether any difference between a claim requirement and the product or method is not substantial, one consideration is whether, at the time of the alleged infringement, persons of ordinary skill in the art would have known of the interchangeability of the part or step with the claimed requirement. But the known interchangeability between the claim requirement and the structure or step of the product or method is not necessary to find infringement under the Doctrine of Equivalents.

V. TECHNOLOGY BACKGROUND

A. High-speed Data Communications to Aircraft In-Flight

29. As Internet usage has grown and matured, the demand for high-speed, symmetric, low-latency applications has increased (e.g. two-way video communication, online gaming, file transfer, cloud-computing, and remote application control). This new demand, in addition to the overall number of users and uses of the Internet, has motivated the need for change for high-speed wireless delivery of data to and from aircraft in flight.

30. Generally speaking, as has been the case for terrestrial high-speed wireless Internet data delivery, the historical focus for delivery of Internet services to aircraft in flight has been on the downlink. Network designers and service providers have optimized the bandwidth that has

been available to the network to the downlink (toward consumer) and allocated significantly less to the uplink. This is predominantly true for two main reasons. First, in many applications, it has been difficult to create enough link margin (i.e. enough signal-to-noise ratio) in the uplink to support higher speeds due to the lower output RF power levels at the user equipment. Second, historically, much of the use of high-speed data communications for the Internet has been focused on consumption of data (watching movies, surfing the web, etc.) with minimal control data (e.g. key board strokes) from the consumer directed back into the network. Additionally, many applications that are predominantly downlink focused have been less dependent on low latency. [1]

31. There are generally only two practical approaches to delivering Internet services to aircraft in flight; air to ground (ground to aircraft) or satellite to air (i.e. satellite to aircraft). The satellite approach has been around for a number of years but has a number of shortcomings. Although satellite-based coverage area has historically been excellent, cost, latency, and aircraft antenna size have limited performance and the range of applications that can be supported. [2]

32. As nationwide terrestrial broadband communications systems – predominantly mobile cellular communications – have become more and more successful, anywhere, anytime use of the Internet has become more and more of a must-have requirement. Looking for an alternative to satellite to aircraft Internet services, network manufacturers and users alike began to look at the advances in terrestrial broadband (high-speed) communication technology.

[1] *See* Corbett Decl. Ex. 54.
[2] *See* Corbett Decl. Ex. 10.

33. As the cost of terrestrial broadband cell sites dropped and the processing performance increased with Moore's Law[3], it became more and more clear that air-to-ground (ATG) delivery could be a viable approach to high-speed delivery of data with aircraft in flight.

34. Benefits of ATG delivery of Internet services to aircraft in flight would include lower latency, the ability to support more symmetric applications, more flexibility in system upgrades, more system capacity, and, potentially lower cost. These benefits, however, would come with increased system complexity and the challenges of finding available spectrum.

35. One of the first commercial ATG data networks, that leveraged terrestrial broadband technology in licensed bands, was created by Aircell using 3 MHz of 850 MHz spectrum acquired from Verizon's legacy Airfone business in 2006. Marketed as Gogo Inflight Internet, the network has been applied to both business aviation and commercial aviation. [4]

36. Although the need for low latency was somewhat addressed by the Gogo network, the demand for higher capacity, higher data speeds, and symmetric applications continued to be unmet. The extremely high cost and limited availability of licensed spectrum was the single biggest impediment to meeting those needs.

B. ISM Unlicensed Band Spectrum

37. An alternative to licensed spectrum is the 900 MHz ISM, 2.4 GHz ISM, and 5.7 GHz UNII/ISM band unlicensed spectrum.[5] ISM is an acronym for Industrial, Scientific, and Medical frequency band allocations by the FCC that were first envisioned in 1947. Multiple "services" share this spectrum amid a range of rules and regulations including military radar and

---

[3] Moore's Law refers to the prediction by Gordon Moore in 1965 that the number of transistors in an integrated circuit doubles about every two years; this implies that processing power will increase at a similar rate

[4] *See* Corbett Decl. Ex. 55.

[5] *See* Corbett Decl. Ex. 56.

medical instrumentation. In 1985, the U.S. FCC first allowed the unlicensed use of a wide range of consumer and business products and applications under FCC regulations Title 47, Part 15.247. These applications include WiFi.

38. This spectrum is particularly interesting as there is significant bandwidth available including 83.5 MHz in the 2.4 GHz ISM band. This is historically where a number of short-range (e.g. less than 1000 ft.) consumer products have operated, notably consumer and business WiFi networks. The FCC, up until the early 2000's, had certification rules that made air to ground usage, for large nationwide networks, effectively impossible in the 2.4 GHz ISM band due to antenna gain limitations based on the assumption that the antenna was omnidirectional or of limited directional gain. However, changes from the original ISM band regulations related to the implementation of more focused, higher directional gain "beamforming" antennas, improved the amount of antenna gain allowable to a signal base station, which opened the opportunity for ATG communications in the ISM bands. Although maximum RF output power, per base station, has remained at 1 watt, antenna gain is effectively unlimited as long as the output power is decreased by 1 dB for every increase of 3 dB of antenna gain over 6 dBi.[6] Application of this power rule increased the allowable gain for a beamforming antenna, thus it became possible to provide reliable communications to aircraft in flight at multiple megabits per second per communications link at distances of up to 100 miles or more.

39. The most significant negative factor for the use of the ISM band unlicensed spectrum is the challenge of co-existing or harmoniously sharing the spectrum with the millions of other, mostly terrestrial, commercial and military users. As explained below, SmartSky's

---

[6] *Id.*

patented technology addresses this coexistence and mutual interference problem, and has enabled the launch of its — and soon to be Gogo's — ATG network using the unlicensed band.

VI. THE PARTIES

A. SmartSky Networks, LLC

40. SmartSky Networks, LLC is a privately held U.S. company that designs, manufactures, sells, installs, and operates a nationwide network delivering high-speed air-to-ground (ATG) communications. The network is designed to provide data and high-speed Internet and related services to business aviation in and around United States airspace.

41. The SmartSky unlicensed band ATG network product was first approved by the FCC on September 28, 2016. The ATG network has been demonstrated in the intervening years and was commercially launched in late 2021.

42. SmartSky's ATG network consists of aircraft electronics and antennas, ground-based, tower positioned antenna and electronics, and a network of servers, routers, and cloud connectivity hardware to support the interconnectivity between the in-flight aircraft and the ground-based network operators, application and delivery partners, and users.

43. The nationwide network leverages 60 MHz of the ISM unlicensed band (2.4 GHz). The cloud-based data server infrastructure supports a variety of applications, including video streaming, voice-over-IP, and Internet. Seamless coverage to in-flight aircraft is enabled by a patented beamforming antenna system that optimizes ATG communications through uninterrupted connections and minimizes interference to other users in the ISM spectrum. The overall network is certified by the FCC under Part 15.247.

B. Gogo Business Aviation

44. Aircell Business Aviation was founded in 1991.

45. As stated earlier, Aircell bought 3 MHz of licensed spectrum in the 850 MHz band and used modified 3G cellular technology (EVDO Rev A and later EVDO Rev B) to support data communications links for air-to-ground communications. Due to the limited spectrum bandwidth, the network had limited data speed, limited overall network capacity, and a limited range of applications.

46. In 2006 their ATG data network was approved by the FCC and in 2008 Aircell began to market and sell an ATG data communications product known as Gogo Inflight Internet to both commercial and business aircraft. In 2011 the company changed its name to Gogo.

47. In 2016, Gogo announced that it intended to use unlicensed spectrum for its next generation ATG network, at the time called "ATG Next Gen."[7] The ATG Next Gen network was never implemented, and instead in 2019 Gogo announced it would be launching a new network in the unlicensed band, branded as the "Gogo 5G" network. The Gogo 5G network was originally scheduled to begin operations in 2021,[8] but has since been delayed until sometime in the second half of 2022.[9]

48. In December, 2020, Gogo sold their satellite-focused commercial aviation business to Intelsat, while retaining its ATG network. The company now, Gogo Business Aviation, focuses exclusively on the business aviation market.

VII. DESCRIPTION OF THE ASSERTED PATENTS

A. The '947 Patent

49. United States Patent No. 9,312,947 ("the '947 Patent"), entitled "Terrestrial Based High Speed Data Communications Mesh Network," was issued on April 12, 2016, and names

[7] *See* Corbett Decl. Ex. 28.
[8] Corbett Decl. Ex. 39.
[9] Corbett Decl. Ex. 57.

Donald L. Alcorn as the inventor. The earliest application related to the ‘947 Patent was filed on August 18, 2005.

50. The ‘947 Patent is generally directed to addressing problems with providing high speed data communications to in-flight aircraft. For example, the ‘947 Patent explains that “cellular high speed wireless data links have a range which i[s] not practical for in-flight use due to throughput limitations.”[10] The ‘947 Patent further notes that a satellite-based system “is costly since it requires a satellite link as well as specialized antennae and other equipment for the aircraft and also consists of throughput limitations which impact usefulness. Consequently, there is a need for a system that provides [a] high speed data communications link to an in-flight aircraft at a reasonable cost.”[11]

51. The ‘947 Patent addresses these problems by configuring a network of base stations to provide aircraft passengers with a “high speed data communications link between the passenger and the ground [that] allows for a direct link that is continuous and uninterrupted in time.”[12] Specifically, the ‘947 Patent explains that the base stations employ a software definable radio (SDR) to configure beamforming of the signal into a “narrow beam [so] that interference with nearby signals on the same or very close frequencies is minimized.” “By using a buffer range between beams of the signals, the same frequencies may be recycled or re-used for different communications links between nodes.”[13] “This has the great advantage of minimiz[ing] the necessary frequency spectrum required to operate the network.”[14] The ‘947 Patent notes that “[a]nother advantage of the use of SDR involves a more stable and manageable system of

---

[10] Corbett Decl. Ex. 1 at 1:33-35.
[11] *Id.*, 1:37-42.
[12] *Id.*, 2:40-46.
[13] *Id.*, 6:6-14.
[14] *Id.*, 6:15-17.

transitioning between communications links among moving nodes. With a narrow beam, a high-quality communication link may be established with a more distant node rather than the closest node. This link will conceivably last longer as the distant node moves through the transmission range towards the base station."[15] Accordingly, the network of base stations described in the '947 Patent provides a specific improvement over prior systems that was not well-known or conventional, resulting in improved connectivity for aircraft passengers.

52. Claim 1 of the '947 Patent recites a network base station within a network that includes at least one in-flight communication node, and a network of base stations configured to communicate with at least one in-flight node. The network base station includes a radio configured via software defined radio to utilize beamforming to generate a plurality of steerable beams. This configuration enables multiple reuses of the same frequency to communicate with respective different in-flight communication nodes via respective different communication links. The respective different communication links are high speed data communication links that are enabled to be maintained continuous and uninterrupted in time while one of the in-flight nodes transitions between a first steerable beam associated with a first coverage area defined by the network base station and a second steerable beam associated with a second coverage area defined by another network base station. The first and second coverage areas are at least partially overlapping. [16]

B. The '717 Patent

53. United States Patent No. 10,257,717 ("the '717 Patent"), entitled "Wedge Shaped Cells in a Wireless Communication System," was issued on April 9, 2019, and names Douglas

[15] *Id.*, 6:18-24.
[16] *Id.*, 10:2-19.

Hyslop as the inventor. The earliest application related to the '717 Patent was filed on March 15, 2013.

54. The '717 Patent is directed to addressing problems with providing continuous wireless communication to aircraft at various distances and altitudes.[17] For example, the '717 Patent explains that "[c]onventional ground based wireless communications systems use vertical antennas to provide coverage for device connectivity[,] . . . and typically provide coverage in the azimuthal, or horizontal, plane with a width of 65 to 90 degrees."[18] "The elevation, or vertical, pattern is typically more narrow in order to maximize the antenna performance in the horizontal plane, which can result in a larger coverage area, increased signal strength or clarity in the coverage area, etc. With focus on the horizontal plane, however, these existing antennas may be unable to support connectivity for aircraft traveling above an elevation of the coverage area."[19]

55. The '717 Patent addresses these technological problems by creating a network of base stations having specific antenna configurations in order to provide wireless coverage for aircraft at varying elevations.[20] Specifically, the '717 Patent explains that a plurality of antennas can "each transmit signals having a radiation pattern defined between two elevation angles resulting in an increasing vertical beam width and smaller azimuth to form a wedge-shaped sector. These wedge-shaped sectors may then be overlapped with each other to progressively build in altitude for providing communications with continuous coverage at high altitudes."[21] The '717 Patent further explains that the network can implement "frequency reuse" so that "adjacent base

---

[17] Corbett Decl. Ex. 3 at 1:21-24.
[18] *Id.*, 1:51-55.
[19] *Id.*, 1:55-62.
[20] *Id.*, 1:66-2:2.
[21] *Id.*, 2:2-9.

stations can use alternating channels in providing the cell coverage areas."[22] More specifically, frequency reuse patterns may be used "to provide frequency diversity between adjacent cell coverage areas."[23] For example, the '717 Patent explains that the base stations include radios that can communicate using licensed spectrum or unlicensed spectrum.[24] Therefore, the network of base stations described in the '717 Patent provides a specific improvement over prior networks that was not well-known or conventional, resulting in improved connectivity for aircrafts at various altitudes.

56. Claim 1 of the '717 Patent recites a network for providing air-to-ground wireless communication in various cells. The network includes a first base station that includes a first antenna array defining a first directional radiation pattern oriented toward a horizon. The network also includes a second base station that includes a second antenna array defining a second direction radiation pattern that at least partially overlaps the with the first base station. The first base station employs unlicensed spectrum, and the second base station employs licensed spectrum. The first and second base stations are each configured to wirelessly communicate with a radio disposed on an aircraft flying through respective cell coverage areas of the first and second base stations. The first and second base stations are each configured to handover communication with the radio as the aircraft moves between the respective cell coverage areas of the first and second base stations. [25]

C. The '417 Patent

[22] *Id.*, 6:34-36.
[23] *Id.*, 6:42-45.
[24] *Id.*, 9:40-46.
[25] *Id.*, 12:5-24.

57. United States Patent No. 11,223,417 ("the '417 Patent"), entitled "Terrestrial Based High Speed Data Communications Mesh Network," was issued on January 11, 2022, and names Donald L. Alcorn as the inventor. The earliest application related to the '417 Patent was filed on August 18, 2005.

58. The '417 Patent is part of the same patent family, and shares the same specification, as the '947 Patent. Therefore, the '417 Patent is likewise directed to addressing problems with providing high speed data communications to in-flight aircraft. The description of the technological solutions addressed by the '947 Patent described above also apply to the '417 Patent, and are incorporated by reference as if fully set forth herein.

59. Claim 1 of the '417 Patent recites a ground station among a network of ground stations configured to provide a wirelessly transmitted high speed data communication link to a receiver station on an in-flight aircraft. The ground station includes an antenna and a software defined radio operably coupled to the antenna. The software defined radio configures the ground station to conduct a handover of the in-flight aircraft to another ground station within the network of ground stations to maintain the high-speed data communication link continuous and uninterrupted in time. The software defined radio is configured to employ a wireless radio access network protocol operating in a communication band from about 2 GHz to about 6 GHz. The ground station is configured to utilize beamforming to generate one or more steerable beams used to form the high-speed data communication link. The ground station is configured to reuse a same frequency to communicate with the receiver station and another receiver station on another in-flight aircraft.[26]

D. The '077 Patent

[26] Corbett Decl. Ex. 2 at 10:28-48.

60. United States Patent No. 9,730,077 ("the '077 Patent), entitled "Architecture For Simultaneous Spectrum Usage By Air-To-Ground And Terrestrial Networks," issued on August 8, 2017, and names Ryan M. Stone and Douglas Hyslop as inventors. The earliest application related to the '077 Patent was filed on January 13, 2015.

61. The '077 Patent is directed to addressing problems related to dual use of radio frequency (RF) spectrum for air-to-ground (ATG) networks and terrestrial networks in the same geographic area.[27] For example, the '077 Patent notes the possibility of dedicating a certain amount of RF spectrum to in-flight communication, but explains that "RF spectrum is extremely expensive due to the massive demands on this relatively limited resource." [28]

62. The '077 Patent addresses this problem by providing example embodiments that may provide interference mitigation techniques that may allow spectrum reuse within a given area so that both terrestrial networks and air-to-ground (ATG) networks can coexist in the same geographical area and employ the same spectrum. [29] For example, the '077 Patent explains that multiple ATG base stations define a first radiation pattern focusing energy toward the horizon. [30] The ATG base stations may be spaced apart from each other so that they create partially overlapping coverage areas to communicate with an in-flight aircraft in an ATG communication layer defined between two altitudes.[31] By focusing energy toward the horizon, the ATG base stations generate wedge-shaped cells (e.g., 212, 214, 216 below) that form overlapping wedges

---

[27] Corbett Decl. Ex. 4 at 1:14-19.
[28] *Id.*, 1:46-52.
[29] *Id.*, 1:63-67.
[30] *Id.*, 2:10-16.
[31] *Id.*, 22:17-22.

that extend out toward the horizon, as shown in Fig. 2 of the '077 Patent, reproduced below as FIG. 1. [32]

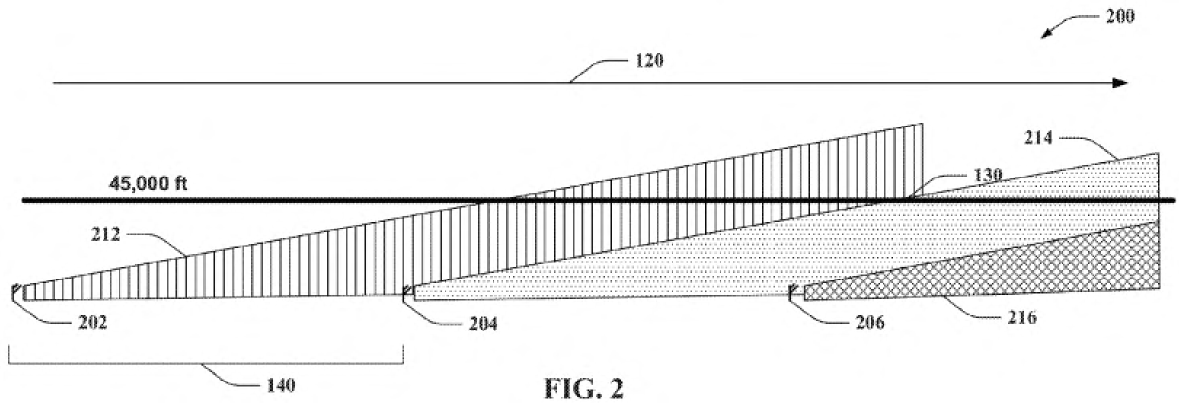


FIG. 1

63. In-flight aircraft may also employ antennas that are capable of focusing toward the horizon, such that the aircraft communicates with distant ATG base stations, rather than the ATG base stations immediately below the aircraft.[33] Because the aircraft is communicating with a distant ATG base station that focuses energy toward the horizon, the aircraft may re-use RF spectrum used by terrestrial networks below the aircraft, without significant interference.[34] Therefore, the network of ATG base stations and the configuration of their respective radiation patterns described in the '077 Patent provides a specific improvement over prior ATG networks that was not well-known or conventional, resulting in more efficient RF spectrum usage.

VIII. PROSECUTION HISTORY OF ASSERTED PATENTS

A. The '947 Patent

[32] *Id.*, 3:40-42
[33] *Id.*, 3:45-50
[34] *Id.*, 3:54-63

64. The ‘947 patent application was filed on April 15, 2013 and issued on April 12, 2016.

65. The ‘947 patent application was rejected twice by the Examiner, who alleged that the claims were unpatentable over prior art references Gresham,[35] DiFonzo, [36] Rhoads,[37] Finn,[38] Xu, [39] and Pierzga.[40][41]

66. More specifically, claims 1, 5-9, 11, and 15-19 of the ‘947 patent application were rejected as allegedly being obvious over Gresham in view of DiFonzo and Rhoads.[42] In response to the rejections, and ultimately in an Appeal Brief filed with the Patent Trial & Appeal Board (“PTAB”), SmartSky argued that the “cited references fail to teach or suggest that any high speed data communications link is maintained continuous and uninterrupted in time during a transition of an in-flight communication node between coverage areas.”[43] In particular, SmartSky argued that Gresham describes a system in which an onboard server 20 communicates with a first base station 90 when in its corresponding coverage cell 400, and communicates with a second base station 120 when in its corresponding coverage cell 410.[44] However, intermittent links are used to periodically upload and download data from a cache of the onboard server 20 to update the server to form a virtual world wide web.[45] The server 20 connects to the station at 15 minute intervals,

---

[35] Corbett Decl. Ex. 58.
[36] Corbett Decl. Ex. 59.
[37] Corbett Decl. Ex. 60.
[38] Corbett Decl. Ex. 61.
[39] Corbett Decl. Ex. 62.
[40] Corbett Decl. Ex. 63.
[41] Corbett Decl. Ex. 5, Page 27/83.
[42] *Id.*, Page 47/83.
[43] *Id.*, Page 27/83.
[44] *Id.*, Page 28/83.
[45] *Id.*, Page 29/83.

and terminates communication sessions with the station 90, and any messages received are stored in the cache until the next connection.[46] When the aircraft enters transition area 420, where cells 400 and 410 overlap, station 90 commands the server 20 to contact station 120 for subsequent connections.[47] SmartSky argued that, therefore, Gresham describes a system where communications between air and ground are conducted in an intermittent fashion to update an onboard server that attempts to replicate the world wide web with stored information, and does not teach "high speed data communications links that are enabled to be maintained continuous and uninterrupted in time while one of the respective different in-flight communication nodes transitions between a first steerable beam associated with a first coverage area defined by the network base station and a second steerable beam associated with a second coverage area defined by another network base station."[48]

67. SmartSky further argued that DiFonzo fails to teach maintaining a high speed data communication link continuous and uninterrupted as the in-flight communication node transitions between steerable beams of different coverage areas. Specifically, SmartSky argued that DiFonzo merely discloses a first example in which the communication nodes are fixed, a second example in which the user is mobile but never leaves the coverage area of the hub it is communicating with, and a third example in which the remote user is stationary while being used, but its geographic location may change in between uses.[49]

---

[46] *Id*.
[47] *Id*., Pages 28-29/83.
[48] *Id*., Page 29/83.
[49] *Id*., Page 31/83.

68. After SmartSky filed its Appeal Brief, but before the Examiner responded or the PTAB issued a ruling, the Examiner issued a Notice of Allowance on Dec. 9, 2015, agreeing with the arguments contained in SmartSky's Appeal Brief.[50]

69. Several years after the '947 patent issued, in March 2020, Gogo Business Aviation, LLC filed a petition requesting *inter partes* review (IPR) of the '947 patent. The following prior art[51] references were brought forward in the case: IEEE-2004,[52] Agee,[53] Xu, DiFonzo, Miura,[54] and Holst.[55]

70. The PTAB ruled that the Petitioner had not shown a likelihood of anticipation or obviousness by IEEE-2004 as it failed to teach "a radio configured via software defined radio to utilize beamforming to generate a plurality of steerable beams". More specifically, SmartSky and Gogo Business Aviation (BA) proposed different versions of the plain and ordinary meaning of "software defined radio to utilize beamforming to generate a plurality of steerable beams." Gogo BA defined the plain and ordinary meaning of this phrase as "to form and/or steer radio waves in a particular direction using software," whereas SmartSky's proposed plain and ordinary meaning was "a radio configured using physical layer elements (including mixers, filters, amplifiers, modulators/demodulators, detectors, etc.), which are typically implemented in hardware using software that is implemented on a programmed computer or embedded system in order to form

---

[50] *Id.*, Page 15-22/83.

[51] I have not analyzed, nor been informed, whether the references raised by Gogo Business Aviation, LLC in the IPR of the '947 patent legally constitute "prior art" under U.S. patent law, and merely note the references raised in the IPR. I reserve the right to supplement my opinions to address whether any of the cited references qualify as prior at.

[52] Corbett Decl. Ex. 64.

[53] Corbett Decl. Ex. 65.

[54] Corbett Decl. Ex. 66.

[55] Corbett Decl. Ex. 67.

and/or steer radio waves in a particular direction." The Board rejected Gogo BA's proposed definition as improperly reading "software defined radio" out of the claim, and replacing it with "software."[56] The Board also found that the Petitioner had not shown a likelihood of anticipation or obviousness for claims 2-10 or 12-20 of the '947 IEEE-2004 or IEEE-2004 in view of Xu or DiFonzo.

71. Additionally, the board ruled that the Petitioner had not shown a likelihood of anticipation or obviousness of claims 1 and 11 of the '947 by Miura considered together with Agee. The PTAB found that the combination failed to teach "a radio configured via software defined radio to utilize beamforming to generate a plurality of steerable beams".[57] It also ruled that the Petitioner had not shown a likelihood of anticipation or obviousness for dependent claims 2-10 and 12-20 by the combination of Miura and Agee in further combination with Holst, Xu, or DiFonzo.

B. The '417 Patent

72. The prosecution history of the '417 Patent includes an October 25, 2021 Office Action where the Examiner rejected claims 1 and 11 noting a failing to comply with the written description requirement for "wherein the software defined radio is configured to employ a wireless radio access network protocol operating in a communication band from about 2 GHz to about 6 GHz."[58]

73. On November 10, 2021, SmartSky responded, noting the '417 patent specification explains that beamforming allows for re-use of frequencies, but does not specify any particular frequency range, indicating that the SDR may employ any frequency range. SmartSky also noted

---

[56] *See* Corbett Decl. Ex. 5 at 8/83.
[57] *See id.* at 11/83 and 12/83.
[58] *See* Corbett Decl. Ex. 6.

that the specification explains various examples of frequency ranges at which the SDR can operate, including 3.5 GHz and 5.8 GHz, and "the 2 to 6 GHz" band.

74. The Examiner subsequently withdrew the rejection, and issued a Notice of Allowance on November 30, 2021.

C. The '717 Patent

75. The prosecution history of the '717 patent[59] includes an August 10, 2018 Office Action where double patenting regarding USP 9,913,149 was put forward along with an obviousness argument based on Ben-Shimol (EP 2278732) and Agrawal (US 7,933,598).

76. On November 8, 2018 the patent owner filed a terminal disclaimer for U.S. patent 9,913,149. Additionally, in a subsequent response to the August 10, 2018 Office Action, the patent owner noted that Ben-Shimol "failed to disclose a base station with a directional radiation pattern, much less one oriented toward a horizon." Also, SmartSky argued that "Agarwal mentions use of unlicensed spectrum, but does not cure the deficiency of Ben-Shimol regarding a base station employing unlicensed spectrum having a particular direction radiation pattern."

77. A Notice of Allowance was issued on November 29, 2018.

D. The '077 Patent

78. The prosecution history of the '077[60] patent includes a November, 28, 2016 Office Action in which the Examiner alleged that claim 12 was obvious in view of Cruz (US2006/0040660) combined with Jalali (US2013/0182790). Claims 1-11 were allowed and claims 13-20 were objected to for depending from rejected claim 12, but allowable.

---

[59] *See* Corbett Decl. Ex. 7.
[60] *See* Corbett Decl. Ex. 8.

79. On January 13, 2017, the patent owner filed an amendment with claim 13 rewritten in independent form and claim 12 cancelled.

80. A Notice of Allowance was issued on April 5, 2017.

IX. BENEFITS OF THE PATENTED TECHNOLOGY

81. The technology claimed in the Asserted Patents includes multiple features that enable a nationwide, contiguous network of terrestrial base stations that operate in the ISM 2.4 GHz band to provide high-speed communications to aircraft in-flight, while co-existing with the millions of WiFi nodes, hotspots, and networks already operating in this free public spectrum.

82. For example, the claims of the ‘717 and ‘077 patents recite base stations defining antenna radiation patterns that are “oriented toward a horizon,” or “focusing energy toward the horizon,” which causes minimal interference to the incumbent terrestrial WiFi and other ISM band users. By contrast, if the base stations used, for example, zenith directed antennas having a radiation pattern directed straight up or at a high elevation angle, the antenna beam on the in-flight aircraft would need to be correspondingly directed down to communicate with a desired base station. But when the aircraft antenna gain is pointed downward, it would have gain in the direction of the unwanted signals from the transmissions of WiFi and other UNII users on the ground near the base station. This would diminish the in-flight aircraft’s ability to communicate with the base station due to a lower signal to noise plus interference ratio (i.e. where the unwanted signals could be considered interference). By creating a network of terrestrial base-station antennas with radiation patterns that are oriented or focused toward the horizon, minimal interference from the millions of WiFi and other UNII users, located on the ground, is seen by the patented ATG network. Reducing harmful interference, i.e. from the other unlicensed band users, is important to enable the use of applications such as videoconferencing that require high signal to noise plus interference ratios.

83. In addition, the asserted '717 patent claims further specify that one base station employs unlicensed spectrum while another base station employs licensed spectrum, and that the base stations are configured to handover communication with a radio disposed on an aircraft as the aircraft flies between cell coverage areas of the two base stations.[61] The use of both licensed and unlicensed spectrum potentially provides additional bandwidth that can be used to support certain applications, such as videoconferencing, that require higher signal to noise plus interference ratios that can support higher user data rates. In addition, the licensed spectrum usage is less susceptible to harmful interference than the usage of the unlicensed spectrum given that fact that unlicensed spectrum is shared in an uncoordinated fashion by multiple unrelated users simultaneously in time and frequency, while licensed band spectrum is controlled by the spectrum owner. Therefore, in densely populated areas, the licensed spectrum may be used to further avoid harmful interference. In addition, the handover from one base station to another base station allows for seamless transitions between coverage areas so users will not notice significant disruption in connectivity as an aircraft moves between cell coverage areas.

84. The '947 and '417 patent claims also include features that enable the use of unlicensed spectrum for an ATG network. The antenna radiation patterns that enable the co-existence in the UNII unlicensed band are created by a patented technique that uses the features of software defined radios (SDR). These SDR's feature beamforming to create the narrow, steerable antenna beams that minimize interference such that there is an uninterrupted connection during any given aircraft's internet session. By using beamforming, to provide a narrower beam, the gain associated with the beam is increased, which supports an increase in the communication range between the base station and the receiver on the aircraft. This increased range, and the base station

---

[61] *See* Corbett Decl. Ex. 3., claims 1 and 12.

radiation patterns oriented or focused toward the horizon, allow the aircraft to communicate with base stations farther away from the aircraft, and avoid terrestrial-based interference in the unlicensed band that would occur when attempting to communicate with a base station located on the ground below the aircraft, i.e. a base station using an antenna beam that is directed, say, more than 45 degrees above the horizon.

85. The ‘947 and ‘417 patent claims further recite that the beamforming allows for the reuse of the same frequency to communicate with antennas to and from different aircraft. Because SDR-based beamforming can focus the antenna radiation pattern into multiple narrow beams, a base station can communicate with multiple aircraft at the same frequency without harmful interference. Gogo’s documentation acknowledges that its “beamforming and beamsteering techniques . . . create[] a better connection with less interference.”[62] Because bandwidth is limited, the ability to re-use the same frequency to communicate with multiple aircraft, allows more aircraft to use the same bandwidth without significantly affecting performance. Moreover, beamforming allows for scalability by avoiding performance degradation as more aircraft use the system. By assigning each aircraft its own beam, as more and more aircraft use the system, each will have their own beam through which to communicate with any accessible base station. This is as opposed to non-multibeam beamforming systems in which additional aircraft compete for the same finite, fixed data capacity available in a single beam.

86. Like the ‘717 and ‘077 patents discussed above, the ‘947 and ‘417 patent claims include maintaining the data communication link to be continuous and uninterrupted in time while the in-flight nodes (i.e. aircraft-based) transition between steerable beams of two different base stations, or are handed over between base stations. By maintaining the data communication link

[62] *See* Corbett Decl. Ex. 34, Page 9.

to be continuous and uninterrupted in time as the aircraft transitions between base stations, a user on the aircraft will be less likely to experience a connectivity disruption that might negatively affect various applications, such as video conferences or file transfers.

87. Without the patented claim features discussed above, it would be extremely difficult for the ATG network to practically co-exist with terrestrial users in the ISM unlicensed band and the internet session on the aircraft would frequently drop every time a handover between base stations occurred during flight.

88. SmartSky's ATG network, which implements many of the patented features of the Asserted Patents, provides significant performance advantages over Gogo's legacy network. While short term burst/peak speeds may vary based on a number of factors, a better measure of performance is the sustained, typical average data rate capacity measured in MB/hour or GB/hour. This can be more useful for comparing the real-world capabilities of different networks. Gogo's published data rates across their legacy network is about 249 MB/hour, as shown below in FIG. 2, which is reproduced from a Gogo investor presentation in September 2021.[63]

[63] Corbett Decl. Ex. 43, slide 6 (see screenshot below).

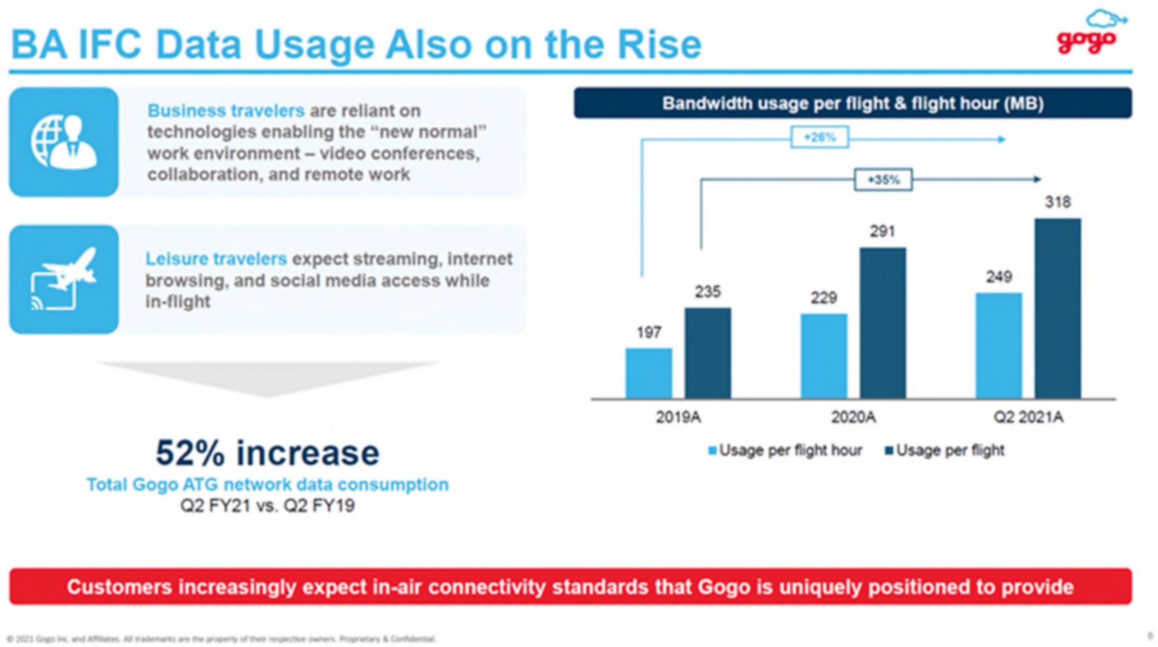


FIG. 2

This reflects a combination of the usage of various applications used by passengers, the effects of different service plans, and the mix of EVDO Rev A and B technologies used by their various products in the market.

89. By way of comparison, SmartSky's system is designed to support typical average usage of roughly 10 times this amount. In many flight demonstrations across different geographies, SmartSky has consistently seen, and immediately reported to passengers, sustained data consumption rates (combination of transmit and receive) of 2.5-5.0 GB/hour or more. For example, on a test flight in 2018 for Northland Capital, SmartSky's ATG network achieved nearly 3.5 GB/hour during a 48 minute flight, as shown in the chart reproduced below as FIG. 3.[64]

[64] Corbett Decl. Ex 68, at page 5.

Figure 3 – SmartSky Test Flight / Demo Summary

48.5	Minutes Connected
2,801.5	MB Consumed
61.1%	Forward Link (Downloading to Plane)
38.9%	Return Link (Uploading off Plane)
122	Beam Handovers
15.4	Mbps Peak Download (forward link) Speed Achieved
19.8	Mbps Peak Upload (return link) Speed Achieved
3,464.5	MB/hr Effective Rate

FIG. 3

90. During two customer demonstration flights in October 2021 that lasted approximately 40-45 minutes, the SmartSky ATG network achieved an effective data rate of roughly 3.2 to 3.4 GB/hour, as shown in the results below reproduced as FIGs. 4 and 5.[65]

[65] *See* Corbett Decl. Ex. 69.

Your SmartSky Personalized Demo Experience Summary	
44.0	Minutes Connected
2463.4	MBytes Consumed
72.7	% Forward link (downloading to plane)
27.3	% Return link (uploading off plane)
13	Site to Site Handovers
6	Sector to Sector Handovers
90	Beam Handovers
21.0	Mbits/second Peak Download (forward link) Speed Achieved
14.0	Mbits/seconds Peak Upload (return link) Speed Achieved
3359.2	MBytes/hr effective rate
7.5	Mbits/second effective rate
67.6	Minimum Roundtrip Latency (ms)
316.0	Total distance covered (nautical miles)
3.0	Sites covered
12	Total devices connected

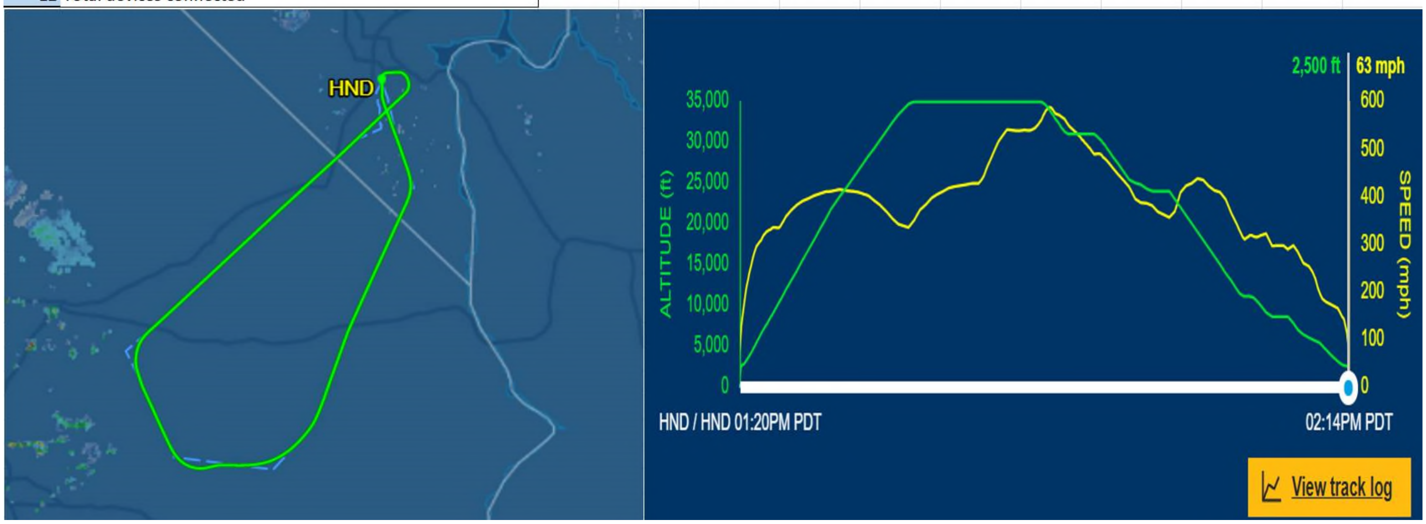


FIG. 4

Your SmartSky Personalized Demo Experience Summary	
41.1	Minutes Connected
2168.0	MBytes Consumed
73.4	% Forward link (downloading to plane)
26.6	% Return link (uploading off plane)
11	Site to Site Handovers
5	Sector to Sector Handovers
85	Beam Handovers
20.0	Mbits/second Peak Download (forward link) Speed Achieved
15.0	Mbits/seconds Peak Upload (return link) Speed Achieved
3167.5	MBytes/hr effective rate
7.0	Mbits/second effective rate
47.3	Minimum Roundtrip Latency (ms)
319.0	Total distance covered (nautical miles)
3.0	Sites covered
11	Total devices connected

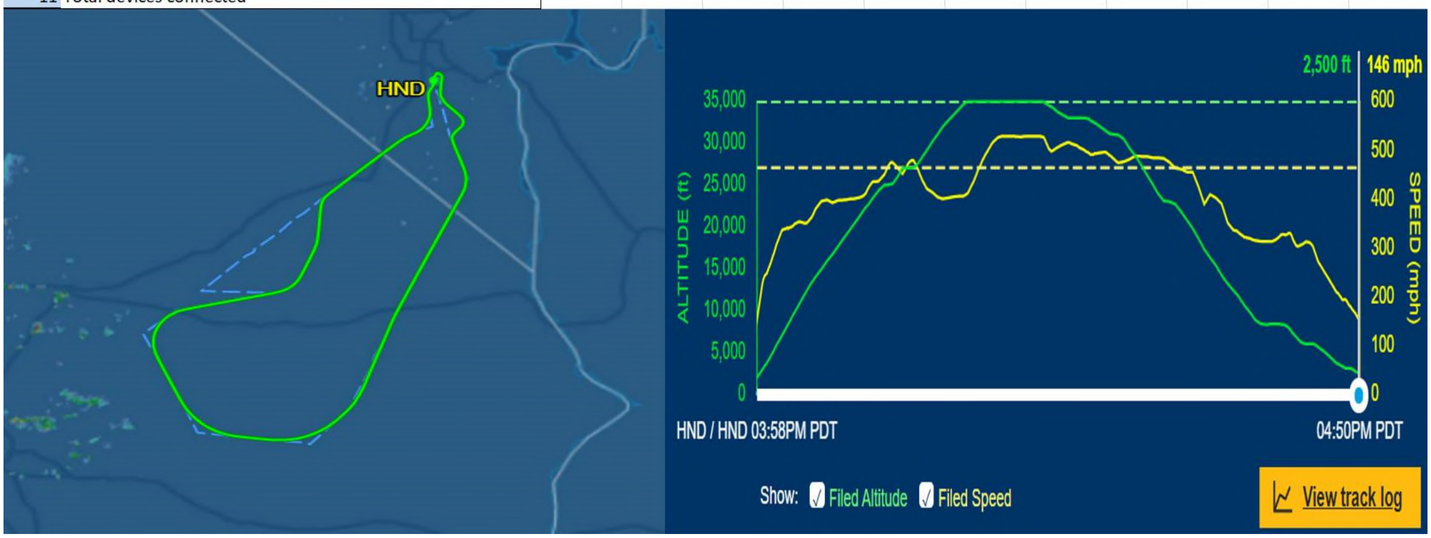


FIG. 5

91. The theoretical capacity of a single channel communications network, in an additive white, Gaussian noise (AWGN) only environment, can be calculated by Shannon's Capacity Theorem [66] For a network that is comprised of multiple independent channels, the theoretical network capacity depends on three factors, the total amount of bandwidth employed, the number of independent channels, and the average signal to noise ratio on the communication channel.

[66] *See* Corbett Decl. Ex. 70.

$$C = \sum_{i=1}^{n} W_i \log(1 + SNR_i)$$

where C is the total theoretical network capacity, n is the number of independent channels, W_i is the bandwidth of the i^{th} channel, and SNR_i is the Signal to Noise Ratio of the ith channel.

92. In the case of SmartSky versus Gogo 5G, both companies are accessing the same basic amount of spectrum in the unlicensed band (60 MHz), so the capacity of each system will be largely based on the use of multibeam beamforming and the network architecture which both directly impact the ‘n’ in the equation, i.e. the number of beams, along with the signal quality (e.g. Signal to Noise Ratio or SNR) which, as it improves, allows the radio to use higher order modulation rates for faster data speeds. SmartSky’s patented features directly contribute to the capacity of its network, and Gogo’s use of SmartSky’s patented features directly contribute to the increased capacity that Gogo has touted for its 5G network.

X. ACCUSED PRODUCTS AND FEATURES

A. Gogo 5G Unlicensed Band System

93. Gogo has announced that it intends to launch its Gogo 5G network as early as mid-2022. Gogo has also disclosed numerous features of its 5G network that incorporate SmartSky’s patented technology. For example, and as explained in more detail below, Gogo’s marketing literature refers to Gogo’s 5G network as including a network of base stations having software-defined radios that use beamforming to generate multiple steerable beams. By generating multiple steerable beams, the same frequency can be re-used to communicate with different in-flight nodes of the network. In addition, also stated is that the Gogo 5G network conducts “make before break” handoffs, in which an in-flight node transitions from a beam associated with one base station to

another beam associated with another geographically-disparate base station to maintain a continuous and uninterrupted connection. Additionally, the public marketing literature also notes that the Gogo 5G base stations use unlicensed spectrum, and include antenna arrays having a directional radiation pattern oriented toward the horizon. By orienting the directional radiation pattern toward the horizon, interference with terrestrial use of unlicensed spectrum may be reduced. At least some of the Gogo 5G base stations are co-located on existing Gogo cell sites that use licensed spectrum, such that communication handover may occur between base stations using licensed and unlicensed spectrum.

94. Gogo notes that "[u]tilizing unlicensed spectrum in the 2.4 GHz range allows Gogo's signal to travel greater distances than the spectrum the wireless carriers can enable."[67] Gogo also touts that its 5G network "will use beamforming and beamsteering techniques that deliver a more direct signal to the aircraft, as opposed to a wide signal that loses strength over distance. This creates a better connection with less interference."[68]

XI. INFRINGEMENT OF THE ASSERTED PATENTS

95. This section summarizes Gogo's infringement of the asserted patents and claims. Each claim element is followed by a discussion explaining how the Gogo 5G system meets the corresponding claim element, with citations to supporting evidence. In my infringement analysis below, I have applied the plain and ordinary meaning of the patent claims discussed below. For purposes of analyzing infringement of the '947 patent, I have applied the construction SmartSky proposed for the "software defined radio" claim element during the IPR proceedings for the '947 patent, as discussed above.

A. The '947 Patent

---

[67] *See* Corbett Decl. Ex. 34 at 9.
[68] *Id.*

Claim 1: Preamble: A network base station within a network including at least one in-flight communication node, the network base station comprising:

96. Gogo's 5G network includes multiple base stations within a network that includes at least one in-flight communication node. See Gogo's infographic in FIG. 6 below where base stations are designated by tower icons operating at 850 MHz and 2.4 GHz. Additionally, the in-flight communication nodes are designated by airplane icons where the in-flight nodes operate at the same, 850 MHz and 2.4 GHz bands as the base stations.[69]

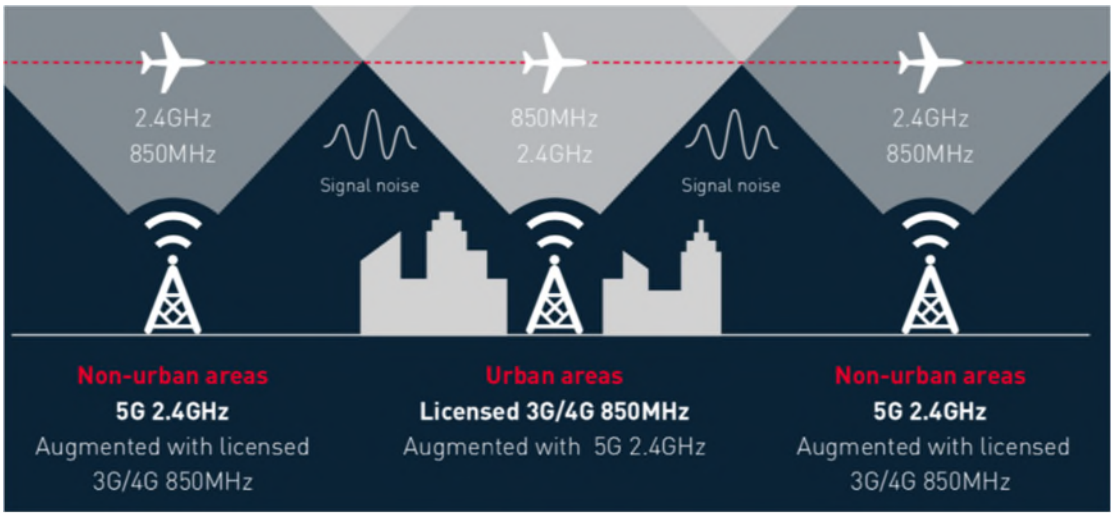


FIG. 6

Claim 1: Limitation (1): a radio configured via software defined radio to utilize beamforming to generate a plurality of steerable beams, to enable multiple reuses of a same frequency to communicate with respective different in-flight communication nodes via respective different communication links,

97. Gogo management has publicly stated that the base station's use software defined radios (SDR) which replace hardware components with software running on a server.[70] More specifically, at a Gogo sponsored seminar at the National Business Aviation Association (NBAA)

[69] *Id.*, at Pages 5, 20.
[70] Corbett Decl. Ex. 35 at 20:50-21:55.

conference in October 2021, Gogo's Director of Network Engineering, Mike Schnepf, explained that Gogo's base stations include a "software-defined radio," which he explained "tak[es] hardware and run[s] it on containerized solutions on common server hardware."[71] Mr. Schnepf further explained that "we [Gogo] take the guts of a physical component and now we're going to run it on a container on a server."[72] As one of ordinary skill in the art would understand, the "hardware" or "guts of a physical component" refers to physical layer elements of a radio, such as mixers, filters, amplifiers, modulators/demodulators, detectors, etc., which are typically implemented in hardware. One of ordinary skill in the art would understand that "run[ning]" these hardware components "on a container" or "on a containerized solution" on a server, means that the hardware components are implemented using software implemented on a programmed computer or embedded system.

98. Additionally, two of Gogo's partners, Airspan Networks and First RF Corporation, which respectively designed the Gogo 5G base stations and aircraft antennas, have explained that the SDR uses beamforming and a phased array to generate steerable beams in particular directions to enable communication with multiple aircraft.[73] In particular, during a Gogo-led panel discussion at an NBAA conference in 2019, Airspan Networks' Senior Vice President of Engineering, Mike Livingstone, explained that Gogo's 5G base stations generate six beams in a particular sector, which can be used to communicate with six different aircraft using the same frequency.[74] Gogo marketing documentation also states that their base station uses "advanced

---

[71] *Id.*
[72] *Id*.
[73] Corbett Decl. Ex. 36; at 16:30-17:10, 24:50-26:00, 28:05-28:35, 40:45-42:25.
[74] *Id*. at 24:50-26:00, 28:05-28:35.

beamforming and tracking techniques," as shown below in FIG. 7.[75] According to Gogo's marketing documents (shown below in FIG. 8), the Gogo 5G base stations "will use beamforming and beamsteering techniques that deliver a more direct signal to the aircraft."[76]

Partner profile:

Airspan

RAN technology

Gogo's 5G system will be based on Airspan's carrier grade radio access network (RAN) platform, Air5G OpenRANGE. The platform will enable end users to experience the full potential of an enhanced mobile broadband network thanks to features such as Airspan's advanced beamforming and tracking techniques, capable of communicating with an aircraft traveling in excess of 750 miles per hour.

"Currently, no other 5G solutions can cope with the high speeds and long ranges typical with business aircraft. But Airspan is providing the RAN horsepower users need to stay productive everywhere."

– MIKE LIVINGSTONE, SENIOR VICE PRESIDENT OF ENGINEERING

FIG. 7

---

[75] Corbett Decl. Ex. 34 at Page 16.
[76] *Id*. at 9.

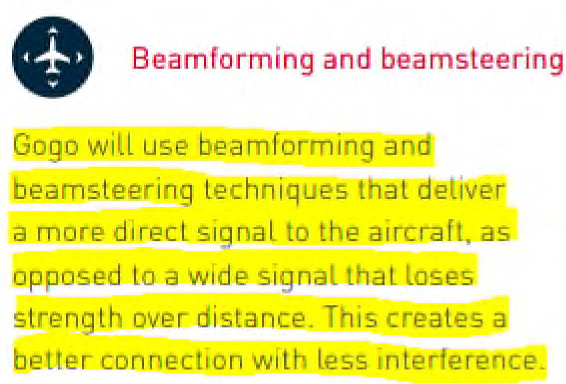


FIG. 8

99. In particular, the Gogo 5G base stations include 16-antenna digital port beamforming antennas using massive MIMO technology, as shown below in FIG. 9.[77]

100. Additionally, in a Businesswire press release on January 20, 2022, Gogo and their partner, Airspan Networks stated "Gogo's 5G ATG network is powered by Airspan's OpenRANGE Air5G Sub-6 GHZ Radio Unit (RU) macros, fully virtualized OpenRANGE vCU (Centralized Unit) and vDU (Distributed Unit) software, and massive MIMO antennas. The unique antenna solutions are ruggedized and proven for harsh environments, and provide a series of critical features including advanced beam shaping, high-precision beam pointing, specifically designed beam profiles for long range air-to-ground applications, critical interference suppression, and support of Doppler Effect exceeding 3GPP (industry standard) speeds by four times -- in excess of 1200 km/hour/750 MPH." In this statement, the use of the words "macros", "virtualized", "vDU software", "advanced beam shaping", "high-precision beam pointing", and "specifically designed beam profile" would indicate to one of ordinary skill in the art that the Gogo 5G base stations are "configured via software defined radio to utilize beamforming to generate a plurality of steerable beams." This is confirmed by noting that Gogo references the

[77] Corbett Decl. Ex. 37 at 4-5.

Airspan Air5G Radio Unit (RU) which utilizes "3D digital beamforming" as described in the Airspan OpenRANGE 5700 Product Summary document.[78]

Airspan Technology

The vast amount of Macro base stations will leverage state-of-the-art features and technologies, such as massive MIMO antenna arrays that use digital beamforming and advanced tracking algorithms. Virtualizing the Radio Access Network (RAN) brings an innovative 5G architecture, based on 3GPP (https://www.3gpp.org), O-RAN (https://www.o-ran.org), and TIP (https://telecominfraproject.com) standards. This will allow the teams to rapidly introduce new, advanced features to improve performance, scale resources based on cloud-native OpenRANGE Software and COTS, and centralize control of all radios to facilitate management and orchestration of the network. Achieving top performance is possible due to the network's v-RAN architecture, interference minimization techniques, and advanced 16-port digital beamforming and tracking techniques that deliver an overwhelming 6-layer multi-user MIMO.

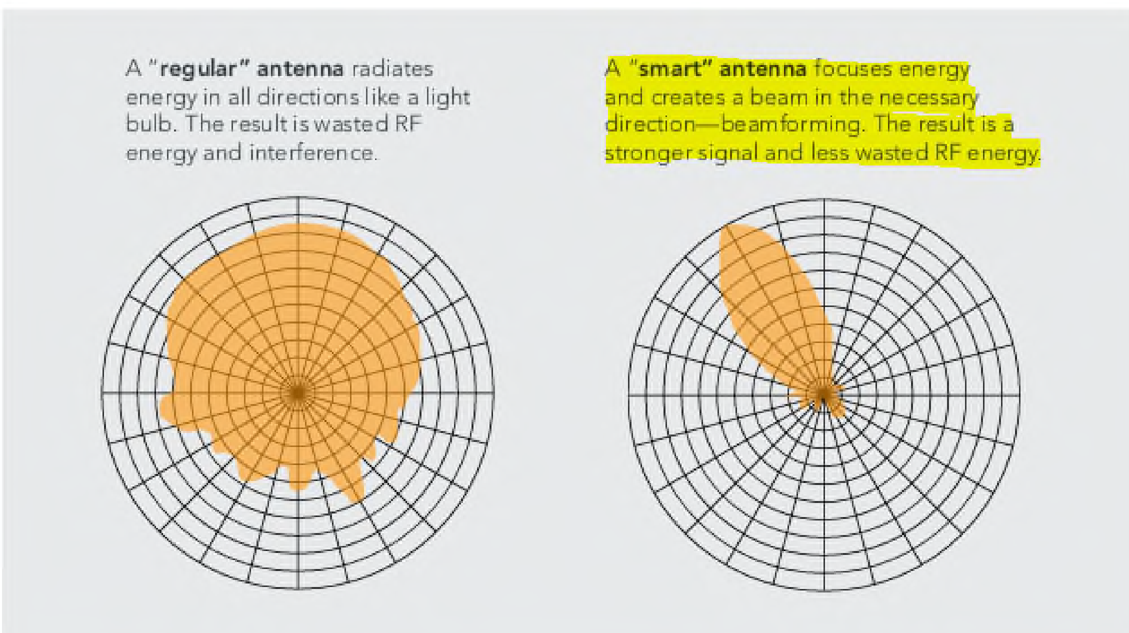


FIG. 9

[78] *See* Corbett Decl. Ex. 82.

101. Finally, Gogo management has stated publicly that multiple beams (at least 6) can be generated and used to utilize the same bandwidth without interference.[79]

> **Claim 1: Limitation (2):** wherein the respective different communication links are high speed data communications links that are enabled to be maintained continuous and uninterrupted in time while one of the respective different in-flight communication nodes transitions between a first steerable beam associated with a first coverage area defined by the network base station and a second steerable beam associated with a second coverage area defined by another network base station, the first and second coverage areas at least partially overlapping.

102. Gogo management has described "make before break" handoffs, in which multiple steerable beams are used to establish communication links leveraging different base stations to create overlapping coverage areas so that the communications link is "made" with the next base station before it is "broken" with the previous base station.[80] Gogo's "make before break" handoffs are one example of a communication link that is "maintained continuous and uninterrupted in time." Additionally, Gogo marketing literature states that the system provides "uninterrupted connectivity" to passengers, as shown in FIG. 10 below.[81]

---

[79] Corbett Decl. Ex. 36 at 25:30-28:35.
[80] *Id.*, at 36:00-38:00.
[81] Corbett Decl. Ex. 38, Page 4.

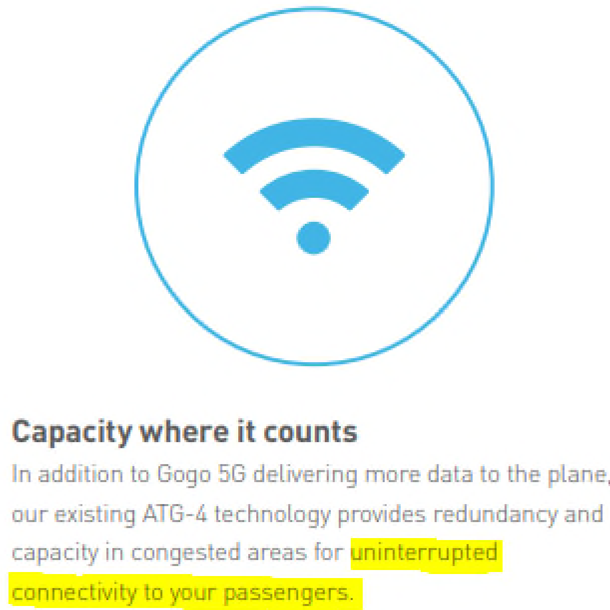


FIG. 10

103. As shown below in FIG. 11, Gogo also claims that its 5G network will provide passengers with "connection speeds similar to what they experience on the ground, including streaming video." This indicates "high speed" operation.[82]

An air-to-ground evolution

Gogo 5G brings a significant change to our North American ground network. By delivering more data than our current ground technology, passengers will enjoy connection speeds similar to what they experience on the ground, including streaming video.

This ground-based technology is optimal for regional jets, smaller mainline jets and private aircraft. Gogo 5G leverages existing equipment and results in low total cost of ownership, minimal install times, and reduced drag.

FIG. 11

Claim 11: Preamble: A network comprising a plurality of network base stations configured to communicate with at least one in-flight node, the network base stations including at least two base stations having coverage areas that at least partially overlap with each other, each of the at least two base stations including:

[82] *Id.*, Page 1.

104. See ¶¶ 96, 102 above.

Claim 11: Limitation (1): a radio configured via software defined radio to utilize beamforming to generate a plurality of steerable beams, to enable multiple reuses of a same frequency to communicate with respective different in-flight communication nodes via respective different communication links,

105. See ¶¶ 97-101 above.

Claim 11: Limitation (2): wherein the respective different communication links are high speed data communications links that are enabled to be maintained continuous and uninterrupted in time while one of the respective different in-flight communication nodes transitions between corresponding steerable beams associated with respective ones of the coverage areas defined by the at least two base stations.

106. See ¶¶ 102-103 above.

B. The '417 Patent

Claim 1: Preamble: A ground station among a network of ground stations configured to provide a wirelessly transmitted high speed data communication link to a receiver station on an in-flight aircraft, the ground station comprising:

107. The Gogo marketing literature describes the Gogo 5G network as being a nationwide network, with roughly 150 base stations, that provide seamless coverage of high-speed data to a receiver station on an in-flight aircraft.[83] See also ¶¶ 96, 102-103.

Claim 1: Limitation (1): an antenna

108. In an article reporting the installation of a 7-tower Gogo testbed, the photo depicted below as FIG. 12 shows a panel antenna array installed on one of Gogo's base stations for the Gogo 5G network.[84] More specifically, the Gogo 5G base stations include 16-antenna digital port beamforming antennas using massive MIMO technology.[85] *See also* ¶ 99.

[83] Corbett Decl. Ex. 34, Pages 10, 11, 19, 20.
[84] *See* Corbett Decl. Ex. 45.
[85] Corbett Decl. Ex. 37 at 4-5.

FIG. 12

> **Claim 1: Limitation (2):** a software defined radio operably coupled to the antenna, the software defined radio configuring the ground station to conduct a handover of the in-flight aircraft to another ground station within the network of ground stations to maintain the high speed data communication link continuous and uninterrupted in time;

109. Gogo management publicly stated that Gogo base stations or cell sites include a "software defined radio" which replaces hardware components using software running on a server.[86] See also ¶¶ 97, 100, 102-103.

> **Claim 1: Limitation (3):** wherein the software defined radio is configured to employ a wireless radio access network protocol operating in a communications band from about 2 GHz to about 6 GHZ,

110. Gogo marketing literature describes the continuous and uninterrupted coverage. Additionally, Gogo management publicly described the "make before break" handoff of coverage between base stations such that continuous coverage is supported.[87] [88] The Gogo marketing

---

[86] Corbett Decl. Ex. 35 at 20:50-21:55.
[87] Corbett Decl. Ex. 36, 36:00-38:00.
[88] Corbett Decl. Ex. 38 at Page 4.

literature also states that the Gogo 5G network uses a “multi-carrier LTE signal that enables more bandwidth.” This refers to an OFDM modulation technology. The same literature notes the network operation in the 2.4 GHz band, as shown below in FIG. 13. [89]

Gogo will build the 5G network on its existing infrastructure of more than 250 towers and will use unlicensed spectrum in the 2.4GHz range, along with a proprietary modem and advanced beamforming technology. Gogo's 5G infrastructure will support all spectrum types (licensed, shared, unlicensed) and bands (mid, high, low), and will allow Gogo to take advantage of new advances in technology as they are developed. Similar to how wireless carriers provide redundancy across their networks, Gogo will continue to employ its 3G and 4G networks throughout the continental U.S. and in Canada that will provide backup to the 5G network when needed.

FIG. 13

Claim 1: Limitation (4): wherein the ground station is configured to utilize beamforming to generate one or more steerable beams used to form the high speed data communication link; and

[89] Corbett Decl. Ex. 39.

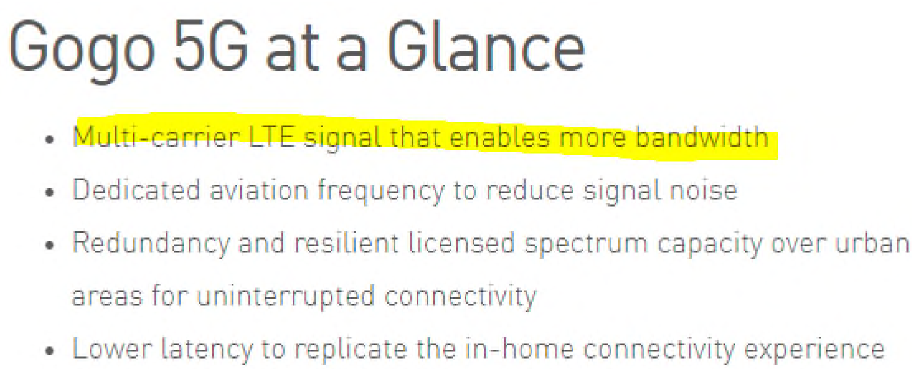
111. See ¶¶ 98-100.

Claim 1: Limitation (5): wherein the ground station is configured to use a same frequency to communicate with the receiver station and another receiver station on another in-flight aircraft.

112. By using beamforming, the Gogo network is able to reuse spectrum by transmitting on multiple simultaneous narrow beams. [90] See ¶¶ 96-98.

Claim 2: The ground station of claim 1, wherein the wireless radio access network protocol includes Long Term Evolution (LTE) terrestrial radio access network protocols.

113. The Gogo marketing literature clearly states that Multi-carrier LTE is used in the Gogo 5G network, as shown below in FIG. 14. [91]


Gogo 5G at a Glance

- Multi-carrier LTE signal that enables more bandwidth
- Dedicated aviation frequency to reduce signal noise
- Redundancy and resilient licensed spectrum capacity over urban areas for uninterrupted connectivity
- Lower latency to replicate the in-home connectivity experience

FIG. 14

Claim 5: The ground station of claim 1, wherein the high speed data communications link is configured to provide internet access, streaming video, or voice-over IP to the receiver station.

114. The Gogo marketing literature clearly states that passengers will be provided "streaming video" as part of the Gogo 5G network experience. [92]

---

[90] Corbett Decl. Ex. 36 at 25:30-28:00.
[91] Corbett Decl. Ex. 39.
[92] Corbett Decl. Ex. 38, Page 1.

Claim 8: The ground station of claim 1, wherein the high speed data communications link employs Orthogonal Frequency Division Multiplexing (OFDM).

115. The Gogo marketing literature clearly states that Multi-carrier LTE is used in the Gogo 5G network.[93] The use of LTE implies the use of Orthogonal Frequency Division Multiplexing (OFDM) as OFDM is an inherent component in every LTE network.[94] In a May 26, 2021 FCC filing, Gogo also stated that "Gogo BA's next-generation ATG system will deploy a new telecommunications standard using Orthogonal Frequency Division Multiplex technology ("OFDM") to improve throughput, coverage, and reliability for inflight connectivity to aircraft in the United States and Canada."[95]

Claim 11: Preamble: A network configured to provide high speed wirelessly transmitted data communications to an in-flight aircraft, the network comprising:

116. See ¶¶ 96, 103.

Claim 11: Limitation (1): a plurality of ground transmission stations, the ground transmission stations begin located such that at least some of the ground transmission stations are within overlapping communications range of respective other ones of the ground stations, the ground transmission stations being configured to communicate with via software defined radio to:

117. See ¶¶ 96, 97, 100, 102.

Claim 11: Limitation (2): communicate with a receiver station located onboard the in-flight aircraft to provide a high speed data communication link continuous and uninterrupted in time with the receiver station employing a wireless radio access network protocol operating in a communication band from about 2 GHz to about 6 GHz, and

---

[93] Corbett Decl. Ex. 39.
[94] Corbett Decl. Ex. 71.
[95] *See* Corbett Decl. Ex. 40.

118. The Gogo marketing literature states that the Gogo 5G network has "uninterrupted connectivity." [96] It also states the use of the 2.4 GHz band spectrum. [97]See also ¶¶ 97, 100, 102, 103, 110.

Claim 11: Limitation (3): utilize beamforming to generate a plurality of steerable beams used to form the high speed data communication link, and reuse a same frequency to communicate with the receiver station and another receiver station on another in-flight aircraft,

119. The Gogo marketing literature states that the Gogo software defined radio uses beamforming to send six signals simultaneously to different aircraft using the same bandwidth and spectrum without interference. This is also known as spatial division multiplexing where different information can be sent on different antenna beams to different in-flight aircraft at the same time without interference. [98] See also ¶¶ 98-101.

Claim 11: Limitation (4): wherein the high speed data communication link is maintained continuous and uninterrupted in time while the in-flight aircraft moves from a coverage area provided by one of the plurality of ground stations to a coverage area provided by another of the plurality of ground stations.

120. The Gogo marketing literature states that the Gogo 5G network has "uninterrupted coverage" provided by an "existing network of cell sites."[99] As discussed above, the Gogo 5G network also conducts "make before break" handoffs as the in-flight aircraft moves from the coverage area of one base station to a coverage area of another base station. See ¶ 102.

Claim 12: The network of claim 11, wherein the wireless radio access network protocol includes Long Term Evolution (LTE) terrestrial radio access network protocols.

---

[96] Corbett Decl. Ex. 38 at Page 4.
[97] *Id.*, Page 3.
[98] Corbett Decl. Ex. 46.
[99] Corbett Decl. Ex. 38 at Page 4.

121. The Gogo marketing literature clearly states that Multi-carrier LTE is used in the Gogo 5G network.[100] The use of LTE implies the use of Orthogonal Frequency Division Multiplexing (OFDM) as OFDM is an inherent component in every LTE network.[101] See also ¶ 113.

Claim 15: The network of claim 1, wherein the high speed data communications link is configured to provide internet access, streaming video, or voice-over-IP to the receiver station.

122. The Gogo marketing literature clearly states that passengers will be provided "streaming video" as part of the Gogo 5G network experience. [102]

Claim 18: The network of claim 1, wherein the high speed data communications link employs Orthogonal Frequency Division Multiplexing (OFDM).

123. The Gogo marketing literature clearly states that Multi-carrier LTE is used in the Gogo 5G network.[103] The use of LTE implies the use of Orthogonal Frequency Division Multiplexing (OFDM) as OFDM is an inherent component in every LTE network.[104] In a May 26, 2021 FCC filing, Gogo also stated that "Gogo BA's next-generation ATG system will deploy a new telecommunications standard using Orthogonal Frequency Division Multiplex technology ("OFDM") to improve throughput, coverage, and reliability for inflight connectivity to aircraft in the United States and Canada."[105]

C. The '717 Patent

Claim 1: Preamble: A network for providing air-to-ground (ATG) wireless communication in various cells, comprising:

---

[100] Corbett Decl. Ex. 39.
[101] Corbett Decl. Ex. 71.
[102] Corbett Decl. Ex. 38, Page 1.
[103] Corbett Decl. Ex. 39.
[104] Corbett Decl. Ex. 71.
[105] Corbett Decl. Ex. 40.

124. The Gogo 5G network provides ATG wireless communication in multiple cells, each including a base station, tower, and antenna array.[106] See also ¶¶ 96, 102.

Claim 1: Limitation (1): first base station including a first antenna array defining a first directional radiation pattern that is oriented toward a horizon; and

125. Gogo management has stated that Gogo base stations have antennas with directional radiation patterns that are located at elevated positions so that they can "see the horizon". [107] [108]Additionally, Gogo has also stated that it locates it base stations "away from an urban environment that can transmit back over the urban environment". [109] By "transmit[ting] back over the urban environment," the antenna array of Gogo's 5G base station is using a directional radiation pattern oriented more toward the horizon than upward.

126. In an article reporting the installation of a 7-tower Gogo testbed, the following photo depicts a panel antenna array installed on one of Gogo's base stations for the Gogo 5G network.[110]

---

[106] Corbett Decl. Ex. 34, Pages 5, 20.
[107] Corbett Decl. Ex. 35, 23:45-24:00.
[108] Corbett Decl. Ex. 34, Page 20.
[109] Corbett Decl. Ex. 35, 41:38-41:47.
[110] Corbett Decl. Ex. 45.

127. The face of the panel antenna arrays depicted above are oriented toward the horizon, indicating that the main lobes of the radiation patterns generated are likely oriented more toward the horizon than, for example, perpendicular to it.

128. Therefore, the Gogo 5G network includes "a first base station including a first antenna array defining a first directional radiation pattern that is oriented toward a horizon."

> **Claim 1: Limitation (2):** a second base station including second antenna array defining a second directional radiation pattern that at least partially overlaps with the first base station,

129. Gogo marketing literature indicates that the Gogo 5G system uses multiple base stations with directional radiation patterns that at one base station with an antenna array and a directional radiation pattern that at least partially overlaps a second base station. [111] See also ¶¶ 102, 125-128.

Claim 1: Limitation (3): wherein the first base station employs unlicensed spectrum,

[111] Corbett Decl. Ex. 34, Page 20.

130. Gogo marketing literature also indicates that the network operates in unlicensed spectrum, e.g. 2.4 GHz. [112] See also ¶ 110.

Claim 1: Limitation (4): wherein the second base station employs licensed spectrum,

131. Gogo marketing literature also indicates that the network includes a second base station that operates using Gogo's 3 MHz of licensed spectrum in the 850 MHz band. [113]

Claim 1: Limitation (5): wherein the first and second base stations are each configured to wirelessly communicate with a radio disposed on an aircraft flying through respective cell coverage areas of the first and second base stations, and

132. Gogo marketing literature also indicates that the base stations, manufactured by Airspan, "consist[] of 5G vRAN base stations with 16-antenna digital port beamforming antennas using massive MIMO (multiple input – multiple output) technology," which allows the base stations to wirelessly communicate with a radio disposed on an aircraft flying through respective cell coverage areas of Gogo's 5G base stations. [114] See also ¶¶ 96, 98-101.

Claim 1: Limitation (6): wherein the first and second base station are each configured to handover communication with the radio as the aircraft moves between the respective cell coverage areas of the first and second base stations.

133. Gogo management has publicly stated that the network base stations are configured to operate in a "make before break" mode, using overlapping beams so that communications to the in-flight communication node (i.e. the aircraft) are handed off without interrupting the connection.[115] See also ¶ 102.

Claim 12: Preamble: A network for providing air-to-ground (ATG) wireless communication in various cells, comprising:

---

[112] *Id.*
[113] *Id.*
[114] Corbett Decl. Ex. 37, Pages 4-5.
[115] Corbett Decl. Ex. 36, 36:00-38:00.

134. See ¶ 124 above.

Claim 12: Limitation (1): first base station including a first antenna array defining a first directional radiation pattern that is oriented toward a horizon; and

135. See ¶¶ 125-128 above.

Claim 12: Limitation (2): a second base station including second antenna array defining a second directional radiation pattern that at least partially overlaps with the first base station,

136. See ¶129 above.

Claim 12: Limitation (3): wherein one of the first base station or the second base station employs unlicensed spectrum, and the other of the first base station and the second base station employs licensed spectrum,

137. See ¶¶ 130-131 above.

Claim 12: Limitation (4): wherein the first and second base stations are each configured to wirelessly communicate with a radio disposed on an aircraft flying through respective cell coverage areas of the first and second base stations and,

138. See ¶132 above.

Claim 12: Limitation (5): wherein the first and second base stations are each configured to handover communication with the radio as the aircraft moves between the respective cell coverage areas of the first and second base stations.

139. See ¶133 above.

D. The ’077 Patent

Claim 1: Preamble: An air-to-ground (ATG) network providing wireless communication to an in-flight aircraft capable of passing through various cells of the ATG network, the ATG network comprising:

140. Gogo marketing literature describes an ATG network providing wireless communication to an in-flight aircraft passing through various cells of the ATG network. The

literature shows multiple base stations with aircraft moving through the various cells. [116] See also ¶ 124 above.

> **Claim 1: Limitation (1):** a first ATG base station defining a first radiation pattern focusing energy toward the horizon;

141. Gogo management has publicly stated that its base stations are located "away from an urban environment that can transmit back over the urban environment." This indicates that the antenna arrays have radiation patterns that transmit toward a horizon. [117] See also ¶¶ `125-128.

> **Claim 1: Limitation (2):** a second ATG base station defining a second radiation pattern focusing energy toward the horizon; and

142. Similarly, Gogo management has also publicly stated that its base stations are located "away from an urban environment that can transmit back over the urban environment." This implies that the antenna arrays from multiple bases stations have radiation patterns that transmit toward a horizon. [118] [119] See also ¶ `129.

> **Claim 1: Limitation (3):** a plurality of additional ATG base stations, each of which defines a corresponding radiation pattern focusing energy toward the horizon,

143. Similarly, Gogo management has also publicly stated that its base stations are located "away from an urban environment that can transmit back over the urban environment." This implies that the antenna arrays from multiple bases stations have radiation patterns that

---

[116] Corbett Decl. Ex. 34, Page 20.
[117] Corbett Decl. Ex. 35, 23:45-24:00.
[118] *Id.*
[119] Corbett Decl. Ex. 34, Page 20.

transmit toward a horizon. [120] [121] Gogo has also shown, in its marketing literature, that Gogo 5G network is nationwide. [122] See also ¶¶ `125-129.

> **Claim 1: Limitation (4):** wherein the first, second and additional ATG base stations are spaced apart from each other to define at least partially overlapping coverage areas to communicate with an antenna assembly on the in-flight aircraft in an ATG communication layer defined between a first altitude and a second altitude via the ATG network,

144. The Gogo marketing literature describes a first, second, and, at least, a third ATG based station that are spaced apart from each other to define at least partially overlapping coverage. The same literature shows aircraft flying though the network coverage areas from the overlapping antenna array radiation pattern. [123] See also ¶ 102.

145. Additionally, Gogo marketing literature states, "Gogo's 5G systems will support service below 10,000 feet AGL using the licensed portion of our spectrum via 4G. The system will seamlessly transition to the full Gogo 5G experience once available above 10,000 feet AGL," which would define the lower end or "first altitude" of an ATG communication layer. [124] Gogo's 5G network will enable communication with an antenna assembly on an in-flight aircraft at elevations up to 35,000 or 40,000, which would define the ceiling or "second altitude" of the ATG communication layer.[125]

> **Claim 1: Limitation (5**): wherein a plurality of terrestrial base stations are configured to communicate primarily in a ground communication layer below the first altitude via a terrestrial communication network, and

[120] Corbett Decl. Ex. 35, 23:45-24:00.
[121] Corbett Decl. Ex. 34, Page 20.
[122] Corbett Decl. Ex. 38, Page 4, 5.
[123] Corbett Decl. Ex. 34, Page 20.
[124] Corbett Decl. Ex. 41.
[125] *See* Corbett Decl. Ex. 72.

146. The Gogo network, as explained in their marketing literature, uses a large number of base stations, to cover an area at least as large as the continental United States. This network coverage area overlaps the nationwide network of personal and business WiFi terrestrial base stations that operate on the ground, well below 10,000 feet (or the "first altitude"). [126]

> **Claim 1: Limitation (6):** wherein the first, second and additional ATG base stations are each configured to communicate in the ATG communication layer using the same radio frequency (RF) spectrum used by the terrestrial base stations in the ground communication layer.

147. The Gogo network, as described in their marketing literature, has multiple base stations each configured to communicate in the ATG communication layer in, at least, the 2.4 GHz unlicensed spectrum, which is the same spectrum used by the nationwide network of terrestrial Wi-Fi base stations below the 10,000 feet "first altitude." [127] See also ¶ 110 above.

> **Claim 2:** The ATG network of claim 1, wherein a serving ATG base station from among the first, second and additional ATG base stations is in communication with the in-flight aircraft while being geographically located outside a coverage area of each of the terrestrial base stations in a portion of the ground communication layer above which the in-flight aircraft is located.

148. Gogo's previous statements indicate that the Gogo base stations are located "away from an urban area" and "transmitting back into the urban area," which indicates that the Gogo 5G antenna beams that are used to communicate with an in-flight aircraft originate from a base station far enough away from the in-flight aircraft that the base station is located outside of a coverage area of the base stations of the terrestrial Wi-Fi network that are below the in-flight aircraft. [128]

---

[126] Corbett Decl. Ex. 34, Page 20.
[127] *Id.*, Page 20.
[128] Corbett Decl. Ex. 36, at 25:00-28:00.

XII. SUMMARY

149. It is my opinion that based on the materials I have studied in this case, that Gogo, through its sale and use of its Gogo 5G network, infringes on each and every one of the limitations of the asserted claims of the asserted patents.

XIII. CONCLUSION

150. The opinions offered above are my opinions based on the information made available to me to date. I reserve the right to supplement or amend the opinions in this declaration to the extent additional information becomes available to me, including new information published or produced by Gogo Inc. or Gogo BA in this litigation. I also reserve the right to respond to any opinions offered by Gogo Inc. or Gogo BA, or their expert(s), in response to my declaration or SmartSky's motion.

[SIGNATURE PAGE TO FOLLOW]

151. I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct.

Dated: 2/28/2022

By: ______________________
Steven H. Goldberg

EXHIBIT A

STEVEN H. GOLDBERG
18480 Chelmsford Drive, Cupertino, California 95014
E-mail: steve_goldberg@comcast.net
Mobile: 650-868-9040

SUMMARY

SENIOR HIGH TECHNOLOGY EXECUTIVE with 30+ years of management experience in both small and large business environments. Strong technical background with emphasis on wireless, security, signal processing, AI/ML, telematics, and networking. A hands-on, energetic, people-oriented leader with proven ability to quickly build effective results-oriented teams with focused business objectives. Strong interpersonal and business skills are equally effective with customers and partners as with employees.

- **Operating Partner at Tier 1 venture capital firm for 10+ years**
- **Serial CEO with early-stage technology companies**
- **25+ cases as Expert Witness for IP and patent disputes**
- **Early-stage technology investor and board member**
- **Built successful teams at Trimble, Cylink, Verticom, Nokia, and Arcwave**
- **Supported revenue generation from pre-revenue (Arcwave) to >$250M (Nokia)**
- **Managed ASIC development at Cylink, Nokia, and CoWave**
- **Functional AI skillset including adaptive filtering and 1D/2D signal processing**

PROFESSIONAL EXPERIENCE

FINISTERE VENTURES, Palo Alto, CA **November 2021 – Present**
Partner

Investing partner at early-stage venture capital firm; focused on technology-based companies focused on food ecosystem including adjacent areas of agriculture, supply chain, finance, robotics, climate, etc.

BUSINESS AND TECHNOLOGY EXECUTIVE, Cupertino, CA **May 2006 to Present**

Support range of markets including wireless communications, IoT, physical and cyber security, signal processing, embedded systems, automotive, robotics, location services, and telematics. Actively involved as independent board member of three technology companies; advisor to several others. Provide Expert Witness support for IP/Patent litigation for wireless, telematics, GPS, and RF-related cases.

VENROCK ASSOCIATES, Palo Alto, CA. **May 2009 to January 2020**
Operating Partner/Investor

Operating partner of Venrock, a leading, global venture capital firm; Chartered to manage a technology portfolio and identify attractive new business opportunities in the wireless, security, location services, IoT, robotics, and satellite technology sectors; Current and past director/observer/advisor of 20+ early stage companies. Frequent pubic speaker and panelist on a variety of management and technology topics. Provide ongoing business and technical diligence support to Venrock on wide variety of technologies including wireless, telematics, automotive, machine learning, robotics, and IoT. Reviewed/diligenced over 5000 technology companies.

DATARUNWAY, Inc., Cupertino, CA **August 2007 to November 2008**
President and CEO

STEVEN H. GOLDBERG

Early-stage, high-technology company focused on providing broadband Internet and phone service to commercial aircraft and private planes in flight. Technology demonstrated to airline industry; company IP ultimately used to support broadband services to cruise ship industry.

VIDIENT SYSTEMS, Inc., Santa Clara, CA **January 2007 to July 2007**
President and CEO

Overall corporate responsibility for 3-year old venture-backed startup (turn-around) in the video surveillance market (specifically video analytics/content analysis); backed by Trident Capital, Blueprint Ventures, Canaan Partners, and Hotung Capital Mgmt.

- Products include the SmartCatch family of software analytics and hardware processing platforms
- Technology/Channel partners include AMAG/G4, Unisys, Intergraph, Broadware, OnSSI, Milestone, NEC
- Lowered cash usage from $750k to $500K/ mo.; restructured business model/go-to-market strategy from VAR/Integrator to OEM model; added marketing function; restructured product offering and focus; relocated company HQ; supported delivery of SmartCatch 3.0 software and IVR2400 analytics appliance; restructured pricing and margin model; renegotiated all sales/employee revenue-based compensation and commission plans
- Wrote two industry white papers on video analytics; gave numerous press/media interviews; Red Herring and AlwaysOn 100 finalists
- Negotiated $4M bridge funding

VENROCK ASSOCIATES, Menlo Park, CA. **April 2005 to April 2006**
Entrepreneur-in-Residence

Engaged as a full-time contractor to Venrock, a leading, global venture capital firm, to assist in identifying attractive new business opportunities in the wireless, security, networking, and/or location markets.

ARCWAVE, Inc. Campbell, California **October 2000 to February 2005**
(CoWave Networks merged with Advanced Radio Cells to form Arcwave in April 2003)
President and CEO

First employee of VC-funded (Mayfield, Venrock, SBV, Comcast, Vulcan, Lucent) wireless startup supplying wireless broadband access products to the global cable industry; oversaw construction of corporate infrastructure, hired executive team; led marketing and sales strategy and key technology developments; led all corporate fundraising activities.

- Key in creating product positioning and branding strategy for residential wireless mesh technology (MeshCast^{TM}); 5 patents
- Positioned technology as mesh component of IEEE 802.16a standard; managed ASIC development
- Managed $12.4M in original Series A funding and raised $3.7M in a Series B round in Dec. 2002
- Initiated and successfully managed merger of CoWave Networks with Advanced Radio Cells, Inc. to form Arcwave, in April 2003; Raised $8M Series C funds in June 2004 led by new investors Comcast Interactive Capital and Vulcan Ventures

- At Arcwave, led definition and oversaw development of last-mile wireless cable extension product for Enterprise broadband voice/data service offering from cable industry
- Arcwave customers included Comcast, Time Warner, Cox, Adelphia, Charter, Mediacomm, CableOne

NOKIA CORP., Mt. View, California **August 1999 to Oct. 2000**
Vice President, Research and Development, Nokia Internet Communications

Brought in to help with the integration of the recently acquired start-up, Ipsilon Networks; overall responsibility for R&D for $70 million R&D budget with 275 engineers worldwide; participated in growth of new business unit from $50M to $250M+ run-rate; hired over 70 engineers and managers; successfully integrated a second 70 person engineering group in Boston, Mass.; core products tied to networking and internet application appliances with strong ties to next generation packet-based cellular systems.

- Actively involved in Sales, Marketing, and Support of global firewall appliance business; regular customer interaction tied to new product development and feature enhancement
- Led development of entire product line, including IP530, IP740, ISS appliance, Anti-Virus appliance, and current version of operating system
- Managed 20+ person ASIC team developing packet processing acceleration ASICs

VERTICOM, INC., Santa Rosa, California **December 1997 to August 1998**
President and CEO

Overall corporate responsibility for a four-year-old private, VC-funded (NEA) wireless restart involved in radio subsystems for satellite and terrestrial wireless infrastructures.

- Recruited to facilitate turn-around; created new $6.5M operating plan for 1998 (revenue peaked at $16M in FY2000); reduced monthly operating loss from $500K to under $300K
- Built new management team including V.P.'s of manufacturing, finance, and engineering and streamlined document control, sales lead tracking, order generation, and project engineering
- Oversaw restart of stalled product shipments and improvement of average gross margins by >20%
- Oversaw global sales and distribution channel
- More than doubled revenue $/direct labor from $100K to over $200K

CYLINK CORPORATION, Sunnyvale, California **March 1995 to Dec. 1997**
Vice President, General Manager, Wireless Communications Division

Reporting directly to CEO, created Wireless business unit/division; products included spread spectrum radio-modems with worldwide distribution in over 90 countries, 6 international sales offices.

- Brought revenues, profitability from under $7M annually to $31M with gross margins of >55%
- Built management team in sales, marketing, engineering, customer service, and manufacturing
- Managed Cylink cordless phone ASIC business
- Intimately involved in highly successful Cylink IPO in February 1996; worked directly with investment banks and wrote key sections of S-1 registration statement
- Positioned division for sale and made key presentation resulting in Cylink Wireless Division sale to P-Com, Inc. in March 1998 for $60.5M

- Returned to P-Com, Inc. from Aug. 1998 to Nov. 1998 to manage Cylink integration

TRIMBLE NAVIGATION, Ltd., Sunnyvale, California
Program Manager – Military Division **Nov. 2008 to Sept. 2009**

- Led interdisciplinary team of engineers (hardware, software, mechanical, RF) in the design of next generation military M-Code GPS receivers for in-flight applications
- Interacted with Program Managers from program partners Raytheon, General Dynamics and with the U.S Air Force GPS Wing contracting organization

Manager – Vehicle Tracking Division – Communications Systems Group **1993 to 1995**

- Led development and marketing group for GPS-based tracking, navigation, and positioning systems
- Co-created new product line for tracking people and cargo using cellular phones with GPS; Tens of thousands sold globally over 10-year period; product line continues today
- On-going global customer interaction during product development and rollout
- Regular interaction with global Sales, Marketing and Support organizations
- Directed engineering teams from concept to fully functional end-user installations; system level interaction with core GPS ASIC development team
- Served as corporate-wide technical resource for strategic planning and intellectual property

Senior Engineer – Survey Division **1991 to 1993**

- Co-lead in Differential Corrections Group that developed the line of TrimTalk radio systems; used to provide local corrections to Trimble Series 4000 GPS survey receivers

APPLIED SIGNAL TECHNOLOGY, Sunnyvale, California **1988 to 1991**
Program Manager – Wireless Communication Division

- Regular interaction with government intelligence customers to define product needs
- Directed development of wideband, 1-40GHz, 'flexible' surveillance receiving system
- Led many corporate marketing activities including technical presentations and proposal writing
- Developed company-wide technical training program for over 200 company employees; Developed and taught DSP, Adaptive Filtering, and Digital Communications courses

HEWLETT-PACKARD CO., Palo Alto, California **1979 to 1988**
Instructor – Microwave and Communications Group Training Center 1980 to 1988
Responsible for course development and teaching of a variety of electronic measurement subjects on a global basis to HP customers and newly hired HP engineers. Topics included transmission lines, network analysis, spectrum analysis, noise figure, general signal processing techniques, modulation and telecommunications principles.

Hewlett-Packard Visiting Professor – North Carolina A&T State University 1982 to 1983
On temporary assignment to teach undergraduate electrical engineering courses. Courses included Communications and Modulation Theory, Circuit Analysis and Synthesis and Circuits and Systems.

Production Engineer – HP Microwave Semiconductor Division 1979 to 1980

STEVEN H. GOLDBERG

Responsible for production line support, product improvement and new product introduction for microwave GaAs FET amplifiers and broad range of RF and microwave passive component line from 1-18GHz.

EMERSON ELECTRIC CO., St. Louis, Missouri **1978 to 1979**
Radar Engineer
Responsible for the design and development of the receiver/transmitter portions of military radar systems. Products included high dynamic range logarithmic receivers and magnetron/klystron-based transmitters.

CALIFORNIA MICROWAVE, Inc., Sunnyvale, California **1976 to 1978**
RF and Microwave Engineer
Responsible for the design and testing of RF and microwave circuits and components for military, telecommunications, and commercial applications. Frequency range from 1-30 GHz.

EXPERT WITNESS EXPERIENCE

1. Type of Matter:	Contract Litigation
Law Firm:	Strategic v. Natomas Park
Services Provided:	Expert report provided for Plaintiff
Disposition:	Judge ruled in favor of Plaintiff
Date:	2006
2. Type of Matter:	Patent Infringement
Law Firm:	Jenkins and Gilchrist
Services Provided	Infringement research; Wireless LAN
Disposition:	Completed/Outcome Unknown
Date:	2006
3. Type of Matter:	Patent Infringement; Defense
Law Firm:	Orrick, Herrington & Sutcliffe, LLP
Services Provided	Infringement research, prior art; SIRF v Global Locate
Disposition:	Completed/Settled
Date:	2007
4. Type of Matter:	Patent Infringement; Plaintiff
Law Firm:	Fish and Richardson
Services Provided:	Infringement expert report; invalidity rebuttal report; deposition; Vehicle IP v GM Corp.
Disposition:	Completed
Date:	2007/2008
5. Type of Matter:	Patent Invalidity; Defense
Law Firm:	Kilpatrick Stockton
Services Provided:	Declaration written; Telematics v. Motorola
Disposition:	Completed/Outcome Unknown
Date:	2008

6. Type of Matter Patent Invalidity; Defense
Law Firm: Keker & Van Nest
Service Provided: Patent Review, Cable Modems; Rembrandt v Comcast
Disposition: Completed/Outcome Unknown
Date: Nov 2008 – Jan 2009

7. Type of Matter Patent Infringement; Plaintiff
Law Firm: Fulbright & Jaworski
Service Provided: Product review; RemoteMDx vs. STOP LLC
Disposition: Completed/Settled
Date: Dec. 2008 - Jan. 2009

8. Type of Matter Patent Infringement; Plaintiff
Law Firm: Kirkland & Ellis
Service Provided: Patent and Prior Art Review; Intel v Wi-Lan
Disposition: Completed/Outcome unknown
Date: Jan. 2009 – March 2010

9. Type of Matter Patent Infringement; Defense
Law Firm: Cravath, Swain, & Moore
Service Provided: Patent and Prior Art Review; ITT v. Qualcomm
Disposition: Completed
Date: Feb. 2010

10. Type of Matter Patent Reexamination; Defense
Law Firm: Fish and Richardson
Service Provided: Reexamination support; Declaration; Vehicle IP
Disposition: Completed
Date: Nov. 2010

11. Type of Matter Patent Infringement; Plaintiff
Law Firm: Paul Hastings
Service Provided: Infringement research, telematics hardware; HTI vs. ProCon
Disposition: Completed
Date: February 2011

12. Type of Matter Patent Infringement; Defense
Law Firm: FTBK Law
Service Provided: Markman Declaration; Visteon v. Mitac
Disposition: Unknown; completed.
Date: July 2011

13. Type of Matter Patent Infringement; Defense
Law Firm: Fish and Richardson
Service Provided Rebuttal Infringement and Invalidity reports; deposed
Parties Involved SkyHawke Technologies, LLC v. Callaway Golf
Disposition Favorably settled before trial; 3/2012

14. Type of Matter Patent Infringement; Plaintiff

Law Firm:	Ostrow Kaufman, LLP
Service Provided:	Claim Construction/Summary Judgment Preparation
Parties Involved:	Advanced Media Networks v. Gogo LLC/Aircell
Disposition:	Favorably settled before trial in Summer 2013

15. Type of Matter	Patent Infringement; Plaintiff
Law Firm:	Fish and Richardson
Service Provided:	Infringement report, Rebuttal Invalidity report, deposition, trial testimony U.S. District Court, Delaware
Parties Involved:	Vehicle IP, LLC v. Werner Enterprises
Disposition:	Jury trial complete in Sept. 2013 favoring defense on infringement; validity upheld

16. Type of Matter	Patent Infringement: Defense
Law Firm:	Fish and Richardson
Service Provided:	Claim Construction and Invalidity report, deposition, trial testimony at ITC
Parties Involved:	Ericsson v. Samsung
Disposition:	Trial at ITC in Sept. 2013; Favorably settled before court decision, Jan. 2014

17. Type of Matter	Patent Infringement; Defense
Law Firm:	Bryan Cave
Service Provided:	Declaration re: Preliminary Injunction Hearing; deposition; hearing testimony; IPR declaration
Parties Involved:	MAcom v. Laird
Disposition:	Favorably settled before trial/IPR, April 2015

18. Type of Matter:	Product Liability: Defense
Law Firm:	Keker and Van Nest, San Francisco, CA
Service Provided:	Declaration re: GPS semiconductor architecture and performance
Parties Involved:	TomTom International v. Broadcom Corp.
Disposition:	Favorably settled before trial, May 2015

19. Type of Matter:	IPR; Plaintiff
Law Firm:	Sheppard Mullin
Service Provided:	Multiple expert declarations; deposition; IPR's
Parties Involved:	TCL
Disposition:	Completed; 2016

20. Type of Matter:	Patent Infringement; Plaintiff
Law Firm:	Fish and Richardson
Service Provided:	Multiple expert reports; multiple depositions
Parties Involved:	Vehicle IP v. ATT/Verizon
Disposition:	Favorably settled with one defendant; 2017

21. Type of Matter:	Patent Infringement; Plaintiff
Law Firm:	Smith, Gambrell, and Russell
Service Provided:	Discovery support
Parties Involved:	InfoGation; ZTE, HTC
Disposition:	Unknown as of Dec. 2017

22. Type of Matter:	Patent Infringement; Defendant
Law Firm:	Fish and Richardson
Service Provided:	Testifying expert; Declaration for IPR
Parties Involved	Confidential/GPS Consumer Electronics
Disposition:	Favorably Settled; July, 2020

23. Type of Matter:	Patent Infringement; Plaintiff
Law Firm:	Bunsow De Mory LLP
Service Provided:	Markman Hearing support; Deposition
Parties Involved:	Confidential/Cellular, consumer electronics
Disposition:	Favorably settled; January 2022

24. Type of Matter:	Patent Infringement; Plaintiff
Law Firm:	Steptoe
Service Provided:	Testifying expert; Infringement report, Rebuttal Report, Witness Statement, Deposition; ITC trial testimony
Parties Involved:	Broadcom v. Toyota
Disposition:	2018-2020; Completed; Decision in favor of Defense; Under Appeal

25. Type of Matter:	Patent Infringement; Defendant
Law Firm:	Amster, Rothstein, and Ebenstein
Service Provided:	Testifying expert; Non-Infringement Rebuttal Report
Parties Involved:	Confidential/Retail, wireless systems
Disposition:	Favorably settled; July 2019

26. Type of Matter:	Patent IPR, Supporting Patent Owner
Subject Matter	Automotive, GPS
Law Firm:	Steptoe
Services Provided:	Three (3) declarations, deposition
Parties Involved:	Broadcom
Disposition:	Unknown

27. Type of Matter:	Patent IPR, Supporting Petitioner
Subject Matter:	Automotive, Mapping
Law Firm:	Erise IP, P.A.
Services Provided:	Two (2) declarations, 2H2020
Parties Involved:	Apple
Disposition:	Awaiting Deposition (if needed)

28. Type of Matter:	Patent IPR, Supporting Patent Owner
Subject Matter:	Vehicle to Vehicle Communication
Law Firm:	McDonnell, Boehnen, Hulbert & Berghoff
Services Provided	IPR Declaration, 2H2020
Parties Involved	AutoBrilliance v Unified Patents
Disposition:	Unknown

29. Type of Matter:	Patent Infringement; Defendant
Subject Matter:	Consumer Electronics
Law Firm:	WilmerHale

STEVEN H. GOLDBERG

Services Provided	Technical/Business Expert; Expert Report; Deposition
Parties Involved:	NextStep v. Comcast
Disposition:	Favorably settled at trial in Sept 2021

30. Type of Matter:	Patent Infringement; Plaintiff
Subject Matter:	Business Communications
Law Firm:	Burr and Foreman
Service Provided	Testifying Expert; full range of deliverables
Disposition:	Early stages

PUBLICATIONS

1. “Bit Error Rate Performance of a A DS/DPSK Spread Spectrum Receiver”, S.H. Goldberg and R.A. Iltis, Proceedings of MILCOM, 1985;

2. “Joint Interference Rejection / Channel Equalization in DS Spread Spectrum Using the CMA Equalizer and Maximum Likelihood Techniques”, R.A. Iltis and S.H. Goldberg, Proceedings of MILCOM, 1987;

3. “PN Code Synchronization Effects on Narrowband Interference Rejection in a Direct-Sequence Spread Spectrum Receiver,” R.A. Iltis and S.H. Goldberg, IEEE Transactions on Communications, 1988;

4. “A single processor packet radio modem for land mobile vehicle tracking applications,” G. Kremer, J. MacKnight, R. Lao, and S. Goldberg, Signals, Systems and Computers, 1994, 1994 Conference Record of the Twenty-Eighth Asilomar Conference;

5. “Separation and bearing estimation of co-channel signals,” B.J. Sublett, R.P. Gooch, S.H. Goldberg, Proceedings of MILCOM 1989;

6. “A DS spread spectrum RAKE receiver with narrowband interference rejection capability: operation in fading channels,” R.A. Iltis, and S.H. Goldberg, S.H. Proceedings of MILCOM 1989

EDUCATION

Ph.D.E.E., Dept. of Electrical and Computer Engineering, University of California, Santa Barbara, CA, 1988
Dissertation Subject Area: Signal Processing for Broadband Communications; strong background in adaptive filtering, communications systems architectures, and statistical signal processing
M.S.E.E., B.S.E.E., Washington University, Saint Louis, Missouri, 1975, 1980
Major areas of study included RF design and communications theory

PATENTS

Patent	Date	Description
5,742,509	4/21/1998	Personal tracking system integrated with base station
4,410,949	10/18/1983	Controller for fuel dispenser

STEVEN H. GOLDBERG

ACTIVITIES - PERSONAL

- Advisor, Alcatraz.ai, Palo Alto, CA; AI-based Security Access Control; January 2018-Present
- Advisor, Bruviti, Campbell, CA; AI-based S/W for Enterprise Industrial Maintenance/Repair; March 2020-Present
- Advisor, Accern, New York, NY; AI-based Enterprise Support; September 2020-Present
- Board Member, Future Dial, Representing Venrock, 2014-Present
- Independent Board Member, SolidPower (NASD:SLDP):, Louisville, Colo.; Sept. 2019 – Present
- Independent Board Member, Savari Networks, Santa Clara, CA; April 2016- December 2020
- Venture Partner, Fusion Fund, Palo Alto, California; June 2020 – August 2021
- Engineering Consultant, Hi Fidelity Genetics, Durham, N.C.; September 2020 – September 2021
- Mentor, Silicon Valley Forum International Programs; 2018-2019
- Board Observer/Board Member/Past Chairman; SVForum, January 2014-May 2018
- Dean's Executive Professor, Santa Clara University, Leavey School of Business, Fall 2015
- National Judge, Ernst and Young 2013/2014/2015 Entrepreneur of the Year Award
- National Judge, VCIC, 2015 (Global MBA student VC competition)
- National Judge, FLoW, 2015 (DOE sponsored Cleantech competition)
- Life Senior Member IEEE; 1994 President IEEE Santa Clara Valley Communications Society
- Adjunct Professor, Electrical Engineering Dept; Santa Clara University, 1990
- Visiting Faculty, Elec. Eng. Dept.; U.C. Santa Barbara, 1985
- Lifetime CA Community College Instructor Credential in Engineering
- Amateur Radio Extra Class License WQ6L
- German language proficiency
- U.S. Soccer Federation Referee; NISOA/NCAA Soccer Referee
- 1996 U.S. Figure Skating Association Masters Pairs Champion
- Married (Monica), Two children (Aren, 27 and Jennifer, 25)