

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

T-Mobile US, Inc., T-Mobile USA, Inc., TeleCommunication Systems, Inc.,
Ericsson Inc., and Telefonaktiebolaget LM Ericsson
Petitioners,

v.

TracBeam, LLC,
Patent Owner.

U.S. Patent No. 7,764,231

Title: WIRELESS LOCATION USING MULTIPLE MOBILE STATION
LOCATION TECHNIQUES

DECLARATION OF DR. WILLIAM R. MICHALSON

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I, William R. Michalson, Ph.D., declare as follows:

I. INTRODUCTION

1. My name is William Michalson, Ph.D. I am over the age of eighteen (18) and otherwise competent to make this declaration.

2. I have been retained as an expert witness on behalf of T-Mobile US, Inc. and T-Mobile USA, Inc. (“T-Mobile”), TeleCommunication Systems, Inc. (“TCS”), and Ericsson Inc. and Telefonaktiebolaget LM Ericsson (“Ericsson”) to provide my opinions regarding the validity of Claims 1, 10, 17, 20, 25, 26, 36, 41, 47, 82, 155, 162, 165, 185, and 215 of U.S. Patent No. 7,764,231 (the “’231 Patent”). I am providing this declaration in connection with the *inter partes* review petitions for the ’231 Patent that are being filed by the parties identified above.

3. I am also providing separate declarations in connection with other *inter partes* review petitions for three patents that are related to the ’231 Patent: U.S. Patent Nos. 7,525,484 (the “’484 Patent”), 8,032,153 (the “’153 Patent”), and 7,298,327 (the “’327 Patent”).

A. Compensation and Prior Testimony

4. I am being compensated for my time in connection with this matter at my standard legal consulting rate of \$500 per hour. I am also being reimbursed for reasonable and customary expenses associated with my work and testimony in this

investigation. My compensation is not contingent on the outcome of this matter or the specifics of my testimony.

5. I previously provided an expert declaration and expert testimony regarding invalidity of the '231 Patent (and the related '484 Patent) in connection with TracBeam's lawsuit against Google: *TracBeam, LLC. v. Google, Inc.*, No. 6:13-cv-00093 (E.D. Tex.).

6. In addition, I have also provided expert consulting services (including expert declarations and/or testimony) for various other patent disputes in both district court proceedings and *inter partes* review proceedings. My consulting engagements are identified in my *curriculum vitae* (Ex. 1005).

B. Background and Qualifications

7. I received my Ph.D. in Electrical Engineering from Worcester Polytechnic Institute in 1989, my Master of Science in Electrical Engineering from Worcester Polytechnic Institute in 1985, and my Bachelor of Science in Electrical Engineering from Syracuse University in 1981.

8. I was employed as an engineer at Raytheon Company from 1981 until 1991. During this period, I worked on a variety of projects which involved both hardware and software design and debugging. These projects involved developing computer systems and software for a variety of applications including: air traffic display systems, signal and data processing systems, and communications systems.

During this time period, I was involved in hardware and software development that included experience working with satellite, airborne, and ground-based systems for navigation and communications. From 1985 until 1988, I received a fellowship from Raytheon to pursue my Ph.D. degree and worked part-time during this period. I returned to Raytheon full-time from 1988 until 1991. I have been a full-time faculty member at the Worcester Polytechnic Institute in Massachusetts since 1991. My emphasis at Worcester Polytechnic Institute is on teaching and conducting research on navigation, communications, and computer system design.

9. I hold eight patents in the fields of audio signal processing, indoor geolocation devices, and handheld GPS (Global Positioning System) mapping devices. I have authored or co-authored over 100 original articles in the fields of communications networks, precision location systems, and GPS, including more than 15 journal papers and 90 conference papers. I have also authored one book chapter relating to optical interconnect networks for massively parallel computers. I became a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE) in 2003.

10. I have worked in the field of computer architecture and computer systems since I began employment at Raytheon in 1981. In addition, I teach classes relating to computer architecture and design, and I also teach classes relating to embedded system designs, advanced system architectures, and real-time

system designs, which relate to the design of computer systems, including real-time operating systems and programming. I have worked extensively in software programming, including during my employment at Raytheon and in a variety of projects relating to navigation and communications systems at Worcester Polytechnic Institute.

11. GPS and GPS-related technologies have dominated the bulk of my research since 1992, and at Worcester Polytechnic Institute, I direct the Center for Advanced Integrated Radio Navigation. I have been involved in numerous academic, consulting, and litigation-related projects involving navigation technologies. Examples of academic projects include (1) a container tracking system in 2003 which explored the application of tracking and communications technologies to track shipping containers, (2) an automotive based system in 2000 which combined GPS and map data in an automotive environment, (3) a remote hazard detection system in 1996 that combined GPS and radio communications to remotely identify hazards to the engineer operating a freight train, and (4) a differential GPS system in 1995 that combined GPS and radio technologies to allow determining the precise path of vehicles operating off-road during forest operations. As a consultant, I have worked with the combination of GPS and radio communications in the context of space shuttle docking operations, transfer of traffic information to GPS devices in a vehicle, combinations of GPS and cellular

communications for the tracking of individuals, and map-based handheld tracking devices.

12. I have extensive experience with the development and maintenance of the hardware and software associated with server computers, including server computers attached to the Internet. This experience includes the installation and maintenance of web servers and file servers, as well as the design, development, test, and maintenance of web based applications. These applications typically employ C/C++, Java, JavaScript, PHP, HTML, MySQL, and other applications, languages and/or utilities as might be appropriate for a given application.

13. I have extensive experience with the design, implementation, and testing of computer hardware and software systems for a variety of military and non-military applications. This experience specifically includes the design, implementation, and testing of hardware and software systems used in navigation systems and geographical information systems (GIS) as well as experience in the design, implementation, and testing of hardware and software systems in the context of a client-server computer architecture in which at least one client computer exchanges navigation and/or geographical information with at least one server computer through a wired and/or wireless network.

14. Since 1992, I have not only been involved with the development of GIS related software for evaluating various aspects of GPS performance, but I have

also used a number of commercial GPS and GIS products. GPS products I am familiar with include products produced by GEC Plessey, Motorola, Rockwell, Trimble, Novatel, Magellan, Garmin, and others. GIS products I am familiar with include products such as ArcView/ArcGIS, GeoRover, and Navtech, as well as various data sets made available by government agencies (for example, USGS topographical maps, Digital Elevation Models, marine and aviation charts, and the like). I am also familiar with numerous GIS and mapping products that existed in the market since the late 1980s, including systems and software developed by Etak, Microsoft, DeLorme, AutoMap, and others. In the conduct of my research and other work, I have routinely used database systems such as Microsoft Access, Borland Paradox, Oracle, SQL and others.

15. I teach undergraduate and graduate classes relating to computer systems and engineering design. I have taught computer architecture classes (undergraduate and graduate), in which I cover memory hierarchies, caching, and communications/networking. I also teach classes relating to embedded system designs, advanced system architectures, real-time system design, communication systems, navigation and robotics. Some of my classes address network protocols at the hardware level (*i.e.*, the low-level hardware interfaces necessary for performing computer communications), while other classes address networking at the architectural level and cover layered protocol models, such as the OSI

reference model developed by the International Standards Organization (ISO). In addition to the classes listed in my *curriculum vitae* (Ex. 1005), I have also taught a number of guest lectures in the areas of satellite navigation, systems engineering, and engineering design. In addition, I teach classes in the Fundamentals of Robot Systems and courses in navigation, both of which cover radiolocation, inertial navigation, and other means of navigating as well as using position information for purposes of guidance, mapping, navigation and path planning.

16. Other projects that I worked on and supervised involved public safety radio systems, aircraft laser communications, and railroad communications between locomotives and railway switches. Many of the projects that I worked on and supervised involved the use of existing communications protocols such as File Transfer Protocol (FTP), Transmission Control Protocol (TCP), and Internet Protocol (IP), while other projects required the design of new communications protocols for data exchange between computers.

17. In my research, I have done extensive work in communications and networking system design, and have worked with all of the digital, analog and software components needed to build communications and navigation systems. My work with communications and networking protocols began in the mid-1980s with TCP/IP over packet radio. I have used these and other communications and networking protocols extensively in conducting my research. In addition, my work

on GPS and navigation systems involved implementing low-latency communications to support differential techniques that allow a GPS receiver to provide more accurate positioning information.

18. In writing this declaration, I have considered my own knowledge and experience, including my work experience in the fields of electrical engineering, computer engineering, networking, wireless location technologies, wireless communication technologies, and navigation and GIS systems; my experience in teaching those subjects; and my experience in working with others involved in those fields.

19. A copy of my *curriculum vitae*, which further describes my qualifications, has been provided as Ex. 1005.

C. Materials Considered

20. In formulating my opinion, I have considered the following materials:

Number	Description
1001	U.S. Patent No. 7,764,231
1002	U.S. Patent No. 7,525,484
1003	U.S. Patent No. 8,032,153
1004	U.S. Patent No. 7,298,327
1007	U.S. Patent No. 5,724,660 to <i>Kauser</i>
1008	U.S. Patent No. 5,936,572 to <i>Loomis</i>
1009	U.S. Patent No. 6,748,226 to <i>Wortham</i>

1010	International PCT Application No. PCT/US93/12179 to <i>Schuchman</i>
1011	U.S. Patent No. 5,327,144 to <i>Stilp</i>
1012	FAA Advisory Circular 20-101C, <i>Airworthiness Approval of Omega/VLF Navigation Systems For Use in the U.S. National Airspace System (NAS) and Alaska</i> (Sep. 12, 1988)
1013	FAA Advisory Circular 20-130A, <i>Airworthiness Approval of Navigation or Flight Management Systems Integrating Multiple Navigation Sensors</i> (Jun. 14, 1995)
1014	<i>FCC Notice of Proposed Rulemaking for Locating Wireless 911 Callers</i> (Released Oct. 19, 1994)
1015	TR45 Joint Experts Meeting (JEM) for Emergency Services (Aug. 18, 1994)
1016	C.J. Driscoll & Associates, <i>Survey of Location Technologies to Support Mobile 9-1-1</i> , July 1994
1017	Claim Construction Order (MetroPCS and TCS lawsuits)
1018	Supplemental Claim Construction Order
1024	American Heritage Dictionary, Houghton Mifflin Company (4th ed. 2000) (definition of “locus”)

II. LEGAL STANDARDS

21. This section provides my understanding of the applicable legal principles regarding the standards for patentability, which I have used in forming my opinions regarding the invalidity of the '231 Patent.

22. I understand that the petitioners have the burden to prove that the claims challenged in its *inter partes* review petitions are not patentable by a

preponderance of the evidence. I understand “preponderance of evidence” to be just enough evidence to make it more likely than not that their position is correct.

23. I understand that patentability of each claim challenged in the petitions is assessed based on documents that predate the '231 Patent, such as other patents and printed publications, which are referred to as “prior art.”

24. It is my understanding that a claim is not patentable if it is directed to subject matter that is not new or if the subject matter recited in the claim would be obvious to a person of ordinary skill in the art in the field of the invention at the time of the invention. I understand that an obviousness analysis involves a consideration of (1) the scope and content of the prior art; (2) the differences between the claimed invention and the prior art; (3) the level of ordinary skill in the pertinent field; and (4) secondary considerations of non-obviousness. I understand that secondary considerations of non-obviousness include failure of others, copying, unexpectedly superior results, perception in the industry, commercial success, and long-felt but unmet need. It is also my understanding that obviousness can be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so. Additionally, it is my understanding that obviousness can be established when the claimed invention is considered to be predictable based on the prior art.

25. I understand that obviousness is determined based on the point of view of a person of ordinary skill in the art. I also understand that the person of ordinary skill in the art has ordinary creativity.

26. I understand that, in an *inter partes* review proceeding, the claims must be given their broadest reasonable interpretation in view of the specification. After interpreting the claims in this manner, the claims can then be compared to the prior art.

III. THE '231 PATENT

A. Overview

27. As the first sentence under the “Summary Discussion” section states: “The present invention relates to a wireless mobile station location system, and in particular, various subsystems related thereto such as a wireless location gateway, and the combining or hybridizing of a plurality of wireless location techniques.”¹

28. The '231 Patent lists various objectives the inventors were trying to achieve, including:

1. To provide a system and method for wireless telecommunication systems to accurately locate people and/or objects in a cost effective manner;
2. To provide such location capabilities using the measurements from wireless signals communicated between mobile stations and a network of base stations; and

¹ Ex. 1001 ('231 Patent) at 10:39-43.

3. To provide a low cost location system and method, adaptable to wireless telephony systems, for using simultaneously a plurality of location techniques for increasing location accuracy and consistency.²

29. To achieve these objectives, the '231 Patent discloses the use of a combination of prior art wireless location technologies that locate mobile stations using measurements from wireless signals communicated between the mobile station and the base stations.³ The use of multiple location technologies (each of which by itself is known in the art) and then selecting or combining the results of the different technologies is the advertised inventive aspect of the '231 Patent:

[A] fundamental aspect of the *present invention* is to use a plurality MS location techniques for generating location estimates and to *analyze* the generated estimates (likely after being adjusted) to detect patterns of convergence or clustering amongst the estimates.⁴

30. In particular, the limitations of the various prior art location technologies were recognized by the inventors and are discussed in the background section of the '231 Patent:

Systems have been proposed that rely upon signal strength and trilateralization techniques to permit location [determinations].... Furthermore, the systems are generally only effective in line-of-sight conditions, such as rural-settings. Radio wave surface reflections,

² Ex. 1001 ('231 Patent) at 7:61-9:32.

³ *Id.* at 12:7-16, 12:33-13:57.

⁴ *Id.* at 66:9-13 (emphasis added).

refractions and ground clutter cause significant distortion, in determining the location of a signal source in most geographical areas that are more than sparsely populated.

GPS is impractical in many applications. The signal power levels from the satellites are low and the GPS receiver requires a clear, line-of-sight path to at least three satellites above a horizon of about 60 degrees for effective operation. Accordingly, inclement weather conditions, such as clouds, terrain features, such as hills and trees, and buildings restrict the ability of the GPS receiver to determine its position.⁵

31. The inventors sought to overcome the limitations of any single location technology using a hybrid location solution:

The present invention relates to a wireless mobile station location system, and in particular, various subsystems related thereto such as a wireless location gateway, *and the combining or hybriding of a plurality of wireless location techniques.*

Yet another objective is to provide a low cost location system and method, adaptable to wireless telephone systems, for using simultaneously a plurality of location techniques for synergistically increasing MS [mobile station] location accuracy and consistency.⁶

32. Figure 4 illustrates a high level diagram of the hybrid location

⁵ *Id.* at 1:43-57, 2:2-9.

⁶ *Id.* at 10:40-43, 9:5-9 (emphasis added).

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base stations are vehicles equipped with base station equipment to provide the functionality of a stationary base station but with the ability to change locations.

34. Figure 4 also features a location center and location applications. The location applications use the location of mobile stations to provide services. Examples of services disclosed in the '231 Patent include 911 emergency response services, taxi services, vehicle navigation services, and stolen vehicle tracking services.⁷ In order to provide these services, the location applications submit location requests to the location center. The location center then activates various different location technologies to obtain multiple location estimates for the target mobile station. After obtaining location estimates from the various technologies, the location center provides a “most likely” location estimate of the target mobile station by selecting or combining the various location estimates from each location technology.

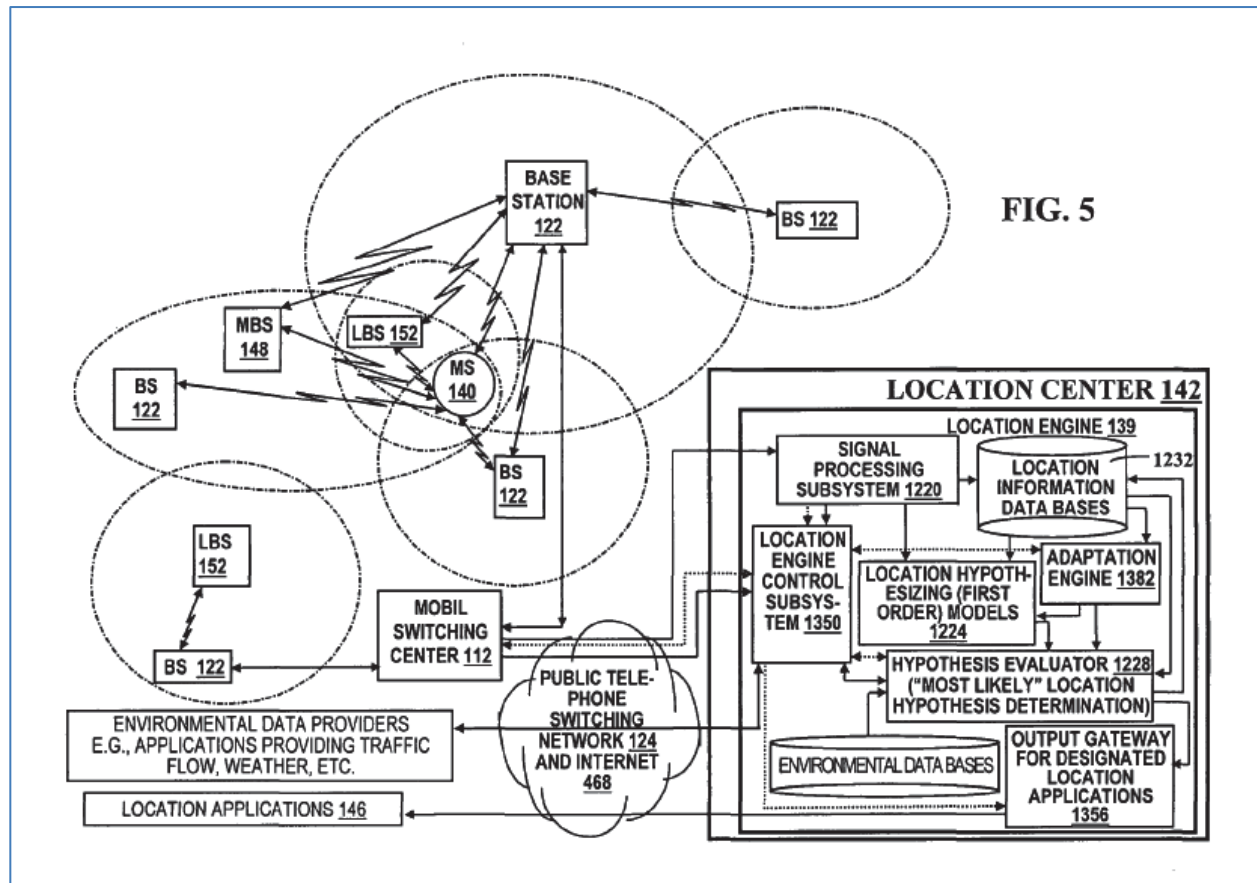
B. Location Center of the Hybrid Location System

35. This section provides an explanation of the “location center” used in the hybrid location system of the '231 Patent.

36. Figure 5 illustrates a more detailed diagram of the location center, which includes, among other components: a signal processing subsystem; location

⁷ Ex. 1001 ('231 Patent) at 8:56-59.

hypothesizing models, which the patent also refers to as “First Order Models,” or FOMs; a hypothesis evaluator; and an output gateway.



37. The location center determines the location of mobile stations using wireless signal measurements of the mobile stations.⁸

38. At a high level, the location center:

- receives a request for the location of a mobile station from a location application
- collects and processes wireless signal measurements associated with the mobile station
- obtains multiple location estimates of the mobile station using a

⁸ *Id.* at 24:46-48.

plurality of different location technologies (*e.g.*, Time of Arrival, Time Difference of Arrival, GPS⁹)

- generates a “most likely” estimate by selecting or combining the various location estimates from the different location techniques
- formats the “most likely” location estimate based on the needs of the requesting location application
- routes the formatted location estimate to the requesting location application

1. Signal processing subsystem

39. When a request for the location of a mobile station is received by the location center, the location center collects measurements of the wireless signals transmitted between the mobile station and one or more base stations within range of the mobile station. For example, in Figure 5, mobile station 140 is within range of various base stations. The jagged arrows between the mobile station and the base stations represent wireless signals. These wireless signals are measured and provided to the location center. For example, the base stations may measure the wireless signals and route the measurements to the location center through the Mobile Switching Center. These wireless signal measurements are then provided to the signal processing subsystem of the location center, which analyzes the measurements in order to identify various characteristics of the wireless signals.

⁹ As explained in Section III.B.2, the original patent application for the '231 Patent only disclosed using GPS to locate the mobile *base* stations (*e.g.*, cell towers attached to a vehicle), but it did not disclose GPS as one of the location technologies used in its hybrid location system to locate the mobile stations (*e.g.*, cell phones). The use of GPS to locate the mobile stations was subsequently added during prosecution.

Examples of wireless signal characteristics include: (i) signal timing measurements, such as those used in time of arrival and time difference of arrival techniques; (ii) signal strength measurements; and (iii) signal angle of arrival measurements.¹⁰

2. Location Hypothesizing Models (FOMs)

40. Next, the location center simultaneously activates multiple location hypothesizing models using the wireless signal characteristics from the signal processing subsystem as input. The location hypothesizing models are also referred to in the patents as First Order Models, or FOMs. Each location hypothesizing model uses a different location technology to generate a “location hypothesis.”¹¹ For example, each location hypothesizing model may use one of the location technologies discussed earlier, such as coverage area, angle of arrival, time of arrival, or time difference of arrival. The location hypothesis from each location hypothesizing model contains an estimate of the location of the mobile station.¹² A location hypothesis may also include additional information, such as a confidence value indicating the likelihood of the mobile station being at or within the estimated location.¹³ In this manner, multiple location estimates are generated

¹⁰ Ex. 1001 ('231 Patent) at 62:35-42.

¹¹ *Id.* at 37:31-36,13:3-17.

¹² *See id.*

¹³ *Id.* at 13:3-17.

by various different location technologies.

41. Notably, as originally filed, the '231 Patent application only disclosed the use of GPS by the mobile base stations (*e.g.*, cell towers attached to a vehicle) to locate themselves, but did not disclose the use of GPS as one of the location hypothesizing models used to locate the mobile stations (*e.g.*, cell phones). In fact, the background of the invention, which discusses the prior art, criticizes GPS due to the expense and complexity of incorporating GPS circuitry into each mobile station.¹⁴

3. Hypotheses Evaluator

42. After receiving the location hypotheses from the various location hypothesizing models, the hypotheses evaluator of Figure 5 then evaluates the location hypotheses to produce a “most likely” location estimate of the mobile station (*e.g.*, by selecting or combining location estimates). For example, the various location hypotheses may each identify different geographical areas as their respective location estimates. Although these location estimates are different, they may overlap or intersect. Because the overlapping area is common to multiple location estimates, there is a greater likelihood that the mobile station is located in the overlapping area. Thus, the hypotheses evaluator may identify a point in the overlapping area as the “most likely” location estimate of the mobile station. If the

¹⁴ *Id.* at 1:58-2:20.

location hypotheses also include confidence values for their respective location estimates, the hypothesis evaluator may consider the confidence values when evaluating the location estimates. For example, a location estimate with a lower confidence may be given less weight than a location estimate with a high confidence.

4. Output Gateway

43. After the hypothesis evaluator determines a “most likely” location estimate, the “most likely” location estimate is provided to the output gateway of the location center. The output gateway is responsible for outputting/routing the “most likely” location estimate to the appropriate destination or application (*e.g.*, the police department for 911 emergencies, taxi companies, trucking companies, etc.).¹⁵

IV. PROSECUTION HISTORY OF THE '231 PATENT

44. The '231 Patent took over 12 years to prosecute (from the September 8, 1997 filing to the July 27, 2010 issuance). The claims were allowed numerous times, but in each instance of allowance, the applicants extended prosecution using various tactics. Despite the very lengthy prosecution, there were no substantive rejections based on prior art. Accordingly, the prosecution history of the '231 Patent provides limited guidance as to the understanding and interpretation of the

¹⁵ See, *e.g.*, Ex. 1001 ('231 Patent) at 8:55-9:4, 61:19-26, 61:29-35, 90:5-9.

claims for purposes of my invalidity analysis in these IPR proceedings.

V. LEVEL OF ORDINARY SKILL IN THE ART

45. A person of ordinary skill in the art in the field of the '231 Patent would typically have (i) a degree in electrical engineering, computer engineering, computer science, or a related field, and (ii) one to four years of experience and/or postgraduate study relating to wireless communication systems and/or wireless location and navigation technologies. However, someone with less technical education but more practical experience, or vice versa, could also meet that standard.

VI. CLAIM CONSTRUCTION

46. I understand that some of the challenged claims were previously construed in connection with TracBeam's prior lawsuits, using the applicable claim construction standards for district court proceedings.¹⁶ I also understand, however, that the claim construction analysis in *inter partes* review proceedings requires the claims to be construed using their broadest reasonable interpretation in view of the specification.

A. ***“mobile station,” “computational machinery,” “location technique(s)” (and related terms), “geographical extent,” and “output criteria”***

47. The terms *“mobile station,” “computational machinery,” “location*

¹⁶ Ex. 1017 (Claim Construction Order).

technique(s)” (and/or variations thereof), “*geographical extent*,” and “*output criteria*” are recited by certain challenged claims. The prior district court proceeding adopted the following constructions: (1) *mobile station*: “*a mobile wireless device that is at least a transmitting device and may include a receiving device*”; (2) *computational machinery*: “*one or more machines (such as a computer or hardware device) that performs computations*”; (3) *mobile station location technique*: “*technique for determining mobile station locations*”; (4) *computational machine location providing sources*: “*computational machinery for providing location information*”; (5) *mobile station location determining sources*: “*source (such as a computer system, device, or component) for determining mobile station locations*”; (6) *mobile station location estimation determiners*: “*machine executed process for providing mobile station location estimates*”; (7) *geographical extent*: “*geographical area or range*”; and (8) *output criteria*: “*data specifying one or more required attributes of the output location data.*”¹⁷

48. While I do not believe that these terms require construction in this *inter partes* review proceeding, I do not otherwise disagree with the prior district court constructions for purposes of this proceeding.

B. “*location information*” and related terms

49. The challenged claims recite the term “*location information*” and/or

¹⁷ *Id.* at 37-38.

variations thereof, including: “*location information*” (Claims 17, 20, 25, 26, 185); “*location related information*” (Claim 1); “*geographical location related information*” (Claim 155); “*geographical location information*” (Claim 10); and “*location related response information*” (Claims 162, 165).

50. The context of the challenged claims requires the “*location information*” terms to contain information that identifies or indicates a location (as opposed to, for example, solely containing an error or failure message).

51. For example, Claim 162 requires “*first location related response information for a location of the mobile station*” to be obtained from a “*first location technique*,” “*wherein said first location technique estimates a location of the mobile station.*”

52. As another example, Claim 25 recites “*there is a predetermined corresponding location technique for determining first location information of the mobile station*” and “*the predetermined corresponding location technique uses the first collection to determine a location for the mobile station.*”

53. As another example, Claim 10 recites “*location information related to a location of one of said mobile stations.*”

54. Similar requirements are found in the other challenged claims.

55. In the prior district court proceeding, however, the court determined that no construction was necessary for these terms, but acknowledged that “the

concept of identifying a location is found in other clauses in the claims.”¹⁸ I agree that the requirement for the “*location information*” terms to identify or indicate a location can be found in the surrounding claim language. Thus, for purposes of this proceeding, I do not disagree with interpreting the “*location information*” terms according to their plain and ordinary meaning under the broadest reasonable interpretation standard.

C. “*locus of locations*”

56. Claim 25 recites using signal measurements “*to determine a location estimate of the mobile station by determining a locus of locations from at least one of the fixed location terrestrial stations.*”

57. Similarly, Claim 17 recites “*a representation of a locus of locations having substantially a same time difference of arrival for wireless signals.*”

58. The specification uses the term “locus” only once:

Basically, such distance models 1224 determine a location estimate of the target MS 140 by determining a distance offset from each of one or more base stations 122...so that an intersection of each area locus defined by the base station offsets may provide an estimate of the location of the target MS.¹⁹

59. Moreover, the American Heritage Dictionary defines “locus” as “the

¹⁸ Ex. 1017 (Claim Construction Order) at 14, 37.

¹⁹ Ex. 1001 (’231 Patent) at 51:1-7 (emphasis added).

set or configuration of all points whose coordinates satisfy a single equation or one or more algebraic conditions.”²⁰

60. Thus, under its broadest reasonable interpretation in view of the claims and specification, I understand a “*locus of locations*” to be “*a collection of points or locations*.”

D. “*wherein said one or more location determining sources perform the following techniques (i), and (ii)*”

61. Claim 10 recites the phrase “*wherein said one or more location determining sources perform the following techniques (i), and (ii)*,” which was construed in the prior district court proceeding as follows:

Wherein each of the location determining sources performs one or both of the following techniques (i) and (ii), and there is at least one location determining source or combination of such sources that collectively perform both techniques.²¹

62. While I do not believe that this phrase requires construction in this *inter partes* review proceeding, I do not otherwise disagree with the prior district court construction for purposes of this proceeding.

E. order of claim elements

63. Certain challenged claims use numeric modifiers, such as “*first*” and “*second*,” to refer to various claim elements associated with the recited location

²⁰ Ex. 1024 (Definition of Locus).

²¹ Ex. 1017 (Claim Construction Order) at 38.

techniques and/or location information provided from those techniques. The challenged claims simply use these modifiers to distinguish between different claim elements, and thus should not be construed as requiring any particular order. “The use of the terms ‘first’ and ‘second’ is a common patent-law convention to distinguish between repeated instances of an element or limitation” and “should not in and of itself impose a serial or temporal limitation.” *3M Innovative Props. Co. v. Avery Dennison Corp.*, 350 F.3d 1365, 1371 (Fed. Cir. 2003) (holding that the terms “first pattern,” “second pattern,” “first embossing step,” and “second embossing step” did not impose an order).

64. For example, Claims 17, 20, 25, 162, and 155 each recite the steps of “*first obtaining*” and “*second obtaining*.” In these claims, the “*first obtaining*” step obtains location information from a satellite technique, and the “*second obtaining*” step obtains location information from a terrestrial technique. These numeric modifiers, however, are simply used to distinguish between the two different “*obtaining*” steps rather than to impose an order on the satellite and terrestrial location techniques. *Unwired Planet, LLC v. Google Inc.*, No. 3:12-CV-00504-MMD, 2014 WL 7012497, at *27 (D. Nev. Dec. 12, 2014) (holding that the steps of “first transmitting” and “second transmitting” are merely “two separate transmission steps” and do not require a sequential order).

65. As another example, Claim 36 recites generating a location estimate

based on output from a “*first technique*,” “*second technique*,” and “*third technique*.” Claim 36 also clarifies, however, that only two of the three recited techniques need to be used for generating the estimate: the “*second technique*” (“B2”) always must be used, along with either the “*first technique*” (“B1”) or the “*third technique*” (“B3”). Thus, given that the “*second technique*” (“B2”) is the only one of the three techniques that is always required, this claim would not make sense if the numeric modifiers imposed an order.

66. As another example, Claim 10 recites the steps of “*first obtaining*” and “*second obtaining*.” In these claims, the “*first obtaining*” step obtains output location data for a first mobile station using a satellite technique, and the “*second obtaining*” step obtains output location data for a second mobile station using a terrestrial technique. This, these steps involve obtaining location data for two different mobile stations, and thus the “*first*” and “*second*” qualifiers are simply used to distinguish between the two obtaining steps rather than requiring one mobile station to be located before the other.

67. Numeric modifiers are also used to distinguish between many other claim elements, including first and second “*collections of measurements*” (Claim 25), “*location techniques*” / “*location processing techniques*” (Claims 36, 155, 162), “*location information*” (Claim 20, 25), “*location related response information*” (Claim 162), “*geographical location related information*” (Claim

155), and “*instances of location information*” (Claim 17).

68. Interpreting these numeric modifies as requiring an order is unsupported (and contradicted) by the specification, and is also inconsistent with a ruling from the prior district court, which determined that both “*obtaining*” steps of Claim 25 are not always required.²²

69. The specification explicitly confirms that the location techniques are not performed in any particular order. For example, the “Field of the Invention” states that “[*t*]he present invention is directed ... to a system and method for locating a wireless mobile station using a plurality of simultaneously activated mobile station location estimators.”²³ Location techniques that are “simultaneously activated” are performed at the same time: they do not have an order. Even if the techniques can be performed serially, however, it is clear from the specification that no particular order is required, because the output from all the location techniques is needed before the resulting location estimate can be determined:

Thus, location information may be obtained from a plurality of the above location techniques for locating a mobile station, and the output from such techniques can be synergistically used for deriving therefrom an enhanced location estimate of the mobile station.

²² Ex. 1018 (Supplemental Claim Construction Ruling).

²³ Ex. 1001 (’231 Patent) at 1:14-20 (emphasis added); *see also id.* at 53:7-11, 54:26-30.

...

[T]he accuracy and reliability in estimating the location of a target MS 140 with the present invention comes from synergistically utilizing a plurality of different MS location estimators, each of which may be undesirable in terms of accuracy and/or reliability in some areas, but when their estimates are synergistically used as in the location engine 139, accurate and reliable location estimates can be attained.²⁴

70. Thus, under the broadest reasonable interpretation of these claims in view of the specification, the numeric modifiers do not require any particular order for the associated claim elements.

F. “*obtained by/from transmissions*”

71. Claim 1 recites “*wireless signal measurements obtained by transmissions between said mobile station M and the communication stations.*”

72. Similarly, Claim 36 recites “*receiving...wireless signal data obtained from transmissions between: (i) said communication stations, and (ii) said mobile station M_i .*”

73. These phrases could be interpreted to cover two possible scenarios: (1) the wireless signal data itself is transmitted between the communication stations and the mobile station (e.g., GPS satellite signal measurements are transmitted from the mobile station to the communication stations), or (2) the

²⁴ *Id.* at 12:7-16, 68:2-8 (emphasis added); *see also id.* at 9:5-11, 66:9-14, 87:44-58.

wireless signal data is simply generated using the transmissions between the communication stations and mobile station (*e.g.*, the mobile station measures the signals transmitted from communication stations).

74. In the prior district court proceeding, TracBeam argued that both of the above scenarios were covered by the above phrase in Claim 1.²⁵ The district court agreed with TracBeam and ruled that both of the above scenarios were covered by this language.

75. For purposes of this proceeding, I agree that the broadest reasonable interpretation of this phrase in Claim 1, and the substantially similar language in Claim 36, covers both of the above scenarios.

VII. STATE OF THE ART / TECHNOLOGY OVERVIEW

76. In this section, I provide an overview of the state of the art at the time of the '231 Patent.

A. Early applications of wireless location technologies

77. As acknowledged by the '231 Patent, wireless location technologies were available many years before the filing of TracBeam's earliest provisional application (September 1996)²⁶ and have been used in a wide range of applications, including aviation, military, automotive, and mobile phone services.²⁷

²⁵ Ex. 1017 (Claim Construction Order) at 27-28.

²⁶ Ex. 1001 ('231 Patent) at 1:43-2:29.

²⁷ *Id.* at 12:17-23 and 100:16-23.

78. Examples of preexisting location determining technologies include GPS, GLONASS, Loran-C, Omega, and various other ground-based positioning technologies, such as signal strength, time-of-arrival (TOA), and time-difference-of-arrival (TDOA) techniques.²⁸

79. As the use of cellular technology increased, systems were also developed that used existing cellular telephone infrastructure to provide wireless location capabilities.²⁹ For example, various wireless location technologies were developed that estimated the location of cellular telephones relative to one or more nearby cell sites in a cellular network. These wireless location technologies were used to provide various services to cellular subscribers, such as 911 services, vehicle tracking/fleet management, and navigation and directions (among others).³⁰ For example, in 1994 the Federal Communications Commission proposed various rules requiring cellular service providers to determine the location of emergency 9-1-1 callers to aid first responders in locating the emergency caller.³¹ In connection with these proposed rules, a survey of available wireless location technologies was

²⁸ Ex. 1009 (*Wortham*) at 2:63-3:5; Ex. 1007 (*Kauser*) at 1:61-2:40, 2:62-66; Ex. 1011 (*Stilp*) at Abs., 5:5-26, 6:41-55, 14:31-39; Ex. 1012 (FAA 20-101C) at 1.

²⁹ Ex. 1009 (*Wortham*) at 1:46-2:12; Ex. 1007 (*Kauser*) at 2:62-66; Ex. 1011 (*Stilp*) at Abs., 5:5-26.

³⁰ Ex. 1007 (*Kauser*) at 1:46-60, 5:33-67, 12:22-35; Ex. 1009 (*Wortham*) at 4:33-39; Ex. 1010 (*Schuchman*) at 1:7 – 2:23.

³¹ Ex. 1014 (FCC E911 Proposal).

conducted and reported to the FCC in July of 1994.³² That survey identified numerous location technologies that were available at the time, including GPS, Time Difference of Arrival, and triangulation, as well as various hybrid approaches using these technologies.³³

B. Hybrid wireless location approaches

80. It was widely recognized at the time of the '231 Patent that every location technology has unique limitations. In particular, it was well known that the reliability of location technologies may be affected by environmental conditions, including varied terrain, weather conditions, or the presence of obstructions between the mobile device and the cell site antennas or satellites. Depending on the particular technology, these conditions may result in a less accurate location estimate or no estimate at all. For example, satellite-based technologies such as GPS typically excel outdoors and in rural environments, while suffering indoors and in urban environments due to obstructions from buildings and other structures. Cell site based location technologies, on the other hand, typically excel in urban areas due to the dense placement of the cell sites, while suffering in rural areas where the cell sites are spaced further apart.

³² Ex. 1016 (Driscoll Survey).

³³ *See generally id.*

81. It was well known at the time of the '231 Patent that these limitations may be minimized by integrating multiple wireless location technologies in order to compensate for the respective limitations associated with any one technology. Such hybrid solutions were widely known and adopted.

82. In fact, the FAA began experimenting with a hybrid solution in its flight management systems in the 1980s and early 1990s.³⁴ Similarly, the automotive industry began incorporating hybrid solutions in vehicle navigation and fleet management systems in the early 1990s.³⁵ As the use of cellular technology increased, systems were also developed that used existing cellular telephone infrastructure to provide wireless location capabilities.³⁶ Various hybrid location technologies were also utilized in these cellular systems.³⁷

C. Fundamental location technologies

83. The section provides an explanation of the various individual location technologies that were available at the time of the '231 Patent, including coverage area, time-of-arrival (TOA), time-difference-of-arrival (TDOA), and satellite based technologies.

³⁴ Ex. 1012 (FAA 20-101C) at 1, 3; Ex. 1013 (FAA Advisory Circular 20-130A) at 1.

³⁵ Ex. 1010 (*Schuchman*) at 1:1-2:23.

³⁶ Ex. 1009 (*Wortham*) at 1:46-2:12; Ex. 1007 (*Kauser*) at 2:62-66; Ex. 1011 (*Stilp*) at Abs., 5:5-26.

³⁷ Ex. 1007 (*Kauser*) at 2:62-66; Ex. 1010 (*Schuchman*) at 1:1-12, 5:22-33, 7:19-26; Ex. 1016 (Driscoll Survey) at stamped pp. 9, 38-39.

1. Coverage Area

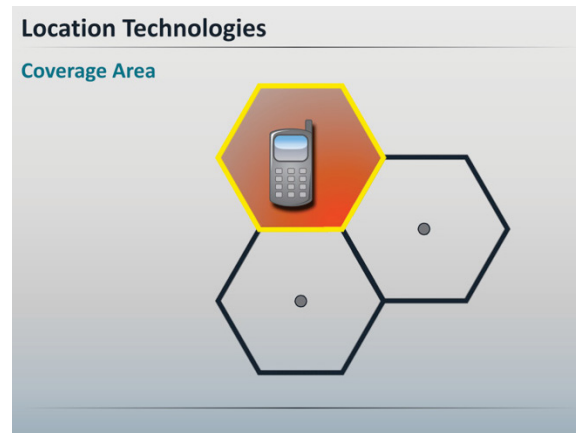
84. Coverage area techniques utilize the coverage area of a cell site to estimate the location of a mobile device.³⁸ For example, a coverage area technique typically estimates the location of a mobile device to be somewhere within the coverage area of the serving cell site of that mobile device. These techniques are often called basic cell identification, or Cell-ID, techniques.

85. Cell-ID is a simple way to locate a mobile device by identifying the serving cell site of the mobile device. Because the location of cell sites are known and the size of their coverage area can be estimated, the location of a mobile device can be approximated as being within the geographic area served by the cell site that the mobile device is connected to. As the mobile device is handed off to another cell site, the estimated location of the mobile device can be updated using the same technique with respect to the new cell site. For cell sites with a smaller coverage area, the accuracy of this technique increases. However, this technique is no more accurate than the estimated size of the coverage area of the serving cell site.

86. For example, the below illustration depicts three “cells”: each cell corresponds to the coverage area of a cell site (represented by the dots in the middle of the cells). A cell phone connected to one of the cell sites is assumed to

³⁸ Ex. 1001 ('231 Patent) at 63:58-66; Ex. 1007 (*Kauser*) at FIG. 2, 4:42-56, 6:1-22.

be in the coverage area of that cell site, and thus its location can be roughly approximated based on the known location and coverage area of the serving cell site.

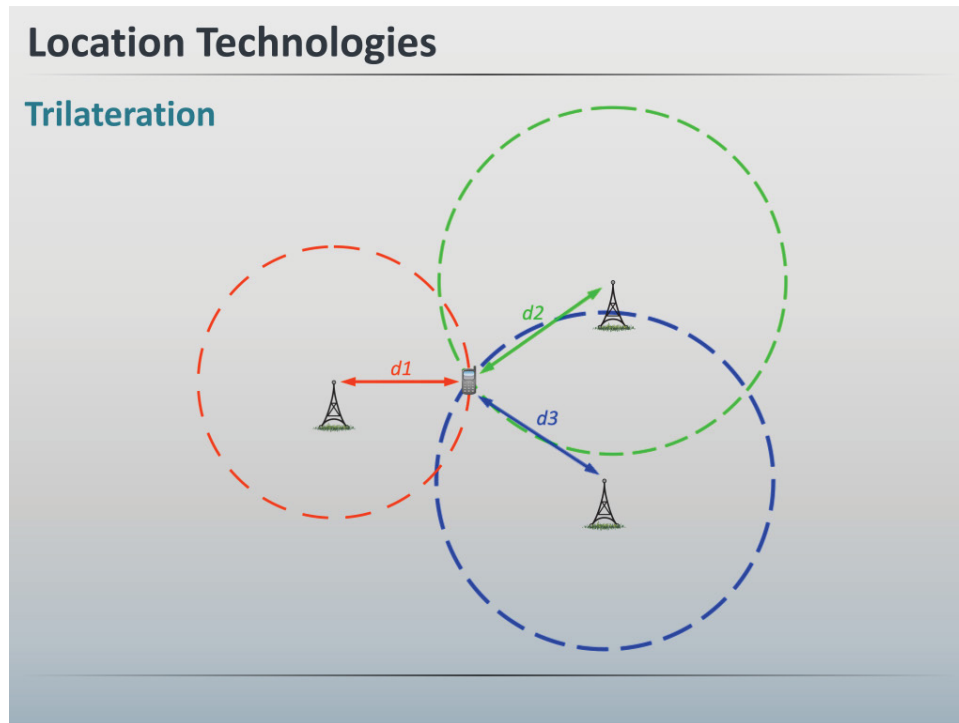


2. Trilateration (time of arrival and signal strength)³⁹

87. Trilateration techniques were also well known at the time of the '231 Patent, including those based on time-of-arrival measurements (TOA) or signal strength measurements. Trilateration a technique that involves estimating the location of a mobile device using the distance from the mobile device to three or more antennas at known locations, such as three or more cell sites. If the distance between a mobile device and an antenna is known, then the area where that mobile device is located can be estimated to be somewhere along the circumference of a circle with a radius equal to the measured distance. If the distance is measured from the mobile device to three antennas, then the location of the mobile device

³⁹ Ex. 1001 ('231 Patent) at 51:8-24; Ex. 1009 (*Wortham*) at 13:39-44, 13:60-62, 14:5-12; Ex. 1007 (*Kauser*) at 3:3-10, 7:42-50, 9:5-18, FIGS. 5-8.

can be estimated as the intersection of the three circles defined by those distances. In cellular networks, trilateration may be implemented using the antennas located on cell sites.



88. There are several ways to measure distance when performing a trilateration calculation, including using either time of arrival (TOA) or signal strength measurements.

89. For example, time of arrival (TOA) measurements can be used to perform the distance calculations by measuring the time it takes a signal to travel between the mobile device and a cell site antenna. The time it takes for the signal to travel between the mobile device and the cell site antenna can be determined by calculating the difference between the time when the signal is sent from the mobile

device and the time when the signal arrives at the cell site antenna. The distance between the mobile device and the cell site can then be calculated by multiplying the travel time by the signal speed.

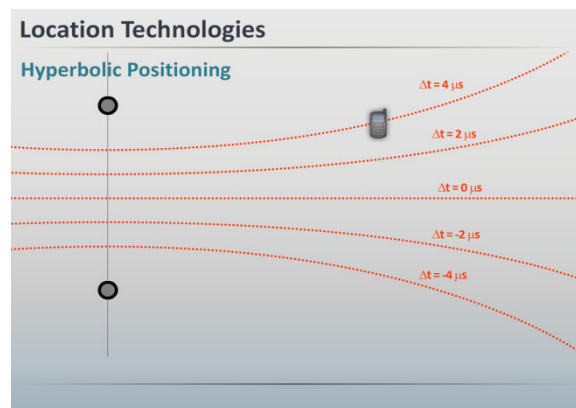
90. Signal strength measurements can also be used to calculate the distances from each antenna. The signal strength of a wireless signal decreases proportionally based on the travel distance (and also the travel time, given the constant propagation speed of a radio signal), and thus, the decrease in signal strength can be used to estimate the distance of the transmitting and receiving devices.

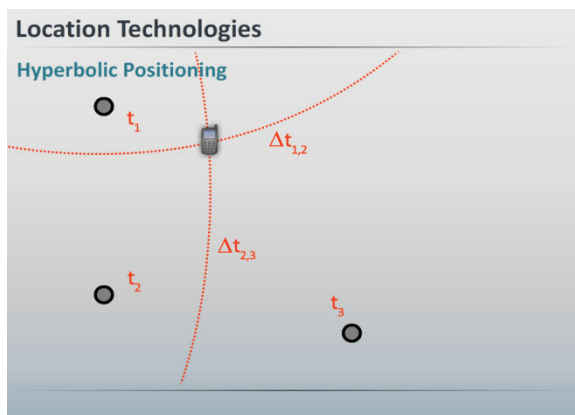
3. Time Difference of Arrival (TDOA)⁴⁰

91. Time Difference of Arrival is another technique that was well known at the time of the '231 Patent. Time Difference of Arrival is a form of multilateration, which is a technique that involves measuring the difference of the times that a signal arrives at various antennas. As illustrated, if a mobile device near two antennas sends a signal, the signal will arrive at the first antenna at a time t_1 and at the second antenna at time t_2 . By knowing the difference between these two times, the possible locations of the mobile device can be narrowed down to somewhere on a hyperbolic curve. For example, if a signal arrives at antenna number one four microseconds before it arrives at antenna number two, then a

⁴⁰ Ex. 1001 ('231 Patent) at 51:8-24.

hyperbolic line-of-position for $\Delta T=4\mu s$ can be identified. If the signal arrives at both antennas at the same time, the location of the mobile device is somewhere on the straight line that runs halfway between the antennas. Similar lines-of-position can be identified for different time differences. If a mobile device is near three antennas, then when the mobile device transmits a signal, there will be three arrival times. As previously discussed, by comparing the arrival times at antenna number one and antenna number two, a line-of-position can be determined based on that time difference. Similarly, by comparing the arrival times at antenna number two and antenna number three, a second line-of-position can be determined. The location of the mobile device can be estimated as the intersection of those two lines.





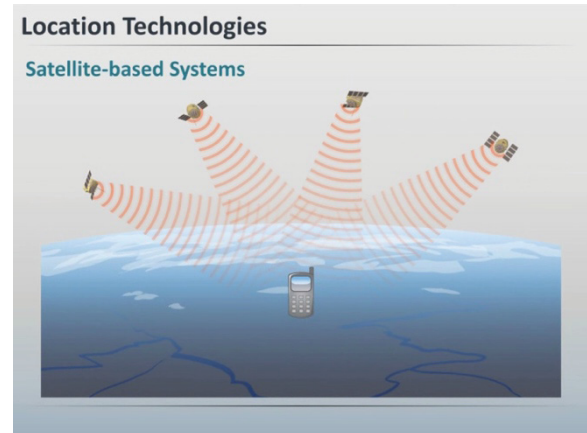
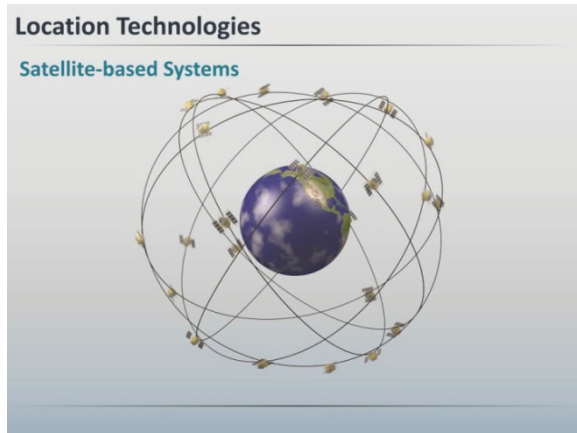
4. Satellite-Based Location Technologies⁴¹

92. An example of a prior art satellite-based system is the Global Positioning System, or “GPS.” GPS uses the trilateration techniques discussed above by measuring distances from satellites orbiting the Earth. GPS was developed by the United States Department of Defense. At any given time, there are several GPS satellites overhead any particular area on the surface of the Earth. The GPS satellites continually transmit messages that identify the transmission time of the message and the satellite’s position in space at the time of transmission.

93. GPS receivers determine the time delay of the signals received from the satellites. Using these time delays, the distance between the GPS receiver and four or more satellites can be determined. By determining these distances, trilateration can be used to estimate the location of the GPS receiver in three dimensions — latitude, longitude, and altitude (or elevation). In some instances,

⁴¹ Ex. 1001 (’231 Patent) at 1:58-64; Ex. 1009 (*Wortham*) at 3:21-25, 5:18-23; Ex. 1007 (*Kauser*) at 9:19-29.

three satellites may be sufficient to estimate a two dimensional location if elevation is not required.



Differential GPS

94. Differential GPS is a form of GPS that increases the accuracy of a GPS location estimate.⁴² Around the 1990 time frame, the United States Department of Defense intentionally degraded the accuracy of the public GPS signals due to concerns that enemies might use the signals to guide weapons targeted against the United States. This degradation, known as Selective Availability (SA), was accomplished by modulating, or dithering, the GPS satellite clock according to a classified algorithm. As a result, the pseudorange measurements made by a GPS receiver would vary in accordance with the GPS clock dithering. Thus, military receivers, which had knowledge of the classified

⁴² Ex. 1001 ('231 Patent) at 2:15-20; Ex. 1009 (*Wortham*) at 3:48-59; Ex. 1010 (*Schuchman*) at 20:21-28; Ex. 1008 (*Loomis*) at 11:20-48.

algorithm, could correct the GPS signals, but civilian receivers were limited in accuracy to approximately 100 meters.

95. However, since GPS receivers operating within about 250 kilometers of each other could receive signals from the same satellites at essentially the same time, these receivers would have essentially the same position error. If one of the receivers was located at a known (or at least stationary) location, it was possible to determine the error associated with SA. This error could then be broadcasted to GPS receivers in the vicinity to allow those receivers to correct their position estimates. Although the accuracy of GPS is no longer intentionally degraded by the Department of Defense, differential GPS is still used to improve the accuracy of GPS location estimates.

Assisted GPS

96. Assisted GPS is another variation of GPS that leverages wireless communications to assist a GPS receiver in determining its location. An implementation sometimes referred to as “mobile-based A-GPS” enables a GPS receiver to generate position estimates significantly faster by providing the GPS receiver with GPS assistance data (referred to as GPS “ephemeris” and “almanac” data)⁴³ over a wireless communications link.⁴⁴ Another implementation sometimes

⁴³ GPS assistance data may also include time and/or frequency assistance information.

referred to as “mobile-assisted A-GPS” involves wirelessly transmitting GPS satellite measurements from a GPS receiver to a remote network component and/or server, which then performs the GPS calculations for the GPS receiver.⁴⁵

VIII. PRIOR ART

97. The prior art references that I believe invalidate certain claims of the ’231 Patent are briefly introduced below.

A. *Kauser*

98. U.S. Patent No. 5,724,660 to *Kauser* et al. (“*Kauser*”), titled “Method and Apparatus for Locating a Mobile Station by Comparing Calculated Location Area with GPS Coordinates,” was filed February 20, 1996 and issued March 3, 1998.^{46,47}

99. *Kauser* discloses a method and apparatus for determining and outputting a resulting location estimate for a mobile telephone using multiple location techniques that generate location estimates from wireless signal measurements.⁴⁸ The location techniques include satellite-based techniques (*e.g.*,

⁴⁴ Ex. 1010 (*Schuchman*) at 6:11-33.

⁴⁵ Ex. 1008 (*Loomis*) at 8:29-35, 20:29-36, Abs.

⁴⁶ My understanding is that the invention described in *Kauser* was actually invented in 1995 and thus qualifies as prior art as of that date as a prior invention under the 102(g)(2) prior art subsection. However, my understanding is that 102(g) prior art cannot be relied on in an IPR proceeding.

⁴⁷ Ex. 1007 (*Kauser*).

⁴⁸ *Id.* at Abs., 2:62-3:15, 6:12-34, 11:35-12:21.

GPS) and terrestrial-based techniques (*e.g.*, cell-site geometric and coverage area techniques). *Kauser's* location function can be initiated for a variety of services, including emergency response services, fleet management, navigation for mobile station users who are lost, etc.⁴⁹

100. *Kauser's* location functionality can be implemented by a mobile location module (MLM), which is a component with a processor and memory that is connected to the mobile telephone system via a mobile switching center (MSC).⁵⁰ The MLM can determine the specific geographic location of a mobile station using the techniques identified above (*e.g.*, GPS, a cell-site geometric technique, and a cell-site coverage area technique).⁵¹ For example, *Kauser* discloses an embodiment whereby the MLM obtains location estimates for the mobile station from each location technique.⁵² The MLM then determines a resulting location estimate using the respective estimates from the various techniques (*i.e.*, the satellite-based technique and the terrestrial-based technique).⁵³

⁴⁹ *Id.* at 1:46-60, 5:33-67, 12:22-35.

⁵⁰ *Id.* at 5:23-32.

⁵¹ *Id.* at 5:23-32, 6:1-23, 11:35-12:21.

⁵² *Id.* at 6:1-23, 11:35-12:21.

⁵³ *Id.* at 11:35-12:21.

The resulting location estimate (and associated confidence value) is then routed to the appropriate end user destination.⁵⁴

B. *Loomis*

101. U.S. Patent No. 5,936,572 to *Loomis* et al. (“*Loomis*”), entitled “Portable Hybrid Location Determination System,” issued August 10, 1999 as a continuation of an application filed February 4, 1994.⁵⁵

102. *Loomis* discloses a method and apparatus for determining and outputting a resulting location estimate for a mobile user carrying a hybrid location determination (“LD”) device (*e.g.*, a mobile station) using multiple location techniques that generate location estimates using wireless signal measurements.⁵⁶ The location techniques include satellite-based techniques (*e.g.*, GPS) and terrestrial-based techniques (*e.g.*, a radio technique). *Loomis*’ location function can be initiated in response to a request from a person or facility.⁵⁷

C. *Wortham*

103. U.S. Patent No. 6,748,226 to *Wortham* (“*Wortham*”), titled “System And Method For Locating A Mobile Unit Within The Service Area Of A Mobile

⁵⁴ *Id.* at 12:22-35.

⁵⁵ Ex. 1008 (*Loomis*).

⁵⁶ *Id.* at Abs., 4:39-5:13, 11:49-13:4, 19:32-20:5, 18:27-32, FIG. 1.

⁵⁷ *Id.* at 12:34-40.

Communications Network,” issued June 8, 2004 as a continuation of an application filed November 16, 1994.⁵⁸

104. *Wortham* discloses a positioning system integrated with a cellular telephone network.⁵⁹ The positioning system can either be a satellite-based technology, such as GPS, or a terrestrial-based technology, such as cell site time-of-arrival (TOA).⁶⁰ Differential GPS may be used as the satellite based technology.⁶¹ In those embodiments, differential GPS correction data is provided to the mobile unit over the cellular network, which is then used by the GPS receiver in the mobile unit “to refine received position signals or computed position.”⁶² In the terrestrial-based embodiments, the mobile unit performs TOA pseudorange measurements using transmissions from the cell site antennas, and then using well-known triangulation techniques, the mobile unit computes its position using the TOA measurements and the known location of the cellular transmitter sites.⁶³

105. Potential applications of *Wortham*’s positioning system include “delivery service dispatch, less-than-full-load (LTL) trucking applications, in-

⁵⁸ Ex. 1009 (*Wortham*).

⁵⁹ *Id.* at 1:46-2:12.

⁶⁰ *Id.* at 1:46-2:12, 2:56-3:25.

⁶¹ *Id.* at 3:49-4:58.

⁶² *Id.* at 3:48-59, 4:10-25.

⁶³ *Id.* at 1:66-2:12, 13:36-62, 14:5-12.

vehicle navigation systems, surveying applications, collision avoidance, emergency location using mobile 911 services, or any other application requiring accurate positioning information of a vehicle, object, or person.”⁶⁴

IX. KAUSER COMBINATIONS

A. Overview

106. In my opinion, the following claims are obvious in view of *Kauser*, either by itself or in combination with *Wortham*:

Challenged Claims	Prior Art References
10, 47, 155, 162, 165, 185	Obvious in view of <i>Kauser</i>
25, 26, 36, 82	Obvious in view of <i>Kauser</i> and <i>Wortham</i>

107. This section describes the functionality disclosed by these prior art references and explains how these references could be combined and/or modified to invalidate the challenged claims.

108. For example, *Kauser's* mobile telephone location system includes a method and apparatus for determining and outputting a resulting location estimate (and associated confidence value) for a mobile telephone using multiple location techniques that generate location estimates using wireless signal measurements.⁶⁵ The location techniques in *Kauser's* location system include satellite-based techniques (*i.e.*, GPS) and terrestrial-based techniques (*i.e.*, cell-site geometric and

⁶⁴ *Id.* at 4:33-39.

⁶⁵ Ex. 1007 (*Kauser*) at Abs., 2:62-3:15, 6:12-34, 9:19-29, 11:35-12:21.

coverage area techniques).⁶⁶ As described throughout this section, a person of ordinary skill in the art would have been motivated to modify and/or combine *Kauser's* mobile telephone location system, for example, with aspects of the positioning systems disclosed in *Wortham*.

109. The reasons why these combinations and/or modifications would have been obvious is explained for each such combination and/or modification. In addition, Section IX.I addresses additional reasons to combine and/or modify that apply globally to all of the combinations and/or modifications discussed throughout this section.

110. Finally, I do not believe that any “secondary considerations of non-obviousness” (identified above in Section II regarding legal standards) demonstrate that the challenged claims are valid. In fact, a number of the secondary considerations provide further affirmation for my opinion that the challenged claims are invalid. For example, there was no long felt, unmet need for the alleged invention, no unexpected results, and no praise of the invention by others. In the event TracBeam presents evidence of secondary considerations of non-obviousness in this proceeding, I will address those secondary considerations at that time.

⁶⁶ *Id.*

B. Satellite / Non-Terrestrial GPS Technique

111. Certain claim elements require: (1) a satellite (or “*non-terrestrial*”) location technique; (2) satellite signal time delay measurements that are used as input to the satellite technique; (3) determining/obtaining “*location information*” (or some variation of that term) for a mobile station when the satellite technique is provided with the signal timing measurements as input; and (4) satellite measurements obtained by terrestrial transmissions.

1. Satellite (non-terrestrial) technique

112. *Kauser’s* location system includes a GPS technique, which satisfies the claim elements that require a satellite or non-terrestrial location technique.⁶⁷

2. Satellite signal time delay measurements

113. In *Kauser’s* location system, the GPS satellite signal measurements used by *Kauser’s* GPS technique satisfy the claim elements that require satellite signal time delay measurements. For example, *Kauser* discloses that the mobile telephone includes “a GPS receiver/processor [that] receives signals from satellites orbiting the earth and translates these signals into latitude and longitude coordinates of the position of the GPS receiver/processor.”⁶⁸ As acknowledged by the ’231 Patent, one of ordinary skill in the art would understand that these GPS signals are “translated” into latitude and longitude coordinates by measuring the

⁶⁷ Ex. 1007 (*Kauser*) at 9:19-29; *see also id.* at Abs., 2:62-3:15, 12:56-13:8.

⁶⁸ *Id.* at 9:19-29; *see also id.* at Abs., 2:62-3:15, 12:56-13:8.

signal travel time delay of the received GPS signals.⁶⁹ This is also confirmed by *Wortham*, which explains that GPS calculations involve “pseudorange” measurements corresponding to the range of the GPS receiver from each satellite in space (*i.e.*, the “*spatial range*” required by some claims), which are determined using the travel/propagation time, or time of arrival, of the satellite signals.⁷⁰ Thus, while these satellite signal time delay measurements are inherently used by any GPS receiver (including that of *Kauser*), they are also explicitly disclosed by *Wortham*.⁷¹

3. Satellite location information

114. In *Kauser*’s location system, the GPS location information generated by the GPS technique satisfies the claim elements that require “location information” (and variations thereof) obtained from a satellite technique.⁷² For example, *Kauser*’s GPS technique (when supplied with GPS signal measurements) provides the following GPS location information: (1) the current latitude/longitude GPS coordinates of the mobile telephone (*i.e.*, Lat(t_n) and Long(t_n)); (2) the most recently stored reliable GPS coordinates (*i.e.*, Lat_reg and Long_reg); (3) peak

⁶⁹ Ex. 1001 (’231 Patent) at 1:54-2:2.

⁷⁰ Ex. 1009 (*Wortham*) at 3:21-25, 5:18-23.

⁷¹ *Id.*

⁷² Ex. 1007 (*Kauser*) at 11:26-34, 9:34-39, 10:66-11:25; *see also id.* at Abs., 9:40-11:25.

error values (*i.e.*, Error_Lat(t_n) and Error_Long(t_n)); and/or (4) error thresholds (*i.e.*, Err_Thresh_Lat and Err_Thresh_Long).⁷³

4. Satellite signal measurements that are obtained by terrestrial transmissions (or “mobile-assisted GPS”)

115. Claim 36 of the '231 Patent requires the location techniques (including the satellite technique) to use “*wireless signal data obtained from transmissions between: (i) said communication stations, and (ii) said mobile station M_i at an unknown location.*”

116. In *Kauser's* location system, the mobile telephone performs the GPS calculations using the GPS satellite signal measurements, and then it simply sends the computed GPS information (*e.g.*, the GPS coordinates) to the cellular network.⁷⁴

117. In another well-known GPS embodiment, sometimes referred to as “mobile-assisted GPS,” a mobile telephone can send the GPS measurements to the network, and the network can perform the GPS calculations rather than the mobile telephone.⁷⁵ Mobile assisted-GPS embodiments are described in Section VII.C.4 (Satellite-Based Location Technologies).

⁷³ *Id.*

⁷⁴ Ex. 1007 (*Kauser*) at 9:34-39, 11:26-34.

⁷⁵ Ex. 1001 ('231 Patent) at 2:21-23.

118. It would have been obvious to modify *Kauser's* location system to use this alternative GPS implementation. Under the proposed modification, *Kauser's* location system would send the GPS signal measurements to the network, and the mobile location module (MLM) in the network would perform the GPS calculations instead of the mobile telephone.

119. Those of ordinary skill in the art would have found it obvious to modify and/or combine the prior art in this manner for various reasons.

120. First, mobile-assisted GPS embodiments were well known to those of ordinary skill in the art at the time of the '231 Patent. In fact, the '231 Patent acknowledges, in the Background of the Invention, that this GPS embodiment was known in the prior art and implemented by prior art location systems: "Additionally, GPS-based location systems have been attempted in which the received GPS signals are transmitted to a central data center for performing location calculations."⁷⁶ As another example, this type of GPS embodiment is also disclosed by *Loomis*, which explains that outdoor LD signals (*e.g.*, GPS signals) "may be transmitted, unprocessed or partly processed or fully processed, to a central processing station . . . to allow determination of the present location of the user."⁷⁷

⁷⁶ Ex. 1001 ('231 Patent) at 2:21-23.

⁷⁷ Ex. 1008 (*Loomis*) at 8:29-35.

121. Second, the proposed modification of *Kauser* is a simple substitution of one known element for another (*i.e.*, substituting one known GPS embodiment with another known GPS embodiment) to obtain predictable results (*i.e.*, both GPS embodiments ultimately provide the same function of locating a mobile device).

122. Third, those of ordinary skill in the art understood that “mobile-assisted GPS” has advantages over standard “mobile-based” GPS implementations. Specifically, when GPS receivers are in use, they are notorious for draining the battery life of a mobile device. Mobile-assisted GPS, however, can preserve battery life by offloading the GPS calculations to the network rather than the mobile telephone. As another example, for 911 calls, once the network receives the GPS signal measurements from the mobile telephone, the network will still be able to locate the 911 caller even if the call drops. In standard “mobile-based” GPS implementations, however, if the call drops before the mobile telephone has finished performing the GPS calculations, the network will be unable to locate the caller. The proposed modification of *Kauser’s* location system simply uses a known technique to improve similar devices in the same way (*i.e.*, the “mobile-assisted” GPS implementation is used to improve *Kauser’s* standard GPS technique).

123. Section IX.I (Global Reasons to Modify and/or Combine) presents additional reasons why it would have been obvious to modify and/or combine the prior art in this manner.

C. Terrestrial Geometric Technique

124. Certain claim elements require: (1) terrestrial communication stations at fixed locations that wirelessly communicate with the mobile stations; (2) a terrestrial location technique used to determine/obtain “location information” (or some variation of that term); (3) wireless signal measurements obtained from transmissions with the terrestrial stations, which are used as input to the terrestrial location technique; and (4) “signal time delay” data included in the wireless signal measurements.

1. Terrestrial communication stations at fixed locations

125. *Kauser*’s mobile telephone location system includes a network of cell sites used to provide two-way wireless communication with mobile telephones.⁷⁸ The cell sites in *Kauser* satisfy the claim elements that require terrestrial communication stations at fixed locations that communicate with mobile stations.

126. Specifically, *Kauser* discloses that a “cell site is the location within a cell which contains the required hardware (e.g. antenna(s) and radio base station)

⁷⁸ Ex. 1007 (*Kauser*) at 1:20-32, 3:53-62, FIGS. 1, 2.

to communicate with the mobile telephones.”⁷⁹ *Kauser* explains that “the locations (in latitude and longitude coordinates) of the cell site antennas are known.”⁸⁰ Thus, each cell site in *Kauser* (*i.e.*, a radio base station and associated antenna) is a fixed or stationary radio transmission structure with a known location on the Earth.⁸¹ As would be understood by those of ordinary skill in the art, these cell site structures are an inherent aspect of any cellular communication network.⁸²

2. Terrestrial location technique

127. *Kauser’s* location system includes a geometric location technique, which satisfies the claim elements that require a terrestrial location technique used to determine/obtain “location information” (or some variation of that term):

In accordance with one embodiment of the invention, the location of a mobile telephone is determined using a geometric location technique .

...⁸³

128. As explained in the following paragraphs, *Kauser’s* geometric location technique calculates location estimates using measurements of wireless signals transmitted between a mobile telephone and the surrounding cell sites.⁸⁴

⁷⁹ *Id.* at 1:20-32; *see also id.* at 3:53-62, FIGS. 1, 2.

⁸⁰ *Id.* at 8:25-28, 9:8-15.

⁸¹ *Id.* at 1:20-32, 3:53-62, 8:25-28, 9:8-15, FIGS. 1, 2.

⁸² Ex. 1009 (*Wortham*) at 1:66-2:12.

⁸³ Ex. 1007 (*Kauser*) at 2:62-66 (emphasis added).

⁸⁴ *Id.* at 2:62-3:10, 1:61-2:2; *see also id.* at Abs., 6:1-39.

3. Wireless signal measurements

129. The cell site signal measurements used by *Kauser's* geometric technique satisfy the claim elements that require the terrestrial technique to use wireless signal measurements obtained from transmissions with the terrestrial stations. Specifically, *Kauser's* geometric technique calculates the location of a mobile telephone using signal strength measurements from the transmissions between the cell sites and the mobile telephone:

In accordance with one embodiment of the invention, the location of a mobile telephone is determined using a geometric location technique A mobile location module within the mobile telephone system receives data representing the signal strengths of the signals surrounding the mobile telephone, which signals are being transmitted from cell site antennas of the mobile telephone system. The distances between the mobile telephone and each of these cell site antennas can be determined by using the signal strength data. . . . These reduced error distances are then used to calculate a location area estimate.⁸⁵

130. For example, in *Kauser*, each mobile telephone maintains a “MAHO list” containing the measured signal strength of the surrounding cell sites, which is periodically sent to the mobile switching center (MSC) in the cellular network.⁸⁶ When the MSC needs to locate a particular mobile telephone, the MSC provides

⁸⁵ *Id.* at 2:62-3:10, 1:61-2:2 (emphasis added); *see also id.* at Abs., 6:1-39.

⁸⁶ *Id.* at 4:63-66, 5:8-12, 5:17-22.

the associated MAHO list to a mobile location module (MLM).⁸⁷ The MLM then performs *Kauser's* geometric location technique using the signal strength measurements in the MAHO list.⁸⁸

4. Signal time delay measurements

131. It would have been obvious to modify *Kauser's* geometric technique to use time-of-arrival (TOA) measurements instead of signal strength measurements, as described in *Wortham*:

Instead, transmitter sites [] transmit time-of-arrival (TOA) data over respective communications links []. Mobile unit [] receives TOA data and computes the position of mobile unit [] using the TOA data and known position coordinates of transmitter sites [].

[M]obile unit [] can generate pseudorange measurements by comparing the message time of arrival to the time of transmission.

TOA data is received by transceiver 92 and sent to processor 100, which uses the TOA data to compute pseudoranges to cellular transmitter sites []. Using well-known triangulation techniques . . . , processor [] may then compute a position fix of mobile unit [] using the pseudoranges and known position coordinates of transmitter sites . . .⁸⁹

⁸⁷ *Id.* at 5:26-32, 6:1-23.

⁸⁸ *Id.* at 2:62-3:10.

⁸⁹ Ex. 1009 (*Wortham*) at 13:39-44, 13:60-62, 14:5-12 (emphasis added).

132. *Wortham's* comparison of the signal arrival and transmission times identifies the delay due to the travel time of the signal.⁹⁰ Thus, one of skill in the art would understand that *Wortham's* time-of-arrival measurements are based on the “*signal time delay*” of a transmitted wireless signal.

133. As explained above, in *Kauser's* normal (unmodified) operation, the signal strength measurements used by the MLM's geometric technique are obtained from the “MAHO list” of signal strength measurements that the mobile telephone periodically transmits to the network.⁹¹ When *Kauser* is modified to use *Wortham's* TOA measurements instead of signal strength measurements, *Kauser's* mobile telephone would provide the TOA measurements to the MLM by (1) including the TOA measurements in the MAHO list of signal strength measurements that is periodically sent to the network/MLM, or (2) separately transmitting the TOA measurements to the network/MLM.⁹²

134. Those of ordinary skill in the art would have found it obvious to modify and/or combine the prior art in this manner for various reasons.

135. First, the proposed combination would require only a trivial modification to *Kauser*, as the respective techniques of *Kauser* and *Wortham* are very similar. For example, *Kauser* and *Wortham* both disclose location techniques

⁹⁰ *Id.*

⁹¹ Ex. 1007 (*Kauser*) at 2:62-3:3, 4:63-66, 5:17-22, 6:1-6.

⁹² *Id.*

that determine location estimates based on the relative distance of a mobile device to multiple cell sites or transmitters.⁹³ The only meaningful difference between the techniques in *Kauser* and *Wortham* is how those distances are calculated: *Kauser* uses signal strength measurements, while *Wortham* uses time-of-arrival (TOA) measurements. Thus, the proposed modification is trivial: *Kauser*'s geometric technique would simply be modified to perform the requisite distance calculations using TOA measurements (as in *Wortham*) instead of signal strength measurements.

136. Second, *Kauser* explicitly teaches that its invention can be implemented "using a geometric location technique other than that described."⁹⁴ *Kauser* also acknowledges that "geometric process[es] such as triangulation" were known in the prior art.^{95,96} Thus, those of skill in the art would have been motivated to implement *Kauser*'s geometric technique using other known prior art location techniques, notably those based on triangulation. Moreover, *Wortham* discloses that its time-of-arrival (TOA) location technique is implemented "[u]sing

⁹³ *Id.* at 3:3-10, 7:42-50, 9:5-18, FIGS. 5-8; Ex. 1009 (*Wortham*) at 14:5-12, 13:39-62, FIG. 6.

⁹⁴ *Id.* at 12:46-48.

⁹⁵ Moreover, time-of-arrival (TOA) based techniques were very well known in the art at the time of TracBeam's purported invention. In fact, GPS (one of the technologies disclosed in *Kauser*) is a technology that calculates locations based on the time-of-arrival of satellite signals.

⁹⁶ Ex. 1007 (*Kauser*) at 1:65-2:2 (emphasis added).

well-known triangulation techniques.”⁹⁷ Thus, *Kauser*’s teaching, suggestion, and motivation of using other geometric techniques such as triangulation would have motivated those of ordinary skill in the art to implement *Kauser*’s location system using *Wortham*’s TOA triangulation technique. This trivial combination involves a simple substitution of one known element for another to obtain predictable results (*i.e.*, using TOA measurements instead of signal strength measurements to perform distance calculations for locating mobile devices).

137. Finally, Section IX.I (Global Reasons to Modify and/or Combine) presents additional reasons why it would have been obvious to modify and/or combine the prior art in this manner. For example, those of ordinary in the art would have also been motivated to combine aspects of *Kauser* and *Wortham* based on the extremely similar nature of the problem solved, and based on the FCC E911 proposals.

D. Terrestrial Coverage Area Technique

138. *Kauser*’s location system also includes a coverage area technique, which uses the known geographic coverage area of the serving cell site to estimate the location of the mobile telephone.⁹⁸ For example, because the mobile telephone is connected to the serving cell site and thus must be within its coverage area, the

⁹⁷ Ex. 1009 (*Wortham*) at 14:5-12 (emphasis added).

⁹⁸ Ex. 1007 (*Kauser*) at FIG. 2, 4:42-56, 6:1-22.

location estimate of the mobile telephone simply corresponds to the known coverage area of the serving cell site.⁹⁹

E. Resulting Location Determination

139. Certain claim elements require: (1) determining resulting location information for a mobile station using the respective location information from multiple location techniques; and (2) using or obtaining an indication of the “likelihood” of the mobile station being at or within a particular location estimate.

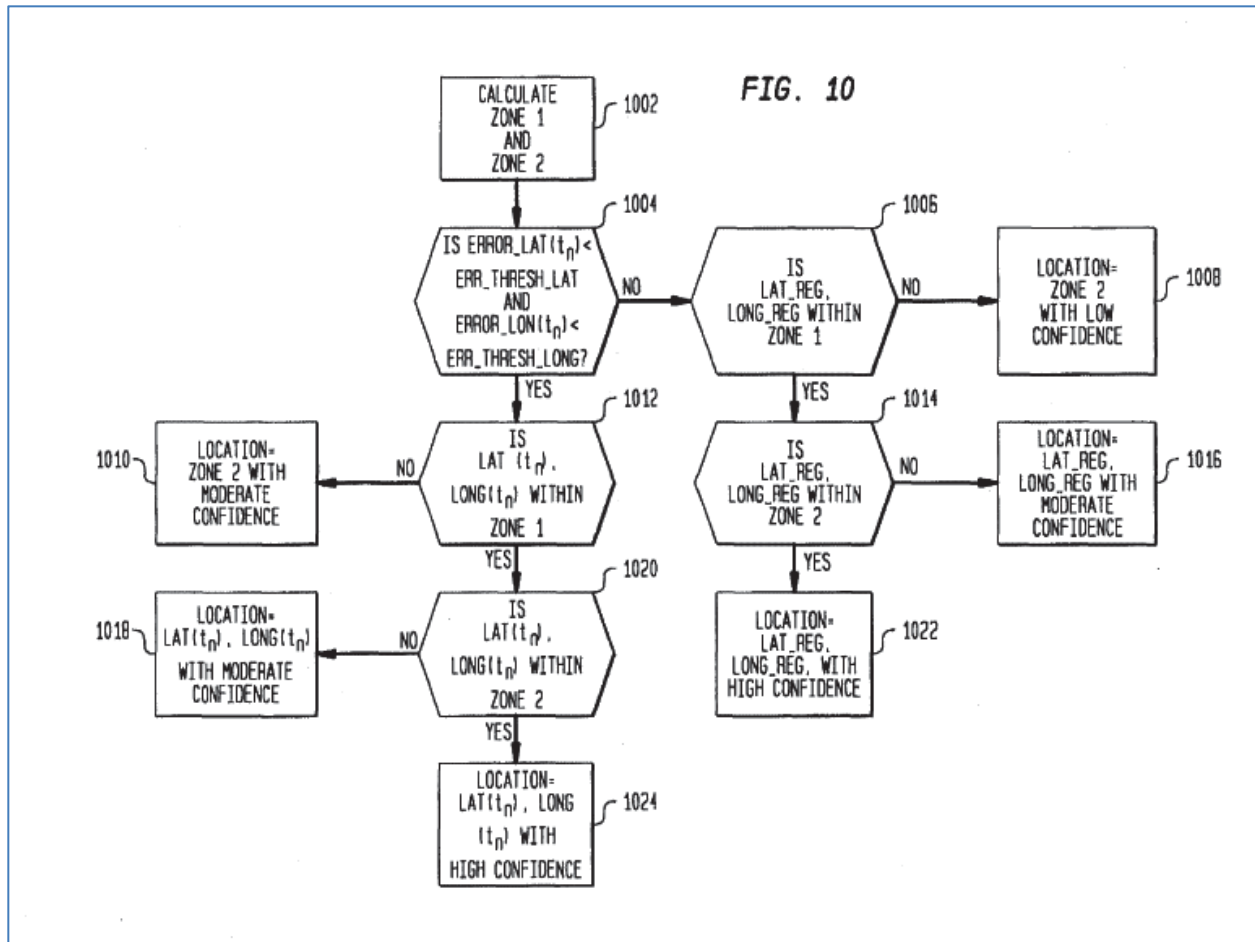
1. Determining resulting location information:

140. The location determining algorithm used by *Kauser*’s location system satisfies the claim elements that require a determination of resulting location information using the respective location information from multiple location techniques. For example, *Kauser* discloses an algorithm for determining a resulting location estimate and confidence value by comparing the respective estimates from the GPS, geometric, and coverage area location techniques.¹⁰⁰

Kauser’s algorithm is depicted in Figure 10:

⁹⁹ *Id.*

¹⁰⁰ *Id.* at FIG. 10, Abs., 2:62-3:25, 6:1-23, 11:27-12:21.



141. Specifically, after obtaining estimates from each technique, the ultimate location of the mobile telephone can be determined by the mobile location module (MLM).¹⁰¹ The MLM may first determine whether the current GPS coordinates are of acceptable accuracy based on whether the associated GPS error values are within the threshold error values.¹⁰² If they are not within the threshold error values, the MLM may use the most recently stored reliable GPS

¹⁰¹ *Id.* at FIG. 10, 11:27-12:21.

¹⁰² *Id.* at 11:48-54, 12:1-8.

coordinates.¹⁰³ The MLM may then compare the respective location estimates from the various techniques.¹⁰⁴ For example, when the current GPS coordinates are used (rather than the stored GPS coordinates), the GPS estimate is first compared with the coverage area estimate.¹⁰⁵ If the GPS estimate is not within the coverage area estimate, then the geometric estimate is returned as the resulting location estimate with a moderate confidence level.¹⁰⁶ If the GPS estimate is within the coverage area estimate, then the GPS estimate is then compared with the geometric estimate.¹⁰⁷ If, based on that comparison, the GPS estimate is within the geometric estimate, the GPS estimate is returned as the resulting location estimate with a high confidence level; but if the GPS estimate is not within the geometric estimate, then the GPS estimate is returned as the resulting location estimate with a moderate confidence level.¹⁰⁸ The process is similar when the stored GPS coordinates are used instead of the current GPS coordinates (*i.e.*, because the current GPS coordinates were determined to be unreliable or unavailable), except that the geometric estimate is returned with a low confidence level (instead of moderate) when the stored GPS coordinates are not within the coverage area

¹⁰³ *Id.*

¹⁰⁴ *Id.* at Abs., 3:13-15, 11:54-67, 12:8-21.

¹⁰⁵ *Id.* at 11:54-67.

¹⁰⁶ *Id.*

¹⁰⁷ *Id.*

¹⁰⁸ *Id.*

estimate.¹⁰⁹ Thus, *Kauser* determines a more accurate location estimate (and associated confidence value) using the respective estimates from each location technique.¹¹⁰

142. *Kauser's* location system then outputs/routes the resulting location estimate and confidence value to the appropriate end user destination.¹¹¹ (See Section IX.F (Output of the Resulting Location Information).)

2. Likelihood indication

143. As described in the preceding paragraphs, *Kauser's* location determining algorithm (1) uses peak error values to determine whether the current GPS coordinates are “within a predefined confidence level” and of “acceptable accuracy,”¹¹² and (2) returns a resulting location estimate with either a high, medium, or low confidence value based on the comparison of the respective estimates from each location technique.¹¹³ Either the GPS peak error values or the resulting confidence value from *Kauser's* location determining algorithm can satisfy the claim elements that require using or obtaining an indication of the “likelihood” of the mobile station being at or within a particular location estimate.

¹⁰⁹ *Id.* at 12:1-21.

¹¹⁰ *See id.* at Abs., 3:13-15, 9:26-29, 11:35-12:21, 13:58-60.

¹¹¹ *Id.* at 12:22-35.

¹¹² *Id.* at 9:34-39, 10:29-35, 11:11-16, 11:48-54, 12:1-8

¹¹³ *Id.* at FIG. 10, 11:56-67, 12:11-21.

144. For example, the resulting confidence value returned by *Kauser's* location determining algorithm (*e.g.*, “high,” “moderate,” or “low”) indicates the likelihood of the mobile telephone being at or within the resulting location estimate (which may be either the GPS estimate or the geometric estimate, depending on which was returned).¹¹⁴

145. Similarly, the GPS peak error values in *Kauser* are used to determine whether the current GPS coordinates are “within a predefined confidence level” and of “acceptable accuracy.”¹¹⁵ Thus, these peak error values indicate the likelihood of the mobile telephone being at or within the location estimate defined by the GPS coordinates.

146. These disclosures from *Kauser* are substantially similar to the corresponding disclosure from the '231 Patent, which explains that each location hypothesis (*i.e.*, location estimate) may include an “estimated error” or “confidence value.”¹¹⁶

F. Output of the Resulting Location Information

147. Certain claim elements also require the resulting location information to be output, for example, to a particular destination. In *Kauser's* location system,

¹¹⁴ *Id.* at FIG. 10, 11:43-12:21.

¹¹⁵ *Id.* at 9:34-39, 10:29-35, 11:11-16, 11:48-54, 12:1-8; *see also id.* at 10:66-11:26.

¹¹⁶ Ex. 1001 ('231 Patent) at 51:37-43, 54:46-50.

after the location of a mobile telephone has been determined, *Kauser* discloses that the location estimate and confidence value are routed to “the appropriate end user destination,” including, for example, a public service provider for a 911 call, a vehicle fleet management company, or the user of the mobile telephone itself (*e.g.*, if the location request originally came from the user).¹¹⁷ *Kauser* discloses that the appropriate routing information can be stored, for example, in memory of the MLM.¹¹⁸

G. Order of Location Techniques

148. As explained in Section VI.E (in the claim construction discussion regarding the order of elements), I do not believe the broadest reasonable interpretation of any challenged claims requires the satellite location technique and the terrestrial location technique to be performed in any particular order. Nonetheless, to the extent the Board determines that certain challenged claims do require an order, it would have been obvious to perform *Kauser’s* location techniques in any order, including obtaining location information from *Kauser’s* GPS technique before the geometric technique.

149. First, the order of the location techniques does not matter in *Kauser’s* location system. Specifically, *Kauser’s* resulting location determination algorithm

¹¹⁷ Ex. 1007 (*Kauser*) at 1:46-60, 12:22-35, 13:56-57.

¹¹⁸ *Id.* at 12:24-25.

simply compares the respective estimates from each location technique.¹¹⁹ Thus, while the GPS and geometric location techniques must both be performed (or at least attempted) before the resulting location determination can be performed, it does not matter in what order those techniques are performed. Given that the order is immaterial, those of ordinary skill in the art would understand that it would be trivial to request and obtain location information from *Kauser's* GPS technique before the geometric technique. Thus, at a minimum it would have been obvious to implement *Kauser's* location system to perform the GPS technique before the geometric technique, or vice versa.

150. Those of ordinary skill in the art would have found it obvious to modify and/or combine the prior art in this manner for various reasons.

151. First, as explained above, the order of the location techniques does not matter in *Kauser's* location system: both techniques simply need to be performed prior to performing the resulting location determination. Thus, those of ordinary skill in the art would recognize that implementing *Kauser's* location techniques in a particular order would be obvious to try given that there is only a finite number of identified, predictable solutions, all with a reasonable expectation for success. For example, the potential solutions for the order of techniques in *Kauser* include

¹¹⁹ *Id.* at 3:9-15, 11:39-12:21, FIG. 10; *see also* Section IX.E (Resulting Location Determination).

performing the GPS technique before, after, or concurrently with the geometric technique. Given that the order of techniques is immaterial in *Kauser's* location system, all of these solutions are predictable and have an extremely strong expectation of success.

152. Second, performing a satellite technique either before or after a terrestrial technique was a concept that was well known in the art. For example, *Loomis* discloses multiple embodiments where the FM radio technique can be performed either before the satellite technique or after the satellite technique.¹²⁰ In addition, *Schuchman* discloses embodiments that perform GPS before an AM radio terrestrial technique.¹²¹

153. Section IX.I (Global Reasons to Modify and/or Combine) presents additional reasons why it would have been obvious to modify and/or combine the prior art in this manner.

154. Moreover, in *Kauser's* location system, location information is in fact obtained from the GPS technique before the geometric technique. Specifically, *Kauser's* GPS technique continuously/periodically determines and sends GPS location information from the mobile telephone to the network independent of

¹²⁰ Ex. 1008 (*Loomis*) at Abs., 19:52-60.

¹²¹ Ex. 1010 (*Schuchman*) at 22:19-26.

whether the location function of the MLM has been initiated.¹²² *Kauser* teaches that the stored GPS coordinates are “always [] the most recent reliable latitude and longitude coordinates.”¹²³ The “zone 2” location information from *Kauser*’s geometric technique, however, is only obtained when the location function of the MLM is initiated (e.g., in response to a location request).¹²⁴ For example, *Kauser* discloses that “[i]f the MSC [] determines that a location function is required it initiates the location function in the MLM.”¹²⁵ When the location function is initiated, “[t]he first step is to calculate two location zones, zone 1 and zone 2.”¹²⁶ The “zone 1” estimate is the coverage area of the serving cell site, and the “zone 2” estimate is the estimate generated by the geometric technique.¹²⁷ Thus, the “zone 2” estimate from the geometric technique is only obtained in response to the location function being initiated, while the GPS location information (which is continuously provided) has already been obtained at the time the location function is initiated. Accordingly, *Kauser*’s location system does indeed obtain location information from the GPS technique before the geometric technique.

¹²² Ex. 1007 (*Kauser*) at 9:40-46, 10:14-16, 11:27-34.

¹²³ *Id.* at 11:23-25; *see also id.* at 9:34-39, 10:66-11:5.

¹²⁴ *Id.* at Abs., 5:57-59, 6:12-24.

¹²⁵ *Id.* at 5:57-59.

¹²⁶ *Id.* at 6:16-17.

¹²⁷ *Id.* at 6:17-23, 9:12-18, Abs.

H. Other features

155. In this section, I address various additional claim elements from the challenged claims and explain how those elements are disclosed and/or obvious in view of the prior art.

1. locus of locations

156. Claim 25 recites a “*locus of locations*.” As discussed above in Section VI.C (in the claim construction discussion for “locus of locations”), the broadest reasonable interpretation of “*locus of locations*” is “*a collection of points or locations*.”

157. *Kauser’s* geometric technique uses cell site signal measurements to determine a location area estimate (i.e., “*locus of locations*,” proposed for construction as “*a collection of points or locations*”) of the mobile telephone based on its relative distance to each cell site:

After the distances d2, d4, and d7 are calculated, a location area is determined by plotting the following circles, as illustrated in FIG. 5. . . . The intersection area 510 of circles 502, 504, 507 estimates the location of the mobile telephone¹²⁸

158. *Kauser’s* geometric location technique solves an equation, using the relative distances, to compute the location area estimate.¹²⁹

¹²⁸ *Id.* at 7:42-8:3, 8:65-9:8, FIGS. 5-8.

¹²⁹ *Id.* at 8:65-9:8.

159. As explained in Section IX.C.4, *Kauser*'s geometric technique can be modified to use signal time delay measurements, as in *Wortham*. Thus, under that combination, the equation used in *Kauser* to compute the estimated location area would be computed/satisfied using the signal time delay measurements of *Wortham*.¹³⁰

2. geographical extent

160. Various challenged claims recite the term “*geographical extent*,” which (as discussed in Section VI.A) was construed in the prior district court proceeding as “*geographical area or range*.”

161. In *Kauser*, both the geometric “zone 2” estimate and the GPS estimate satisfy the prior district court construction of “*geographical extent*” as “*geographical area or range*.”

162. First, *Kauser* refers to the resulting location estimate (which can be either the GPS estimate or geometric “zone 2” estimate) as “the geographic location area [that] is determined.”¹³¹ Thus, clearly either the GPS estimate or the geometric “zone 2” estimate can represent a “*geographical extent*” (construed as “*geographical area or range*”).

¹³⁰ *Id.* at 8:65-9:8; Ex. 1009 (*Wortham*) at 13:39-62, 14:5-12.

¹³¹ Ex. 1007 (*Kauser*) at 12:22-24 (emphasis added).

163. Second, *Kauser* also refers to the geometric “zone 2” estimate as the “location area” calculated using the geometric technique.¹³² Thus clearly the “zone 2” geometric estimate is a “*geographical extent*” (construed as “*geographical area or range*”).

164. Third, those of ordinary skill in the art would understand that GPS latitude/longitude coordinates correspond to an area whose size depends on the precision of the determined latitude/longitude coordinates. For example, depending on the precision of the degrees, minutes, and seconds expressed for the determined latitude/longitude coordinates, the location represented by those coordinates will vary in size — less precision in the coordinates correlates to a larger area, and more precision correlates to a smaller area. Thus, the GPS coordinates in *Kauser* also correspond to a “*geographical extent*” (construed as “*geographical area or range*”).

3. availability of location techniques

165. Certain claims include elements that relate to using the terrestrial technique in some situations rather than the satellite technique.

166. For example, Claim 25 recites “*wherein for receiving a second collection of measurements obtained from wireless signals transmitted between said mobile station and one or more fixed location terrestrial stations, at least*”

¹³² *Id.* at 9:12-18, 11:43-47 (emphasis added).

when said first collection is not available, there is a predetermined corresponding location technique for determining second location information of the mobile station.”

167. As another example, Claim 185 recites “*wherein for at least one mobile station (M_p) of the mobile stations M_k and the corresponding location for M_p according to (B) above, the location indicative data for M_p is not obtained using geographic data indicative of a spatial range between the mobile station M_p and one or more transmitting stations above and not supported on the Earth's surface.”*

168. Those of ordinary skill in the art would understand that, in *Kauser's* location system, the terrestrial technique and associated signal measurements are used to generate a location estimate even when the GPS satellite signal measurements are unavailable, for example, due to a blockage/outage.¹³³ For example, *Kauser* explains that “[a] known problem with GPS receivers is that location accuracy requires line of sight communication with multiple satellites . . . [t]hus, they do not return accurate latitude and longitude coordinates if the line of sight is blocked, for example, inside a building.”¹³⁴ *Kauser* explains that it addresses this problem by “using the last GPS coordinate position which is

¹³³ Ex. 1007 (*Kauser*) at 9:30-39.

¹³⁴ *Id.* at 9:30-39.

within a predefined confidence level” when the line of sight to the GPS satellites is blocked.¹³⁵ In that situation, because the current GPS coordinates are either unavailable or unreliable, *Kauser’s* resulting location determination is simply performed using the geometric technique and the “last GPS coordinate position . . . within a predefined confidence level.”¹³⁶

169. Those of ordinary skill in the art would understand that, in any GPS-based system such as *Kauser’s*, GPS signals will not always be available, either because they are completely obstructed or at least sufficiently obstructed that they do not produce a reliable estimate. In either situation, the collection of GPS signal measurements would be considered unavailable. Thus, those of ordinary skill in the art would find it both inherent and obvious that *Kauser’s* “zone 2” geometric estimate would still be returned as the resulting estimate when there is a blockage or outage of GPS signals and no current or recent GPS estimate is available.

4. requests for locations

170. Claims 10 and 185 recite “requests” for locations. For example, Claim 10 recites “*receiving...a plurality of input requests for locations of the mobile stations.*” As another example, Claim 185 recites “*a network node for*

¹³⁵ *Id.*

¹³⁶ *Id.* at 9:30-39, 11:43-47, 12:1-21, FIG. 10.

receiving a plurality of network requests for location indicative data of a plurality of the mobile stations.”

171. *Kauser’s* location system includes both a Mobile Location Module (MLM) and Mobile Switching Center (MSC) in the cellular network,¹³⁷ which receive location requests¹³⁸ for the mobile telephones in the cellular network¹³⁹ When a location request is received, *Kauser* discloses that the MSC “initiates the location function in the MLM.”¹⁴⁰

172. For example, “a mobile telephone user who is lost may request location information.”¹⁴¹ In addition, location requests can be initiated in response to a variety of circumstances, such as by dialing certain numbers (*e.g.*, 911) and/or based on criteria in stored user profiles for each mobile telephone.¹⁴² For example, in one embodiment, the MSC analyzes the calling mobile telephone number and called telephone number to determine if a location function is required, and if so, the MSC initiates a location function of the MLM.¹⁴³ The location function can also be initiated based on other criteria/conditions, which can be specified in a user

¹³⁷ *Id.* at 5:23-32, 6:1-15.

¹³⁸ *Id.* at 1:50-60, 12:22-35, 11:35-42, 5:37-59.

¹³⁹ *Id.* at 1:20-26, 3:53-56, 5:50-52 (referring to plural “mobile telephones”).

¹⁴⁰ *Id.* at 5:23-32, 5:37-49, 6:1-13.

¹⁴¹ *Id.* at 1:46-60.

¹⁴² *Id.* at 5:37-57.

¹⁴³ *Id.* at 5:33-67, 11:35-42.

profile stored in the MSC.¹⁴⁴ A mobile telephone can also request its own location from the mobile telephone system.¹⁴⁵

173. *Kauser* discloses that the location function can be initiated/requested for various service providers, such as the police, fleet management companies, mobile telephone users who are lost, etc.¹⁴⁶

5. location based service

174. Claim 185 recites the term “*location based service*”: “*the network destination accesses the location indicative data for M_n in performing a location based service related to a corresponding one of the requests for the location indicative data for M_n received by the network node.*”

175. In *Kauser's* location system, the particular end user application/destination uses the location information to provide a service, such as 911 emergency services, assistance to motorists with disabled vehicles, tracking a fleet of vehicles, and/or assisting a user that is lost.¹⁴⁷ That service is provided in connection with the location request from the particular end user application/destination. Those of ordinary skill in the art would understand that the

¹⁴⁴ *Id.* at 5:33-67, 11:35-42.

¹⁴⁵ *Id.* 5:41-47, 12:32-35.

¹⁴⁶ *Id.* 1:46-60, 5:33-67, 12:22-35.

¹⁴⁷ *Id.* at 1:32-60, 5:41-47, 12:22-35.

end user destinations in *Kauser* are providing a “*location based service*” using the location of the mobile telephone.

6. plurality of mobile stations

176. Certain claims include elements that relate to locating a plurality of mobile stations:

- Claim 36 recites “[a] method for locating at least one mobile station, *M*, of a plurality of mobile stations.”
- Claim 10 recites “[a] method for locating mobile stations.”
- Claim 185 recites “[a] mobile station location system for a network having plurality of terrestrially based stationary location communication stations for wirelessly communicating with a multiplicity of mobile stations.”
- Claim 155 recites “[a] method for locating each mobile station (*M*) of a plurality of terrestrial mobile stations.”

177. *Kauser*’s location system is implemented in a cellular network and can be used to locate any of the mobile telephones connected to the network:

Mobile telephone systems, also called cellular telephone systems, are becoming increasingly popular. These systems are generally made up of cell sites, each of which serves a coverage area, or cell. The cell site is the location within a cell which contains the required hardware (e.g. antenna(s) and radio base station) to communicate with the mobile telephones.¹⁴⁸

...

¹⁴⁸ *Id.* at 1:20-26 (emphasis added).

Each cell 1-7 contains an antenna 101-107 which is used to transmit signals to, and receive signals from, *mobile telephones*, e.g. mobile telephone 120, within the mobile telephone system serving area 100.¹⁴⁹

...

For example, a company which uses a fleet of vehicles may want a *location function performed each time a call is initiated from one of its mobile telephones*.¹⁵⁰

I. Global Reasons to Modify and/or Combine

178. The preceding sections explain why each particular combination and/or modification would have been obvious to those of ordinary skill in the art. This section presents additional obviousness reasons that apply globally to the various combinations and/or modifications discussed in the preceding sections.

179. Design incentives and other market forces, such as the increased popularity and use of cellular phones in the 1990s and the FCC's proposed rules for locating wireless callers, would have prompted those of ordinary skill in the art to modify and implement existing location technologies into cellular telephone networks to comply with the FCC-imposed rules.¹⁵¹ Specifically, in 1994, the rapid increase in the use of cellular telephones prompted the FCC to propose rules

¹⁴⁹ *Id.* at 3:53-56 (emphasis added).

¹⁵⁰ *Id.* at 5:50-52 (emphasis added).

¹⁵¹ Ex. 1014 (FCC E911 Proposal) at ¶¶ 2, 9-10, 37, 39.

requiring cellular service providers to locate wireless 911 callers both inside and outside of buildings.¹⁵² To provide the requisite location capabilities, the FCC suggested incorporating existing location technologies into cellular telephone systems, such as GPS and terrestrial radio location systems.¹⁵³ As a result of these and other market forces, those of ordinary skill in the art were actively looking to modify existing location systems in a predictable manner (*i.e.*, combine and implement existing location technologies into cellular networks).¹⁵⁴ Thus, one of skill in the art would have been motivated to explore combinations and/or modifications of existing location systems, such as those of *Kauser* and *Wortham*, for purposes of providing a location system that complies with the FCC-imposed rules.

180. Moreover, the industry recognized that, “[o]n the whole, GPS is well suited for in-vehicle 9-1-1 location, but it would need to be used in combination with other technologies to cover in-building emergency calls from portable cellular or PCS phones.”¹⁵⁵ Given that *Kauser’s* solution uses GPS in combination with a

¹⁵² *Id.* at ¶¶ 2, 9-10, 45-46.

¹⁵³ *Id.* at ¶¶ 39, 45-46.

¹⁵⁴ *Id.* at ¶¶ 46-47; *see also* Ex. 1016 (Driscoll Survey) at stamped pp. 4-5, 12; Ex. 1015 (TR45 Experts Meeting) at 2 (Background), 5 (Identify Caller’s Initial Location).

¹⁵⁵ Ex. 1016 (Driscoll Survey) at stamped p. 12.

cell site geometric technique,¹⁵⁶ those of ordinary skill in the art would appreciate that *Kauser's* location system would be particularly well suited for adaptation to provide an FCC compliant location system. Thus, those of skill in the art would have been motivated to explore combinations of *Kauser's* location system with other prior art location systems, such as the cellular location system disclosed in *Wortham*.¹⁵⁷

181. Those of ordinary skill in the art would have also been motivated to combine aspects of *Kauser* and *Wortham* based on the extremely similar nature of the problem solved: they both (1) provide solutions for locating mobile devices in wireless communication networks, such as cellular networks,¹⁵⁸ (2) can use satellite and terrestrial location techniques,¹⁵⁹ and (3) can be used for many similar applications, including emergency 911 services, vehicle tracking/fleet management, and navigation/directions.¹⁶⁰ The extremely similar nature of the problem solved by *Kauser* and *Wortham*, and the similar manner in which they each solve that problem, would have motivated those of ordinary skill in the art to combine elements of the respective prior art location systems in *Kauser* and

¹⁵⁶ Ex. 1007 (*Kauser*) at Abs., 2:62-3:15.

¹⁵⁷ Ex. 1009 (*Wortham*) at 1:46-2:12.

¹⁵⁸ Ex. 1007 (*Kauser*) at 1:13-31; Ex. 1009 (*Wortham*) at 1:46-53.

¹⁵⁹ *Id.* at Abs.; Ex. 1009 (*Wortham*) at 3:57-59.

¹⁶⁰ *Id.* at 1:46-60, 12:22-35; Ex. 1009 (*Wortham*) at 4:26-39, 4:43-58.

Wortham, according to the known methods described in those references, to yield predictable results (*e.g.*, swapping one location technique for another).

X. *LOOMIS* COMBINATIONS

A. Overview

182. In my opinion, the following claims are obvious in view of *Loomis* in combination with *Wortham*:

Challenged Claims	Prior Art References
1, 17, 20, 25, 26, 41, 155, 162, 215	Obvious in view of <i>Loomis</i> and <i>Wortham</i>

183. This section describes the functionality disclosed by these prior art references and explains how these references could be combined and/or modified to invalidate the challenged claims.

184. For example, *Loomis*' hybrid location system includes a method and apparatus for determining and outputting a resulting location estimate for a mobile user carrying a hybrid LD device (also referred to in *Loomis* as a "mobile station"¹⁶¹ using multiple location techniques that generate location estimates using wireless signal measurements.¹⁶² The location techniques in *Loomis*' hybrid location system include satellite-based techniques (*e.g.*, GPS) and terrestrial-based

¹⁶¹ Ex. 1008 (*Loomis*) at 2:7-25, 3:63-4:4, 11:24-29.

¹⁶² *Id.* at Abs., 4:39-5:13, 11:49-13:4, 19:32-20:5; *see also id.* at 18:27-32, FIG. 1.

techniques (*e.g.*, a radio technique).¹⁶³ As described throughout this section, a person of ordinary skill in the art would have been motivated to modify and/or combine *Loomis*' hybrid location system with aspects of the positioning systems disclosed in *Wortham*. As one example, *Loomis*' location system can be integrated into an existing mobile communications infrastructure, such as a cellular telephone network, as described in *Wortham*.¹⁶⁴

185. The reasons why these combinations and/or modifications would have been obvious is explained for each such combination and/or modification. In addition, Section X.I addresses additional reasons to combine and/or modify that apply globally to all of the combinations and/or modifications discussed throughout this section.

186. Finally, I do not believe that any "secondary considerations of non-obviousness" (identified above in Section II regarding legal standards) demonstrate that the challenged claims are valid. In fact, a number of the secondary considerations provide further affirmation for my opinion that the challenged claims are invalid. For example, there was no long felt, unmet need for the alleged invention, no unexpected results, and no praise of the invention by others. In the

¹⁶³ *Id.*

¹⁶⁴ Section X.B (Two-Way Communication); Ex. 1009 (*Wortham*) at 1:46-2:12.

event TracBeam presents evidence of secondary considerations of non-obviousness in this proceeding, I will address those secondary considerations at that time.

B. Two-Way Wireless Communication and Location Functionality

187. Certain claim elements require the mobile station to be in two-way communication with the terrestrial transmitters and/or that those terrestrial transmitters be used to obtain terrestrial wireless signal measurements from the mobile station.

188. *Loomis*' hybrid LD device (*i.e.*, mobile station) includes an FM radio receiver/processor for locating the mobile station using FM radio signal measurements, and a cellular communications transmitter/receiver for communicating with another person or facility using telecommunication signals.¹⁶⁵ It would have been obvious to modify *Loomis*' hybrid LD device to use the cellular communications transmitter/receiver to provide both the location capabilities (*i.e.*, instead of the FM radio receiver) and the communications capabilities, as described in *Wortham*.¹⁶⁶

189. For example, under the proposed combination, *Loomis*' hybrid LD device would use its cellular communications transmitter/receiver and associated cellular towers (which would be present for use with any cellular communications

¹⁶⁵ Ex. 1008 (*Loomis*) at 6:20-29, 6:46-55, 11:52-65, 12:16-20, 12:27-40, FIG. 6.

¹⁶⁶ Ex. 1009 (*Wortham*) at 1:46-2:12, 7:48-55, 7:67-8:4.

transmitter/receiver) for both locating the mobile station and wirelessly communicating with another person or facility. In particular, *Loomis*' hybrid location system could be modified to implement its terrestrial location capabilities using (1) the same cell towers of *Loomis* that provide cellular communication capabilities (as described in *Wortham*), instead of *Loomis*' FM radio towers, and (2) *Loomis*' cellular transmitter/receiver, instead of its FM radio receiver/processor.¹⁶⁷

190. Under this proposed combination, the mobile station in *Loomis* would be capable of two-way communication with the same terrestrial transmitters that are used to provide the location capabilities (*i.e.*, receiving signals from and transmitting signals to the cell towers).¹⁶⁸ For example, *Loomis*' mobile station could obtain wireless signal measurements using signals transmitted from the cell towers and/or transmit wireless signal measurements (such as satellite signal measurements and/or cell tower signal measurements) to the network of cell towers to provide location information of the mobile station to a person or facility.¹⁶⁹

191. Those of ordinary skill in the art would have found it obvious to modify and/or combine the prior art in this manner for various reasons.

¹⁶⁷ Ex. 1009 (*Wortham*) at 1:46-2:12, 7:48-55, 7:67-8:4.

¹⁶⁸ *Id.*

¹⁶⁹ See Ex. 1008 (*Loomis*) at 8:29-34, 12:27-40, 20:29-42; Ex. 1009 (*Wortham*) at 1:46-2:12, 7:48-55, 7:67-8:4.

192. First, as explained further in Section X.I, the FCC's E911 proposals for locating wireless 911 callers motivated those of ordinary skill in the art to explore modifications and/or combinations of existing location systems for purposes of complying with the FCC's proposed regulations.

193. Second, similar to the FM radio towers in *Loomis*, the cellular towers corresponding to the cellular transceiver in *Loomis* also would be fixed or stationary radio transmission structures with known locations (as taught by *Wortham*).¹⁷⁰ *Loomis* also discloses that the mobile station includes "cellular communication means" for communicating with "another transmitter or receiver" and/or "another person or facility by cellular telecommunications."¹⁷¹ Under this proposed combination, *Loomis*' cellular transmitter/receiver and associated cell towers would be modified to provide the terrestrial location capabilities (in addition to the cellular communication capabilities) instead of its FM radio receiver/processor and associated FM radio towers, as in *Wortham*.¹⁷² In other words, *Loomis*' mobile station would be capable of two-way communication with the same radio towers that are used to provide the location capabilities (*i.e.*, cell towers).¹⁷³ Thus, *Loomis*' location system would simply be modified to provide

¹⁷⁰ Ex. 1009 (*Wortham*) 1:67-2:6, 3:3-5, 13:29-32, 13:39-44.

¹⁷¹ Ex. 1008 (*Loomis*) at Fig. 6, 11:49-52, 12:27-40.

¹⁷² Ex. 1009 (*Wortham*) at 1:46-2:12, 7:48-55, 7:67-8:4.

¹⁷³ *Id.*

the location and cellular communication capabilities using the same cell towers (as in *Wortham*).

194. It would be easy to implement *Loomis*' location capabilities using cell towers instead of FM towers: *Loomis*' radio location technique would simply be performed using signals transmitted at cellular frequencies instead of FM radio frequencies. For example, *Loomis* discloses that "[w]hen the radio LD unit 13 is provided with a recent measurement of these relative phases, the radio LD unit can determine the location of its antenna 15, using intersections of three or more hyperboloids that are defined by the relative times of arrival of the three radio LD signals."¹⁷⁴ Under the proposed modification, *Loomis*' radio technique would simply perform the requisite phase/signal timing measurements using signals received at cellular frequencies instead of FM radio frequencies.

195. Finally, Section X.I presents additional reasons why it would have been obvious to modify and/or combine the prior art in this manner. For example, those of ordinary in the art would have also been motivated to combine aspects of *Loomis* and *Wortham* based on the extremely similar nature of the problem solved, and based on the FCC E911 proposals.

¹⁷⁴ *Id.* at 6:47-55 (emphasis added); *see also id.* at 9:61-67, 10:24-39, 11:61-65.

C. Satellite / Non-Terrestrial GPS Technique

196. Certain claim elements require: (1) a satellite (or “non-terrestrial”) location technique; (2) satellite signal time delay measurements that are used as input to the satellite technique; and (3) determining/obtaining “location information” (or some variation of that term) for a mobile station when the satellite technique is provided with the signal timing measurements as input.

1. Satellite (non-terrestrial) technique

197. *Loomis*’ location system includes a GPS technique (*i.e.*, the outdoor LD module), which satisfies the claim elements that require a satellite or non-terrestrial location technique.¹⁷⁵ In the *Loomis-Wortham* combination, *Loomis*’ GPS technique can be implemented using D-GPS¹⁷⁶ and/or A-GPS.¹⁷⁷ As explained in the following paragraphs, *Loomis*’ GPS technique calculates location estimates using measurements of wireless signals transmitted between a hybrid LD device (*i.e.*, a mobile station) carried by a mobile user and three or more satellites. As would be understood by those of ordinary skill in the art, each GPS satellite is a non-terrestrial wireless transmitter not supported on Earth’s surface.

¹⁷⁵ Ex. 1008 (*Loomis*) at Abs., 7:9-22; *see also id.* at 4:66-5:9, 6:55-58, 11:66-12:15.

¹⁷⁶ *Id.* at 11:20-48.

¹⁷⁷ *Id.* at 8:29-35, 20:29-36, Abs.

2. Satellite signal time delay measurements

198. In *Loomis*' location system, the satellite signal measurements used by *Loomis*' GPS technique satisfy the claim elements that require satellite signal time delay measurements. For example, *Loomis* discloses that the mobile station includes a GPS signal receiver/processor (referred to in *Loomis* as the "outdoor LD unit") that receives wireless signals from satellites and uses those signals to estimate a location of the mobile station:

The hybrid LD system . . . includes a satellite-based outdoor LD unit [], carried or transported by or attached to the user. This outdoor LD unit [] includes an outdoor LD signal antenna [] and associated outdoor LD signal receiver/processor [] that receive outdoor LD signals from three or more satellites [] whose locations at any time are known with acceptable accuracy. The antenna [] receives the outdoor LD signals and the receiver/processor [] determines the present location of this antenna, using well known techniques. The Global Positioning System (GPS) and the Global Orbiting Navigation Satellite System (GLONASS) are two suitable examples of satellite-based outdoor LD systems.¹⁷⁸

199. GPS calculations are performed by measuring the signal travel time delay of the received GPS signals. This is an inherent aspect of any GPS receiver,

¹⁷⁸ Ex. 1008 (*Loomis*) at 7:9-22; see also *id.* at Abs., 4:66-5:9, 6:55-58, 11:66-12:15, 12:21-27.

and it is also acknowledged by the '231 Patent.¹⁷⁹ In addition, this is confirmed by *Wortham*, which explains that GPS calculations involve “pseudorange” measurements corresponding to the range of the GPS receiver from each satellite in space (*i.e.*, the “*spatial range*” required by some claims), which are determined using the travel/propagation time, or time of arrival, of the satellite signals.¹⁸⁰ Thus, while these satellite signal time delay measurements are inherently used by any GPS receiver (including that of *Loomis*), they are also explicitly disclosed by *Wortham*.¹⁸¹

3. Satellite location information

200. In *Loomis*' location system, the GPS location information generated by *Loomis*' GPS technique satisfies the claim elements that require “location information” (and variations thereof) obtained from a satellite technique.¹⁸² For example, *Loomis*' GPS technique (when supplied with GPS signal measurements) provides the following GPS location information: (1) the present GPS location

¹⁷⁹ Ex. 1001 ('231 Patent) at 1:54-2:2.

¹⁸⁰ Ex. 1009 (*Wortham*) at 3:21-25, 5:18-23; *see also* Ex. 1008 (*Loomis*) at 22:57-23:13.

¹⁸¹ Ex. 1009 (*Wortham*) at 3:21-25, 5:18-23; *see also* Ex. 1008 (*Loomis*) at 22:57-23:13.

¹⁸² Ex. 1008 (*Loomis*) at 15:54-59, 19:42-47, FIG. 9; *see also id.* at Abs., 12:21-27, 21:48-57.

coordinates $(x_u, y_u, z_u)_{out}$ of the mobile station, and (2) GPS signal indicium I_{out} (*i.e.*, a measure of signal quality and/or signal strength).¹⁸³

D. Terrestrial Radio Technique

201. Certain claim elements require: (1) terrestrial communication stations at fixed locations that wirelessly communicate with the mobile stations; (2) a terrestrial location technique used to determine/obtain “*location information*”; (3) wireless signal measurements obtained from transmissions with the terrestrial stations, which are used as input to the terrestrial location technique; and (4) “*signal time delay*” data included in the wireless signal measurements.

1. Terrestrial communication stations at fixed locations

202. *Loomis*’ location system is implemented using radio towers, such as FM radio towers. For example, *Loomis* discloses that the mobile station receives FM subcarrier signals “from three or more radio signal sources with fixed, known locations,” which include “transmitting antennas.”¹⁸⁴ *Loomis* explains that “[t]he sources of these FM subcarrier signals may be a plurality of FM broadcasting stations located in or near the user.”¹⁸⁵ Thus, each radio source in *Loomis* (*i.e.*, an

¹⁸³ *Id.* at FIG. 9, Abs., 12:21-27, 19:42-47, 20:14-16, 21:48-57.

¹⁸⁴ *Id.* at 5:32-36, 8:61-64; *see also id.* at 4:44-56, 6:25-29, 8:53-60, 21:36-38, FIG. 1.

¹⁸⁵ *Id.* at 6:35-37; *see also id.* at 4:44-56.

FM broadcasting station and associated transmitting antenna) is a fixed or stationary radio transmission structure with a known location on earth.¹⁸⁶

2. Terrestrial location technique

203. *Loomis*' location system includes a radio location technique (*i.e.*, the radio LD module), which satisfies the claim elements that require a terrestrial location technique used to determine/obtain "*location information*" (or some variation of that term).¹⁸⁷ As explained in the following paragraphs, *Loomis*' radio location technique calculates location estimates using measurements of wireless signals transmitted between a mobile station and the surrounding radio sources.¹⁸⁸ Under the proposed combination with *Wortham* mentioned above, those radio sources would be cell towers.¹⁸⁹

3. Wireless signal measurements

204. The radio signal measurements used by *Loomis*' radio technique satisfy the claim elements that require the terrestrial technique to use wireless signal measurements obtained from transmissions with the terrestrial stations. Specifically, *Loomis*' radio technique calculates the location of a hybrid LD device

¹⁸⁶ *Id.* at 4:44-56, 5:32:36, 6:25-29, 6:35-37, 8:53-64, 21:36-38, FIG. 1.

¹⁸⁷ *Id.* at Abs., 4:51-56, 6:20-29, 6:41-52, 11:52-65.

¹⁸⁸ *Id.* at 6:20-29, 6:41-52, 11:52-65.

¹⁸⁹ Ex. 1009 (*Wortham*) at 1:46-2:12; *see also* Section X.B (Two-Way Communication).

(i.e., a mobile station) using signal phase measurements from the transmissions between the radio sources and the mobile station:

[A] hybrid LD system [] is carried or transported by or attached to a user [] and includes a radio LD unit []. The radio LD unit [] preferably includes an FM carrier or subcarrier signal antenna [] and FM subcarrier signal receiver/processor []. The *radio LD unit* [] receives radio LD signals from three or more radio LD signal sources [] that have fixed locations with known location coordinates.

. . . .

The *relative phases of the radio signals transmitted by the sources* [] may change from time to time. When the *radio LD unit* [] is provided with a recent *measurement of these relative phases*, the radio LD unit can determine the *location* of its antenna.¹⁹⁰

205. For example, in *Loomis*, the radio receiver/processor of the mobile station performs signal phase measurements using radio signals transmitted from the radio sources, and then uses those signal phase measurements to determine radio location information of the mobile station.¹⁹¹ Alternatively, the mobile station can transmit the signal phase measurements to a central station (either unprocessed, partially processed, or fully processed) to allow the radio technique to be performed by the central station.¹⁹²

¹⁹⁰ Ex. 1008 (*Loomis*) at 6:20-29, 6:46-55; see also *id.* at 7:23-29, 11:52-65.

¹⁹¹ *Id.* at 6:25-29, 6:41-55, 11:55-65.

¹⁹² *Id.* at 8:26-35, 20:29-42.

4. Signal time delay measurements

206. *Loomis*' radio technique is one form of the time difference of arrival (TDOA) based techniques explained above in Section VII.C.3, which involve measuring the difference in the arrival times of wireless signals.

207. For example, as explained by *Loomis*, “[w]hen the radio LD unit [] is provided with a recent measurement of these relative phases, the radio LD unit can determine the location of its antenna [], using intersections of three or more hyperboloids that are defined by the relative times of arrival of the three radio LD signals at the antenna.”¹⁹³ Thus, the relative signal phase measurements in *Loomis* correspond to the relative “times of arrival” of each signal.¹⁹⁴

208. Those of ordinary skill in the art would understand that the relative signal “times of arrival” (as disclosed in *Loomis*) are based on the relative delay in the arrival time of each signal, and thus the phase measurements used by *Loomis*' radio technique constitute the “*signal time delay*” or “*signal timing*” measurements required by certain claims.

209. *Loomis* acknowledges that these types of location techniques based on signal timing measurements (*i.e.*, the claimed “*signal time delay*” or “*signal timing*” data) were well known in the prior art. For example, in the Background of

¹⁹³ Ex. 1008 (*Loomis*) at 6:47-52 (emphasis added).

¹⁹⁴ *Id.*

the Invention, *Loomis* discloses various known prior art location techniques that determine locations using signal timing measurements:

An integrated radio location and communication system for a mobile station is disclosed by Martinez in U.S. Pat. No. 4,651,156. Each mobile station carries a transceiver that issues radio signals that are received by two or more signal transceiver reference sites having fixed, known locations. . . . The radio station and the mobile station each transmit a brief, distinguishable range tone at a known sequence of times, and the range tone from each station is received by each reference station. *From an analysis of the differences in arrival times of the range tones received from the radio station and from the mobile station, the reference stations determine the two-dimensional location of the mobile station.*¹⁹⁵

...

In U.S. Pat. No. 4,799,062, Sanderford et al disclose a radio location method that uses a central processing station, a plurality of signal repeater base stations with fixed, known locations, and a mobile station with a known location at any time. The central station transmits a master grid synchronization pulse, which serves as a time reference, to the other stations at a selected sequence of times. A roving station with unknown location transmits a pulse that is received by three or more base stations and is retransmitted to the central station. *The central station determines the location of the roving*

¹⁹⁵ Ex. 1008 (*Loomis*) at 2:7-25 (emphasis added).

station using the differences in time of arrival at each base station of the pulse transmitted by the roving station.¹⁹⁶

...

Westfall, in U.S. Pat. No. 5,073,784, discloses a system for location of a transmitter (“unknown”) at large distances, using a large network of pairs of spaced apart radio wave receivers whose locations are known and whose relative phases are synchronized. A signal, broadcast by the unknown transmitter at less than HF frequencies, is received at different time and space points by pairs of receivers. *Simple geometrical computations allow determination of the location of the unknown transmitter by comparing times of arrival of the transmitted signal.*¹⁹⁷

E. Resulting Location Determination

210. Certain claim elements require: (1) determining resulting location information for a mobile station using the respective location information from multiple location techniques; and (2) using or obtaining an indication of the “likelihood” of the mobile station being at or within a particular location estimate.

1. Determining resulting location information

211. *Loomis’* location system performs an algorithm for determining a resulting location estimate using the respective estimates from the GPS and radio

¹⁹⁶ *Id.* at 2:42-61 (emphasis added).

¹⁹⁷ *Id.* at 3:24-33 (emphasis added).

techniques.¹⁹⁸ Specifically, after obtaining estimates from each technique, the ultimate location of the mobile station can be determined by comparing the signal indicium (*i.e.*, uncertainty) of the estimates from each technique, and selecting the location estimate having the least amount of uncertainty as the resulting location:

The controller [] receives the present location coordinates $(x_u, y_u, z_u)_{rad}$ of the user [] from the radio LD signal receiver/processor [], receives the present location coordinates $(x_u, y_u, z_u)_{out}$ of the user [] from the outdoor LD signal receiver/processor [], and receives the indicia I_{rad} and I_{out} , for comparison with the respective indicia thresholds $I_{rad,thr}$ and $I_{out,thr}$.

. . . .

If $I_{rad} \geq I_{rad,thr}$ and $I_{out} \geq I_{out,thr}$, the controller module [] is free to choose the coordinates $(x_u, y_u, z_u)_{rad}$ or the coordinates $(x_u, y_u, z_u)_{out}$ as the present location of the user []. Differences in accuracy between these two determinations of present location would lead the controller to choose one of these triples as the coordinates of the user's present location. For example, if the outdoor LD system is GPS . . . whose inaccuracies are much lower than the inaccuracies of a radio LD system such as the FM subcarrier system, the controller module [] would probably choose $(x_u, y_u, z_u)_{out}$ as the present location coordinates of the user []. If $I_{rad} \geq I_{rad,thr}$ and $I_{out} < I_{out,thr}$, the controller chooses the coordinates $(x_u, y_u, z_u)_{rad}$ as the present location coordinates of the user. If $I_{rad} < I_{rad,thr}$ and $I_{out} \geq I_{out,thr}$, the controller module [] chooses the

¹⁹⁸ *Id.* at FIG. 9, Abs., 5:14-22, 12:21-27, 12:47-13:4, 19:48-63; *see also id.* at 5:63-6:4, 18:19-33.

coordinates $(x_u, y_u, z_u)_{out}$ as the present location coordinates of the user. If $I_{rad} < I_{rad,thr}$ and $I_{out} < I_{out,thr}$, the controller module [] chooses neither set of coordinates as the present location coordinates of the user, and the controller module notifies any interested person or facility that the methods used for location determination have an unacceptably high errors associated with them and should not be used, or should be used with caution.¹⁹⁹

212. Thus, *Loomis* determines a more accurate location estimate using the respective estimates from the GPS and radio techniques.²⁰⁰

213. In one embodiment of *Loomis*, the signals from both the radio technique and the GPS technique are optimally blended together using an estimator such as a Kalman filter.²⁰¹ In another embodiment, the signals from the radio technique and/or the GPS technique are transmitted to a central processing station for the determination of the mobile station location.²⁰²

214. *Loomis'* location system then outputs/transmits the resulting location estimate to the appropriate person or facility.²⁰³

¹⁹⁹ *Id.* at 12:21-27, 12:47-13:1; *see also id.* at 5:14-21, 14:52-55, 16:39-51, 19:48-63.

²⁰⁰ *See, e.g., id.* at 4:17-42, 5:23-27.

²⁰¹ *Id.* at 15:39-42.

²⁰² *Id.* at 8:29-39.

²⁰³ *See* Section X.F (Output of the Resulting Location Information); *see also* Ex. 1008 (*Loomis*) at 5:14-22, 12:30-40.

2. Likelihood indication

215. As described in the preceding paragraphs, *Loomis*' location determining algorithm (1) uses signal indicia I_{rad} and I_{out} and indicia thresholds $I_{rad,thr}$ and $I_{out,thr}$ to determine which of the respective location estimates from the GPS and radio techniques are likely to be the most accurate,²⁰⁴ and (2) provides a resulting location estimate based on the comparison of the respective estimates and/or associated signal indicia from each location technique.²⁰⁵ For example, *Loomis*' location determining algorithm may first determine whether the signals received by the GPS and/or radio techniques are adequate for location determination by comparing signal indicia I_{rad} and I_{out} with the respective threshold values $I_{rad,thr}$ and $I_{out,thr}$.²⁰⁶ If they are both within the indicia threshold values (*i.e.*, $I_{rad} \geq I_{rad,thr}$ and $I_{out} \geq I_{out,thr}$), the location algorithm may then compare radio signal indicia I_{rad} with GPS signal indicia I_{out} and/or the radio coordinates $(x_u, y_u, z_u)_{rad}$ with the GPS coordinates $(x_u, y_u, z_u)_{out}$ to determine which estimate is likely to be the most accurate location of the mobile station and is ultimately used as the resulting location.²⁰⁷ If $I_{rad} \geq I_{rad,thr}$ and $I_{out} < I_{out,thr}$, then the radio coordinates $(x_u, y_u, z_u)_{rad}$ are used as the resulting location; but if $I_{rad} < I_{rad,thr}$ and $I_{out} \geq I_{out,thr}$, then the GPS

²⁰⁴ Ex. 1008 (*Loomis*) at 12:47-13:1, 16:39-51, 19:48-52, 20:6-20.

²⁰⁵ *Id.* at FIG. 9, Abs., 5:19-21, 12:47-64, 16:40-51, 19:48-60.

²⁰⁶ *Id.* at Abs., 12:47-64, 16:40-51.

²⁰⁷ *Id.* at 5:15-21, 5:65-6:4, 12:47-58, 16:40-51.

coordinates $(x_u, y_u, z_u)_{out}$ are used as the resulting location.²⁰⁸ Thus, the signal indicia from *Loomis*' location determining algorithm satisfies the claim elements that require using or obtaining an indication of the "likelihood" of the mobile station being at or within a particular location estimate.

F. Output of the Resulting Location Information

216. Certain claim elements also require the resulting location information to be output, for example, to a particular destination. In *Loomis*' location system, after the location of a mobile user carrying a mobile station has been determined, *Loomis* discloses that the location estimate may be provided to an interested person or facility.²⁰⁹ As one example, *Loomis* discloses:

At one or more selected times, or upon receipt by the controller module [] of a command by radiowave signals or telecommunication signals, the controller module causes the cellular communication means [] to send information on the present or recent location of the LD unit [] to a person or facility spaced apart from this LD unit.²¹⁰

217. The controller and/or central station can transmit, store, and/or "visually or audibly" display the location of the mobile station.²¹¹

²⁰⁸ *Id.* at 12:58-62.

²⁰⁹ *Id.* at 5:14-22, 12:30-40; *see also id.* at 12:62-13:1.

²¹⁰ *Id.* at 12:34-40.

²¹¹ *Id.* at 19:63-65, 20:40-42.

G. Order of Location Techniques

218. As explained in Section VI.E (the claim construction discussion regarding the order of claim elements), I do not believe the broadest reasonable interpretation of the challenged claims requires the satellite location technique and the terrestrial location technique to be performed in any particular order. Nonetheless, to the extent the Board determines that certain challenged claims require obtaining location information from the satellite technique before the terrestrial technique: (1) *Loomis* discloses embodiments that use both possible order of techniques (satellite then terrestrial, or vice versa), and (2) it would have been obvious to perform the location techniques in *Loomis* in any order, including obtaining location information from *Loomis*' GPS technique before the radio technique.

219. Specifically, *Loomis* discloses multiple embodiments where the GPS satellite technique can be performed either before the FM radio technique or after the FM radio technique.²¹² Thus, in some embodiments of *Loomis*, location information is in fact obtained from the GPS technique before the radio technique.²¹³ For example, *Loomis* teaches embodiments that use the GPS technique first, but if the GPS signals are not adequate to allow for determination

²¹² *Id.* at Abs., 19:52-60.

²¹³ *Id.* at 19:52-60.

of the present location of the mobile station, then subsequently use the radio technique:

If the outdoor LD signals are adequate and the outdoor LD unit is selected, in step 181, to determine the location, the system (or controller) uses the outdoor LD unit information to determine the present location of the user. If the radio LD signals are adequate and the radio LD unit is selected, in step 183, to determine the location, the system (or controller) uses the radio LD unit information to determine the present location of the user.²¹⁴

220. In other embodiments, *Loomis* discloses that location information is obtained from the radio technique before the GPS technique:

The radio LD signals and outdoor LD signals are used to (1) determine the location of the radio LD module, (2) determine the location of the outdoor LD module and (3) determine an indicium representing signal strength or signal quality for the radio LD signals and for the outdoor LD signals. The radio LD signal indicium and the outdoor LD signal indicium are compared with threshold values for these indicia, and at most one of the radio LD module location and the outdoor LD module location is selected as the present location of the apparatus user.²¹⁵

²¹⁴ *Id.*; see also *id.* at FIG. 9.

²¹⁵ *Id.* at Abstract.

221. Accordingly, *Loomis*' location system can indeed obtain location information from the GPS technique before the radio technique, or from the radio technique before the GPS technique.

222. Moreover, those of ordinary skill in the art would have found it obvious to implement *Loomis* by performing the techniques in either order.

223. First, the order of the location techniques does not matter in *Loomis*' location system. Specifically, *Loomis* discloses an embodiment where the resulting location determination algorithm simply obtains estimates from both location techniques and compares their associated signal indicia to determine which to return as the resulting estimate.²¹⁶ Thus, while the GPS and radio location techniques must both be performed (or at least attempted) before the resulting location determination can be performed, it does not matter what order those techniques are performed. Given that the order is immaterial, those of ordinary skill in the art would understand that it would be trivial to request and obtain location information using *Loomis*' GPS technique before the radio technique. Thus, at a minimum it would have been obvious to implement *Loomis*' location system to perform the GPS technique before the radio technique, or vice versa.

²¹⁶ *Id.* at 12:21-27, 12:47-13:1, FIG. 9; *see also* Section X.E (Resulting Location Determination).

224. Second, those of ordinary skill in the art would recognize that implementing *Loomis*' location techniques in a particular order would be obvious to try given that there is only a finite number of identified, predictable solutions, all with a reasonable expectation for success. For example, the potential solutions for the order of techniques in *Loomis* include performing the GPS technique before, after, or concurrently with the radio technique. Given that the order of techniques is immaterial in *Loomis*' location system, all of these solutions are predictable and have an extremely strong expectation of success.

225. Third, performing a satellite technique either before or after a terrestrial technique was a concept that was well known in the art. As explained above, *Loomis* itself discloses performing the techniques in either order. In addition: (1) *Kauser* discloses obtaining location information from a GPS technique before a cell-site geometric technique²¹⁷; (2) *Schuchman* discloses embodiments that perform GPS before an AM radio terrestrial technique.²¹⁸

226. Section X.I (Global Reasons to Modify and/or Combine) presents additional reasons why it would have been obvious to modify and/or combine the prior art in this manner.

²¹⁷ Ex. 1007 (*Kauser*) at Abs., 5:57-59, 6:12-24, 9:12-18, 9:40-46, 10:14-16, 11:23-34.

²¹⁸ Ex. 1010 (*Schuchman*) at 22:19-26.

H. Other features

227. In this section, I address various additional claim elements from the challenged claims and explain how those elements are disclosed and/or obvious in view of the prior art.

1. time difference of arrival (TDOA)

228. Claim 17 recites a location technique that is based on “*time difference of arrival*” concepts: “*a representation of a locus of locations having substantially a same time difference of arrival for wireless signals communicated between: the mobile station, and each of at least two of the transceivers.*”

229. Time difference of arrival (TDOA) techniques are explained above in Section VII.C.3 (Time Difference of Arrival (TDOA)). As explained in that section, TDOA techniques measure the difference in the arrival time of wireless signals. For example, TDOA can measure the difference in arrival times of signals received by a mobile device from multiple transceivers (*e.g.*, cell towers), or the difference in arrival times of a signal transmitted by the mobile device and received by multiple transceivers (*e.g.*, cell towers). These differences in arrival times can be used to calculate hyperbolic lines of positioning, as depicted in the illustrations in Section VII.C.3. The intersection of the hyperbolic lines serves as an estimate of the location of the mobile device.

230. The radio technique described in *Loomis* is a TDOA technique. For example, *Loomis* discloses that its radio technique “use[s] the common intersections of three or more hyperboloids that are defined by the relative times of arrival of the three radio LD signals” at the mobile station’s antenna from the radio towers to estimate the location of the mobile station.²¹⁹ Those skilled in the art would understand that the “relative times of arrival” of the three radio signals refers to the differences in their respective arrival times (relative to each other). By measuring the difference in arrival times of a signal at three towers to form three or more hyperboloids, the location of the mobile station can be estimated as the intersection of those hyperboloids.²²⁰ Thus, those of ordinary skill in the art would understand that *Loomis*’ radio technique is a time difference of arrival (TDOA) technique.

231. *Loomis* also discloses that these types of time difference of arrival (TDOA) techniques were known in the prior art. For example, in the Background of the Invention, *Loomis* discloses various known prior art location techniques that determine locations using “differences in time of arrival . . . of the pulse transmitted by the roving station” or “differences in arrival times of the range tones received from the radio station”:

²¹⁹ *Id.* at 6:47-55, 9:61-67, 10:24-39, 11:61-65.

²²⁰ *Id.* at 6:47-52, 10:24-39, 11:61-65.

An integrated radio location and communication system for a mobile station is disclosed by Martinez in U.S. Pat. No. 4,651,156. Each mobile station carries a transceiver that issues radio signals that are received by two or more signal transceiver reference sites having fixed, known locations. . . . The radio station and the mobile station each transmit a brief, distinguishable range tone at a known sequence of times, and the range tone from each station is received by each reference station. From an analysis of the differences in arrival times of the range tones received from the radio station and from the mobile station, the reference stations determine the two-dimensional location of the mobile station.²²¹

...

In U.S. Pat. No. 4,799,062, Sanderford et al disclose a radio location method that uses a central processing station, a plurality of signal repeater base stations with fixed, known locations, and a mobile station with a known location at any time. The central station transmits a master grid synchronization pulse, which serves as a time reference, to the other stations at a selected sequence of times. A roving station with unknown location transmits a pulse that is received by three or more base stations and is retransmitted to the central station. *The central station determines the location of the roving station using the differences in time of arrival at each base station of the pulse transmitted by the roving station.*²²²

²²¹ Ex. 1008 (*Loomis*) at 2:7-25 (emphasis added).

²²² *Id.* at 2:42-61 (emphasis added).

2. locus of locations

232. Claims 17 and 25 each recite a “*locus of locations*.”

233. For example, Claim 17 recites: “*a representation of a locus of locations having substantially a same time difference of arrival for wireless signals communicated between: the mobile station, and each of at least two of the transceivers.*”

234. Similarly, Claim 25 recites: “*wherein said second collection of measurements is used . . . to determine a location estimate of the mobile station by determining a locus of locations from at least one of the fixed location terrestrial stations, wherein for locations identified by said locus of locations, a signal time delay dependent condition is satisfied using the signal time delay data.*”

235. As discussed above in Section VI.C (in the claim construction discussion for “*locus of locations*”), the broadest reasonable interpretation of “*locus of locations*” is “*a collection of points or locations.*”

236. *Loomis*’ radio technique uses radio signal measurements to determine a location estimate of a mobile station by determining a “*locus of locations*” (or “*a collection of points or locations*”) representing its relative distance from the known location of each of the surrounding radio towers.²²³ For example, *Loomis* teaches

²²³ *Id.* at 6:47-55, 9:61-10:4, 10:24-39, 11:61-65.

that the phase differences of signals arriving from surrounding radio towers indicate a distance between each cell tower and the mobile station:

[R]adio LD signal source number m ($m=21, 23, 25$) has known coordinates (x_m, y_m, z_m) . From the determinable phase differences of the signals arriving from each radio LD signal source at a selected location with as-yet-undetermined coordinates (x,y,z) , . . . source number m is determined to lie at a distance d_m from the selected location. Three radio LD signals, emitted from radio LD sources . . . would arrive at the selected location [] with measurable differences of phase ϕ_i and ϕ_k .

....

Equation (6) defines a three-dimensional hyperboloid. The weighted phase differences Δ_{ik} [] define three intersecting hyperboloids or similar quadratic surfaces, each having two sheets. In general, the common intersections of each of these three groups of sheets should define a point or segment of a curve, where the two points (or curve segments) I1 and I2 . . . are mirror images of each other with respect to the plane P(21,23,25) defined by the coordinates (x_i, y_i, z_i) of the three transmitters of the radio LD signals. The radio LD signal monitor, because it is displaced from and does not lie on the plane P(21,23,25), receives radio LD signals that have two distinct phase differences at the intersection points or segments I1 and I2. The radio LD signal monitor can thus distinguish between I1 and I2 and allow determination of the correct coordinates (x,y,z) for the selected

location.²²⁴

237. One of ordinary skill in the art would understand that the claimed “*locus of locations*” is satisfied by the “hyperboloids or similar quadratic surfaces” disclosed in *Loomis* because they define a collection of points or curve segments representing the possible locations of the mobile station.

238. Moreover, the equation used in *Loomis* to generate the hyperboloids is computed/satisfied using the relative signal time of arrival measurements (*i.e.*, satisfying the following limitation from Claim 25: “*a signal time delay dependent condition is satisfied using the signal time delay data*”).²²⁵

3. geographical extent

239. Claims 25, 26, 162, and 215 recite the term “*geographical extent*,” which (as discussed in Section VI.A) was construed in the prior district court proceeding as “*geographical area or range*.”

240. For example, Claim 25 recites “*data for indicating a likelihood of the mobile station being in a geographical extent represented by of at least one of said first location information and said second location information.*”

241. As another example, Claim 162 recites “*wherein said second location technique estimates a location of the mobile station by using one or more*

²²⁴ *Id.* at 9:61-10:4, 10:24-39.

²²⁵ *Id.* at 6:47-55, 9:61-67, 10:24-39, 11:61-65.

measurements for a wireless signal between the mobile station and at least one of the communication stations, CS, for determining a geographical extent for the mobile station, the one or more measurements dependent upon a location of the at least one communication station CS.”

242. The claimed “*geographical extent*” (previously construed as “*geographical area or range*”) can be satisfied by the following in *Loomis*: (1) the radio LD location coordinates or outdoor/GPS location coordinates (which represent an “area” defined by the precision and accuracy of the coordinates); (2) the hyperbolic lines that are determined by *Loomis*’ radio technique using the relative signal times of arrival (as those hyperbolic lines represent the range of possible locations of the mobile station).²²⁶

243. First, with respect to the radio LD coordinates and outdoor/GPS coordinates, those of ordinary skill in the art would understand that the coordinates correspond to an area whose size depends on the precision of the determined coordinates. For example, depending on the precision of the determined coordinates, the location represented by those coordinates will vary in size—less precision in the coordinates correlates to a larger area, and more precision correlates to a smaller area. Thus, the radio LD coordinates and outdoor/GPS LD

²²⁶ *Id.* at 6:47-55, 9:61-67, 10:24-39, 11:61-65.

coordinates in *Loomis* correspond to a “*geographical extent*” (construed as “*geographical area or range*”).

244. Second, with respect to the hyperbolic lines of *Loomis*’ radio technique, that technique is a form of the time difference of arrival (TDOA) techniques explained above in Section VII.C.3. *Loomis* discloses that its radio technique locates the mobile station “using intersections of three or more hyperboloids that are defined by the relative times of arrival of the three radio LD signals” at the mobile station’s antenna from the radio towers.²²⁷ These hyperboloids are calculated relative to the fixed, known location of the radio towers.²²⁸ Thus, each hyperbolic line represents a range of possible locations of the mobile station, or “*geographical extent*” (construed as “*geographical area or range*”).

4. availability of location techniques

245. Certain claims include elements that relate to the availability of the respective location techniques, their associated signal input, and/or their respective location estimates.

246. For example, Claim 1 recites: “*wherein, when available, the first location related information includes at least a first geographical indication for a*

²²⁷ *Id.* at 6:47-55, 9:61-67, 10:24-39, 11:61-65.

²²⁸ *Id.* at 10:27-33, 6:25-29.

location of the mobile station M’ and “wherein, when available, the second location related information includes at least a second geographical indication for the location of the mobile station M.”

247. As another example, Claim 25 recites “*wherein for receiving a second collection of measurements obtained from wireless signals transmitted between said mobile station and one or more fixed location terrestrial stations, at least when said first collection is not available, there is a predetermined corresponding location technique for determining second location information of the mobile station.*”

248. Those of ordinary skill in the art would understand that, in *Loomis’* location system, the radio technique and associated signal measurements are used to generate a location estimate even when the GPS satellite signal measurements are unavailable, for example, due to an obstruction of the satellite signals.²²⁹ For example, *Loomis* explains that GPS systems “do not work well where some of the signal sources are obscured by structures outdoors, or when the object to be located is positioned indoors.”²³⁰ *Loomis* teaches that it addresses this problem by using the GPS coordinates provided by the GPS technique when the mobile station is outside of buildings and the radio coordinates provided by the radio technique

²²⁹ Ex. 1008 (*Loomis*) at 18:27-32, 20:21-28.

²³⁰ *Id.* at 1:20-35.

when the mobile station is inside of buildings.²³¹ In addition, *Loomis* teaches selecting either the GPS or radio technique based on the adequacy of their respective signals, and therefore if the GPS signals are inadequate, the radio signals would be used.²³² Thus, when the GPS coordinates are either unavailable or unreliable, *Loomis*' resulting location determination is simply performed using the radio technique.

249. Those of ordinary skill in the art would understand that, in any GPS-based system such as *Loomis*, GPS signals will not always be available, either because they are completely obstructed or at least sufficiently obstructed that they do not produce a reliable estimate. In either situation, the collection of GPS signal measurements would be considered unavailable. Thus, those of ordinary skill in the art would find it both inherent and obvious that *Loomis*' radio technique would still be used even when there is a blockage or outage of GPS signals.

250. Thus, one of ordinary skill in the art would understand that radio and GPS location techniques provide their respective location coordinates only if each technique was able to successfully determine its respective coordinates.²³³

²³¹ *Id.* at 18:27-32, 20:21-28.

²³² *Id.* at 19:48-60.

²³³ *See also* Sections X.C (Satellite/Non-Terrestrial GPS Technique), X.D (Terrestrial Radio Technique); Ex. 1008 (*Loomis*) at 6:25-29, 6:41-55, 7:9-22, 11:55-65, 12:8-15, 12:21-27, 19:52-60.

5. plurality of mobile stations

251. Certain claims include elements that relate to locating a plurality of mobile stations. For example, Claim 1 recites “[a] method for locating each terrestrial mobile station of a plurality of terrestrial mobile stations.” As another example, Claim 155 recites “[a] method for locating each mobile station (M) of a plurality of terrestrial mobile stations.”

252. Those of ordinary skill in the art would understand that *Loomis*’ location system is able to locate more than one mobile station or user.

253. First, *Loomis* discloses that its hybrid LD device (or mobile station) includes “cellular communication means” for communicating with “another transmitter or receiver” and/or for communicating with “another person or facility by cellular telecommunications.”²³⁴ *Loomis* also discloses that other prior art cellular/pager location systems were known in the art.”²³⁵ Cellular networks and pager systems were intended to serve multiple users. In fact, a cellular network with only one user would be irrational, as there would be no other “person or facility” to communicate with (which is one of the disclosed functions of *Loomis*’ system.)²³⁶

²³⁴ Ex. 1008 (*Loomis*) at Fig. 6, 11:49-52, 12:27-40.

²³⁵ *Id.* at 1:35-43, 3:34-44.

²³⁶ *Id.* at Fig. 6, 11:49-52, 12:27-40.

254. Thus, it would have been obvious to those skilled in the art that *Loomis*' location system could be used to locate multiple users that each have their own hybrid LD device.

6. different techniques that generate different estimates

255. Certain challenged claims require the respective location techniques to use different input data, different location technologies, and/or generate different location estimates.

256. For example, Claim 1 recites "*wherein said location estimation determiners provide different geographical indications of an unknown location of said mobile station M when said location estimation determiners are supplied with corresponding input data.*"

257. *Loomis* discloses that the GPS technique "operates independently" of the radio technique and that each of these techniques provides "a separate determination of user location" (i.e., the various techniques "*provide different geographical indications of an unknown location of said mobile station M*").²³⁷ For example, as explained above, *Loomis*' radio technique provides radio location coordinates $(x_u, y_u, z_u)_{rad}$ of the mobile station when supplied with radio input data.²³⁸ Similarly, *Loomis*' GPS technique provides GPS location coordinates

²³⁷ *Id.* at 5:7-10, 5:63-6:4.

²³⁸ Section X.D (Terrestrial Radio Technique); *see also* Ex. 1008 (*Loomis*) at 11:55-65, 12:21-27.

$(x_u, y_u, z_u)_{out}$ of the mobile station when supplied with GPS input data.²³⁹ One of ordinary skill in the art would understand that the GPS and radio coordinates are “different geographical indications of an unknown location of said mobile station.”

I. Global Reasons to Modify and/or Combine

258. The preceding sections explain why each particular combination and/or modification would have been obvious to those of ordinary skill in the art. This section presents additional obviousness reasons that apply globally to the various combinations and/or modifications discussed in the preceding sections.

259. Design incentives and other market forces, such as the increased popularity and use of cellular phones in the 1990s, and the FCC’s proposed rules for locating wireless callers, would have prompted those of skill in the art to modify and implement existing location technologies into cellular telephone networks to comply with the FCC-imposed rules.²⁴⁰ Specifically, in 1994, the rapid increase in the use of cellular telephones prompted the FCC to propose rules requiring cellular service providers to locate wireless 911 callers both inside and outside of buildings.²⁴¹ To provide the requisite location capabilities, the FCC suggested incorporating existing location technologies into cellular telephone

²³⁹ Section X.C (Satellite/Non-Terrestrial GPS Technique); *see also* Ex. 1008 (Loomis) at FIG. 9, Abs., 12:21-27, 19:42-47, 20:14-16, 21:48-57.

²⁴⁰ Ex. 1014 (FCC E911 Proposal) at ¶¶ 2, 9-10, 37, 39.

²⁴¹ *Id.* ¶¶ 2, 9-10, 45-46.

systems, such as GPS and terrestrial radio location systems.²⁴² As a result, those of ordinary skill in the art were actively looking to modify existing location systems in a predictable manner (*i.e.*, combine and implement existing location technologies into cellular networks).²⁴³ Thus, one of skill in the art would have been motivated to combine an existing location system, such as that of *Loomis*, with a cellular telephone network to comply with the FCC-imposed rules. This is particularly true in light of the fact that *Loomis*' location system would comply with the third implementation phase of the rules, which requires that the location information include three-dimensional location coordinates of the mobile station.²⁴⁴

260. Moreover, the industry recognized that, "[o]n the whole, GPS is well suited for in-vehicle 9-1-1 location, but it would need to be used in combination with other technologies to cover in-building emergency calls from portable cellular or PCS phones."²⁴⁵ Given that *Loomis*' solution uses GPS in combination with an FM radio location technique to provide location functionality both inside and outside of buildings (as the Driscoll Survey taught would be needed for 911

²⁴² *Id.* ¶¶ 39, 45-46.

²⁴³ *Id.* ¶¶ 46-47; *see also* Ex. 1016 (Driscoll Survey) at stamped pp. 4-5, 12; Ex. 1015 (TR45 Experts Meeting) at 2 (Background), 5 (Identify Caller's Initial Location).

²⁴⁴ Ex. 1014 (FCC E911 Proposal) at ¶ 51; Ex. 1008 (*Loomis*) at 12:21-25.

²⁴⁵ Ex. 1016 (Driscoll Survey) at stamped p. 12.

location-compliant solutions), those of ordinary skill in the art would appreciate that *Loomis*' location system could be implemented in a cellular network to yield a compliant location system.²⁴⁶ Therefore, it would have been obvious to incorporate *Loomis*' hybrid location system, which uses a combination of GPS and terrestrial techniques, into a cellular network.

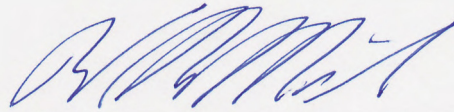
261. Those of ordinary in the art would have also been motivated to combine aspects of *Loomis* and *Wortham* based on the extremely similar nature of the problem solved: they both provide solutions for locating mobile devices using satellite and terrestrial location techniques.²⁴⁷ The extremely similar nature of the problem solved by *Loomis* and *Wortham*, and the similar manner in which they each solve that problem, would have motivated those of ordinary skill in the art to combine elements of the respective prior art location systems in *Loomis* and *Wortham*, according to the known methods described in those references, to yield predictable results (e.g., using *Loomis*'s cellular capabilities to provide both the communications and location functionality, as in *Wortham*).

²⁴⁶ Ex. 1008 (*Loomis*) at 5:23-31, 18:27-32; *see also id.* at Abs., 19:32-37.

²⁴⁷ *Id.* at Abs., 19:32-37; Ex. 1009 (*Wortham*) at 1:46-53, 3:57-59.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the results of these proceedings.

Executed on: August 7, 2015



Dr. William R. Michalson