

**IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

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FOR THE EASTERN DISTRICT OF TEXAS
MARSHALL DIVISION**

FRACTUS, S.A.,

v.

**ADT LLC d/b/a ADT SECURITY
SERVICES**

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**Civil Action No. 2:22-cv-00412-JRG
(Lead Case)**

Jury Trial Requested

FRACTUS, S.A.,

v.

VIVINT, INC.

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**Civil Action No. 2:22-cv-00413-JRG
(Member Case)**

Jury Trial Requested

P.R. 4-3 JOINT CLAIM CONSTRUCTION STATEMENT

Pursuant to the Court's Docket Control Order (Dkt. No. 41) and Local Patent Rule 4-3, Plaintiff Fractus, S.A. ("Fractus") and Defendants ADT LLC and Vivint, Inc. ("Defendants") hereby submit their Joint Claim Construction and Prehearing Statement. The claim construction hearing on January 18, 2024 is scheduled to address nine patents: U.S. Patents No. 7,471,246 (the "'246 Patent"), No. 7,907,092 (the "'092 Patent"), No. 8,456,365 (the "'365 Patent"), No. 8,674,887 (the "'887 Patent"), No. 8,738,103 (the "'103 Patent"), No. 8,994,604 (the "'604 Patent"), No. 10,135,138 (the "'138 Patent"), No. 10,468,770 (the "'770 Patent"), and No. 11,349,200 (the "'200 Patent").¹

¹ The term "Asserted Patents" means U.S. Patent Nos. 7,471,246; 7,907,092; 8,456,365; 8,674,887; 8,738,103; 11,349,200; 8,994,604; 10,135,138; and 10,468,770. ADT does not take a position on construction of claim terms, phrases, or clauses found in the patents that are not

I. P.R. 4-3(a) Agreed Claim Constructions

There are no agreed constructions.

II. P.R. 4-3(b) Proposed Constructions for Terms in Dispute

See Exhibit A for a chart showing the Parties' proposed constructions with intrinsic and extrinsic evidence supporting such constructions. All Parties reserve the right to rely upon any intrinsic or extrinsic evidence identified by any other Party, and any evidence obtained through claim construction discovery. In addition, each Party reserves the right to amend, correct, or supplement its claim construction positions and supporting evidence in response to any change of position by any other party, or for other good cause.

III. P.R. 4-3(c) Anticipated Length of Time for Claim Construction Hearing

The Parties propose that each side receive 90 minutes for oral argument on claim construction issues.

IV. P.R. 4-3(d) Anticipated Witnesses at the Claim Construction Hearing

No Party will call any live witnesses at the claim construction hearing. Fractus reserves the right to rely on the written expert testimony of Dr. Stuart Long. Defendants reserve the right to rely upon any expert testimony, evidence, or testimony of Dr. Stuart Long. Defendants reserve the right to object to any expert testimony proffered by Fractus that was not properly disclosed by the deadline of October 5, 2023 in accordance with P.R. 4-3(b) and the Court's Docket Control Order (Dkt. 41 at 4).

V. P.R. 4-3(e) Other Issues to be Addressed at Claim Construction Prehearing Conference.

Fractus respectfully suggests that the Court address its pending motion to compel (Dkt. 53) that was fully briefed as of July 12, 2023 (Defendants' responses, Dkt. 57 & 59).

asserted against it. Similarly, Vivint does not take a position on construction of claim terms, phrases, or clauses that are found in the patents that are not asserted against it.

Dated: October 5, 2023

Respectfully submitted,

By: /s/ Max L. Tribble

Max L. Tribble
TX State Bar No. 20213950
mtribble@susmangodfrey.com
Joseph S. Grinstein
TX State Bar No. 24002188
jgrinstein@susmangodfrey.com
Justin A. Nelson
TX State Bar No. 24034766
jnelson@susmangodfrey.com
Adam Tisdall
TX State Bar No. 24106885
atisdall@susmangodfrey.com
SUSMAN GODFREY L.L.P.
1000 Louisiana, Suite 5100
Houston, TX 77002-5096
Telephone: (713) 651-9366
Facsimile: (713) 654-6666

Genevieve Vose Wallace
Washington State Bar No. 38422
SUSMAN GODFREY L.L.P.
401 Union Street, Suite 3000
Seattle, WA 98101
Phone: (206) 516-3880
Fax: (206) 516-3883

Craig Smyser
TX State Bar No. 24117083
csmyser@susmangodfrey.com
SUSMAN GODFREY L.L.P.
1301 Avenue of the Americas, 32nd Floor
New York, NY 10019
Telephone: (212) 336-8330
Facsimile: (212) 336-8340

S. Calvin Capshaw
TX Bar No. 03783900
ccapshaw@capshawlaw.com
Elizabeth L. DeRieux
TX Bar No. 05770585
ederieux@capshawlaw.com
CAPSHAW DERIEUX, L.L.P.
114 East Commerce Avenue

Gladewater, Texas 75647
Telephone: (903) 845-5770

T. John Ward, Jr.
TX Bar No. 00794818
jw@wsfirm.com
Claire Abernathy Henry
TX Bar No. 24053063
claire@wsfirm.com
Andrea L. Fair
TX Bar No. 24078488
andrea@wsfirm.com
WARD, SMITH & HILL, PLLC
P.O. Box 1231
Longview, Texas 75606-1231
Telephone: (903) 757-6400
Facsimile: (903) 757-2323

ATTORNEYS FOR FRACTUS, S.A.

By: /s/ Michael E. Zeliger
Steven Tepera (24053510)
Pillsbury Winthrop Shaw Pittman LLP
steven.tepera@pillsburylaw.com
401 Congress Avenue, Suite 1700
Austin, TX 78701-3797
Phone: 512.580.9600
Fax: 512.580.9601

Michael E. Zeliger (Lead Attorney)
(pro hac vice)
Ranjini Acharya (pro hac vice)
Pillsbury Winthrop Shaw Pittman LLP
michael.zeliger@pillsburylaw.com
ranjini.acharya@pillsburylaw.com
2550 Hanover Street
Palo Alto, CA 94304-1115 USA
Telephone: 650.233.4500
Fax: 650.233.4545

David A. Simons (pro hac vice)
Pillsbury Winthrop Shaw Pittman LLP
david.simons@pillsburylaw.com
1650 Tysons Boulevard
14th Floor
McLean, VA 22102-4856 USA

Phone: 703.770.7900

Fax: 703.770.7901

Theresa A. Roozen (pro hac vice)

Pillsbury Winthrop Shaw Pittman LLP

theresa.roozen@pillsburylaw.com

1200 17th St NW,

Washington, DC 20036

Phone: 202.663.8000

Fax: 202.663.8007

ATTORNEYS FOR DEFENDANT ADT LLC

By: /s/ Andy Tindel

Andy Tindel (Texas Bar No. 20054500)

MT² Law Group

122 W. Line Street, Suite 304

Tyler, Texas 75702

(903) 596-0900

atindel@andytindel.com

David R. Wright (*Lead Attorney*)

(*Admitted Pro Hac Vice*)

Jared J. Braithwaite (*Admitted Pro Hac Vice*)

Michael Manookin (*Admitted Pro Hac Vice*)

Maren Laurence (*Admitted Pro Hac Vice*)

FOLEY & LARDNER LLP

95 South State Street, Suite 2500

Salt Lake City, Utah 84111

(801) 401-8900

drwright@foley.com

jbraithwaite@foley.com

mmanookin@foley.com

J. Michael Thomas (Texas Bar No.
24066812)

FOLEY & LARDNER LLP

2021 McKinney, Suite 1600

Dallas, Texas 75201

214-999-3000

jnthomas@foley.com

***ATTORNEYS FOR DEFENDANT VIVNT,
INC.***

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing was served on counsel of record via ECF on October 5, 2023.

By: /s/ Adam Tisdall
Adam Tisdall

Summary report: Litera Compare for Word 11.2.0.54 Document comparison done on 10/5/2023 3:01:38 PM	
Style name: Default Style	
Intelligent Table Comparison: Active	
Original filename: CLEAN Fractus ADT_Vivint PR 4-3 Jnt Claim Construction Statement[1].doc	
Modified filename: Fractus ADT_Vivint PR 4-3 Jnt Claim Construction Statement (PWSP Edits) (foley edits).doc	
Changes:	
<u>Add</u>	67
<u>Delete</u>	3
<u>Move From</u>	0
<u>Move To</u>	0
<u>Table Insert</u>	0
<u>Table Delete</u>	0
<u>Table moves to</u>	0
<u>Table moves from</u>	0
Embedded Graphics (Visio, ChemDraw, Images etc.)	0
Embedded Excel	0
Format changes	0
Total Changes:	70

Exhibit A

Exhibit A – Disputed Constructions¹

Term, Patent(s), & Claim Number(s)²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
“not similar/in shape/in size” • '092 Patent, claim 1; • '246 Patent, claims 13, 15, 30	Fractus: Not indefinite. No construction necessary. <u>Intrinsic Evidence:</u> <u>'092 and '246 Specifications:</u> • “Also, the antenna can include different holes with different shapes and sizes in a radiating element shaped by means of a polygonal, multilevel or loaded structure.” '092 Patent 1:67–2:3; '246 Patent 1:55–58. • “FIG. 1 shows three different antennas including one hole; those are, a circular, an elliptical, and a rectangular antenna. All the cases are polygonal shapes, including the circles and the ellipses as they can be considered polygonal structures with a large number of sides.” '092 Patent 2:31–35; '246 Patent 2:19–23 • “FIG. 10 shows an antenna, having a circular radiating element, in which the perimeter of a hole formed therein is shaped with a hexagonal geometry.” '092 Patent 2:49–52; '246 Patent 2:37–40. • “In FIG. 3, case 12 shows a radiating element with a triangular shape which includes one hole shaped by means of a space-filling curve (12 b). Case 13 shows a multihole antenna with a circular hole, wherein the hole intersects the	Defendants: Indefinite. <u>Intrinsic evidence:</u> '092 Patent, including, Abstract; 1:64-2:27; Figs. 1-10; 4:63-8:14 and related disclosures. '246 Patent, including, Abstract; Figs. 1-10; and all related disclosures. File Histories of the '246 and '092 Patents. <u>Extrinsic evidence:</u> Fractus' infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

¹ ADT does not take a position on construction of claim terms, phrases, or clauses found in the patents that are not asserted against it. Similarly, Vivint does not take a position on construction of claim terms, phrases, or clauses that are found in the patents that are not asserted against it.

² The list of claim numbers is derived directly from Defendants' P.R. 4-1 disclosures. Fractus does not admit that Defendants have identified the relevant claims for each term. Fractus expressly reserves the right to object to Defendants' modification of these claim identifications.

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	perimeter of the radiating element at a distance to the feeding point shorter than a quarter, or longer than three quarters, of the external perimeter of the radiating element. Case 14 describes a radiating element (14 a) composed by a rectangular and a circular shape, which includes two holes; those are, a circular-shaped hole (14 b) and a hole shaped by means a multilevel structure (14 c). Case 15 shows another radiating element with a hole with a circular shape (15 b).” ’092 Patent 2:61–3:5; ’246 Patent 2:49–60. • “Cases 1 to 3 show an antenna where the radiating element (1 a, 2 a, 3 a) is a circle including one hole (1 b, 2 b, 3 b), wherein the size of the hole (1 b, 2 b, 3 b) increases from cases 1 to 3, being the biggest one (3 b) and the smallest one case (1 b).” ’092 Patent 2:35–39; ’246 Patent 2:23–27. • “FIG. 2 shows three different types of multihole antenna. Case 7 shows a radiating element with a circular shape with two identical circular holes (7 a) and with a third bigger hole (7 b).” ’092 Patent 2:53–56; ’246 Patent 2:41–44. • “FIG. 9 shows a multihole antenna. Case 25 shows a radiating element with a circular shape with two identical holes (25 a) and with a third bigger hole (25 b).” ’092 Patent 3:27–29; ’246 Patent 3:14–16. ’246 Patent File History • “Applicant respectfully submits that Song fails to teach or suggest	

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	at least one of the distinguishing features of independent claim 1 and 33, namely, an antenna wherein the perimeter of the radiating element and perimeter of the at least one hole are not both circles and an antenna wherein the perimeter of the radiating element and perimeter of the at least one hole are not both ellipses.” FRAC-ADT-00002963 • “Song discloses a set of self-contained scaled circular rings, each one half the size of the previous ring superimposed together to form a single antenna. See Song § 6.2.1; FIGS 6.1 a & 6.1 b. Song further discloses a similar design using elliptical scaled rings. See Song§ 6.3.1; FIG. 6.8. Applicant respectfully submits that Song contains no disclosure whatsoever regarding an antenna wherein the perimeter of the radiating element and at least one hole are not both circles or ellipses as now required by claims 1 and 33. Applicant respectfully submits that, for at least this reason, independent claims 1 and 33 distinguish over Song. Withdrawal of the rejection of independent claims 1 and 33 is respectfully requested.” FRAC-ADT-00002963 • “Dependent claim 15 relates to an antenna wherein the radiating element comprises at least two holes and wherein the at least two holes are not similar in shape. Applicant respectfully submits that Song fails to teach or suggest at least one of the distinguishing features of dependent claim 15, namely, an antenna wherein the radiating element comprises at least	

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	two holes and wherein the at least two holes are not similar in shape. Song discloses a set of self-contained scaled circular rings, each one-half the size of the previous ring superimposed together to form a single antenna. See Song§ 6.2.1; FIGS. 6. 1a & 6.1b. The rings of FIGS. 6.1a and 6.1b, as well as the ellipses of figure 6.8, are symmetrically aligned with respect to the vertical axis of the radiating element. Applicant respectfully submits that Song contains no disclosure whatsoever regarding an antenna wherein the radiating element comprises at least two holes and wherein the at least two holes are not similar in shape as recited in claim 15. Applicant respectfully submits that dependent claim 15 distinguishes over Song. Withdrawal of the rejection of dependent claim 15 is respectfully requested.” FRAC-ADT-00002964 <u>Extrinsic Evidence:</u> • Claim Construction Order, Case 6:09-cv-00203-LED -JDL, Dkt. 526 at 24 (“‘Similar’ is not a technical term and the Court finds that its plain and ordinary meaning should control. <i>Phillips</i>, 41 5 F.3d at 1312 (citing <i>Vitronics</i>, 90 F.3d at 1582)), 27 (“[T]he Court construes ‘substantially similar’ and ‘basically the same’ according to their plain and ordinary meaning.”). • Declaration of Dr. Long ¶ 34.	
“hole(s) intersects the (external) perimeter”	Fractus: Not indefinite. No construction necessary.	Defendants: Indefinite. <u>Intrinsic evidence:</u>

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
'092 Patent, claims 11, 32; '246 Patent, claims 18, 28	<u>Intrinsic Evidence:</u> <i>'092 and '246 Specifications:</i> “The key point of the invention is the shape of the radiating element which includes a set of holes practised in the radiating element. According to the present invention the antenna is a monopole or a dipole which includes at least one hole. Also, the antenna can include different holes with different shapes and sizes in a radiating element shaped by means of a polygonal, multilevel or loaded structure.” '092 Patent 1:64–2:3; '246 Patent 1:52–58. “Due to the addition of the holes in the radiating element, the antenna can feature a multifrequency behaviour with a smaller size with respect to other prior art antennas operating at the same frequency. In typical embodiments, the radiating element is shorter than a quarter of the longest operating wavelength of the antenna. For the mentioned multifrequency behaviour, said hole in a monopole or dipole antenna features an area of at least a 20% of the area included inside the external perimeter of the radiating element of said antenna.” '092 Patent 2:4–12; '246 Patent 1:59–67. “The novel monopole or dipole includes a radiating element of a conducting or superconducting material with at least one hole, wherein the hole can be filled with a dielectric or partially filled by a conducting or superconducting material different from the conductor used for the radiating	'092 Patent, including, Abstract; 1:64-2:27; 2:31-3:32; Figs. 1-10; 4:63-8:14 and related disclosures. '246 Patent, including, Abstract; Figs. 1-10; and all related disclosures. File Histories of the '246 and '092 Patents. <u>Extrinsic evidence:</u> Fractus' infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	element.” ‘092 Patent 2:13–17; ‘246 Patent 2:1–5. • “In the novel antenna, the holes, or a portion of them, can be shaped with a geometry chosen from the set: multilevel, loaded, space-filling or polygonal structures.” ‘092 Patent 2:18–20; ‘246 Patent 2:6–8. • “FIG. 1 shows three different antennas including one hole; those are, a circular, an elliptical, and a rectangular antenna. All the cases are polygonal shapes, including the circles and the ellipses as they can be considered polygonal structures with a large number of sides. Cases 1 to 3 show an antenna where the radiating element (1 a, 2 a, 3 a) is a circle including one hole (1 b, 2 b, 3 b), wherein the size of the hole (1 b, 2 b, 3 b) increases from cases 1 to 3, being the biggest one (3 b) and the smallest one case (1 b). Also, cases 1 to 3 include a hole (1 b, 2 b, 3 b) with a circular shape. Case 4 and 5 describe an elliptical monopole with an elliptical hole (4 b, 5 b). In case 4, the hole (4 b) is not symmetrically located with respect to the vertical axis of the radiating element (4 a). Case 6 shows a rectangular monopole including one rectangular hole (6 b). In all cases in FIG. 1 the area of the hole (1 b, 2 b, 3 b, 4 b, 5 b, 6 b) is at least a 20% of the area included in the external perimeter of the radiating element (1 a, 2 a, 3 a, 4 a, 5 a, 6 a). FIG. 9 shows an antenna in which the perimeter of a hole formed therein is shaped with a hexagonal	

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	geometry. FIG. 10 shows an antenna, having a circular radiating element, in which the perimeter of a hole formed therein is shaped with a hexagonal geometry.” ’092 Patent 2:31–52; ’246 Patent 2:19–40. • “FIG. 2 shows three different types of multihole antenna. Case 7 shows a radiating element with a circular shape with two identical circular holes (7 <i>a</i>) and with a third bigger hole (7 <i>b</i>). The antennas in cases 8 and 9 are multihole antennas where the hole (8 <i>b</i>, 9 <i>b</i>) is shaped as a curve, said curve intersecting itself at a point. Cases 10 and 11 shows a polygonal radiating element (10 <i>a</i>, 11 <i>a</i>) with one (10 <i>b</i>) and three holes (11 <i>b</i>), respectively, shaped using a multilevel structure.” ’092 Patent 2:53–60; ’246 Patent 2:41–48. • “In FIG. 3, case 12 shows a radiating element with a triangular shape which includes one hole shaped by means of a space-filling curve (12 <i>b</i>). Case 13 shows a multihole antenna with a circular hole, wherein the hole intersects the perimeter of the radiating element at a distance to the feeding point shorter than a quarter, or longer than three quarters, of the external perimeter of the radiating element. Case 14 describes a radiating element (14 <i>a</i>) composed by a rectangular and a circular shape, which includes two holes; those are, a circular-shaped hole (14 <i>b</i>) and a hole shaped by means a multilevel structure (14 <i>c</i>). Case 15 shows another radiating element with a hole with a circular	

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	shape (15 b).” ’092 Patent 2:61–3:5; ’246 Patent 2:49–60. • “FIG. 4, case 16, shows a loaded radiating element (16 a) including two rectangular holes (16 b).” ’092 Patent 3:6–7; ’246 Patent 2:61–62. • “FIG. 9 shows a multihole antenna. Case 25 shows a radiating element with a circular shape with two identical holes (25 a) and with a third bigger hole (25 b).” ’092 Patent 3:27–29; ’246 Patent 3:14–16. • “FIG. 10 shows an antenna, having a circular radiating element, in which the perimeter of a hole formed therein is shaped with a hexagonal geometry.” ’092 Patent 3:30–32; ’246 Patent 3:17–19. ’246 Patent File History • [Patentee]: “The Office Action asserts that claims 20, 32 and 35-36 are indefinite because the claim limitation "wherein the at least one hole intersects the perimeter of the radiating element at a distance to its feeding point shorter than a quarter, or longer than three quarters, of the external perimeter of the radiating element" is unclear. Applicant respectfully disagrees. Applicant respectfully submits that those having skill in the art will appreciate that an intersection point of the at least one hole of the radiating element that is shorter than a quarter of the external perimeter of the radiating element when the distance between the intersection and the feeding point is reached in one direction by definition results in a distance greater than three quarters of the	

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	external perimeter when measured in the opposite direction along the perimeter of the radiating element. In Fig. 3, if an intersection point is located at a distance from the feeding point of greater than three quarters in, for example, the clockwise direction of the entire perimeter of the circular radiating element 13a, then that same intersection point will be less than one quarter of the entire perimeter from the radiating element in the counter-clockwise direction. Applicant respectfully asserts that for at least this reason, claims 20, 32, and 36 are not indefinite. Applicant respectfully requests the withdrawal of the § 112, second paragraph rejection of claims 20, 32, and 36.” FRAC-ADT-00003091–92. <u>Extrinsic Evidence:</u> • Declaration of Dr. Long ¶ 35 • “an opening through something; gap; aperture . . . a hollow place in a solid body or mass; a cavity . . . opening; slot” The Random House Dictionary of the English Language, 911 (2nd Ed. 2001).	
“4G communication standard / communication standard(s)” • ’103 Patent, claims 12, 16, 19, 20; • ’200 Patent, claims 1, 6, 11	Fractus: Not indefinite. No construction necessary. <u>Intrinsic Evidence:</u> <i>’103 and ’200 Patents Specification:</i> • “Broadband operation may be achieved by two closely neighboring bands which then require additional space for the resonating physical structure of each of the bands. Further, those	Defendants: Indefinite. <u>Intrinsic evidence:</u> ’103 Patent, including, Abstract; Figs. 1-20; 3:21-29; 4:51-5:3; 6:22-29; 8:47-9:19; 9:26-10:10; 10:24-38; 24:22-67; 25:1-13; 32:11-36; 35:45-61; 41:20-44:46; and related disclosures. ’200 Patent, including, Abstract; Figs. 1-20; 5:5-26; 5:30-6:56; 9:5-45; 9:59-

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	two antenna portions may not be provided too close together since, due to electric coupling between the two elements, the merging of the two bands into a single band is not achieved, but rather splitting the resonant spectrum into independent sub-bands which is not acceptable for meeting the requirements of wireless communication standards.” ‘103 Patent 3:21–29; ‘200 Patent 3:38–47. • “One problem is solved by providing the MFWD with an RF system and an antenna system with the capability of fully functioning in one, two, three or more communication standards (such as e.g. GSM 850, GSM 900, GSM 1800, GSM 1900, UMTS, CDMA, W-CDMA, etc.), and in particular mobile or cellular communication standards. • “In a MFWD 100 according to an embodiment of the present invention, the structure of the antenna system is advantageously shaped to efficiently use the volume of physical space made available for its integration within the MFWD 100 in order to obtain a superior RF performance of the antenna system (such as for example, and without limitation, input impedance level, impedance bandwidth, gain, efficiency, and/or radiation pattern) and/or superior RF performance of the MFWD 100 (such as for example and without limitation, radiated power, received power and/or sensitivity) in at least one of the communication standards of operation in at least	11:13; 25: 15-26:5; 33:17-56; 35:64-37:5; 41:3-31; 42:55-45:3; and related disclosures. File Histories of the ‘200 and ‘103 Patents. <u>Extrinsic evidence:</u> Fractus’ infringement contentions. VIVINT0002686-2797 Report ITU-R M.2134 Gupta, Baron, <i>Unpacking 3GPP Standards</i>, March 24, 2015 Krause, WWRF Future Standardization LTW, Oct. 2012 FCC-14-76A1 FCC-10-201A1_Rcd ITU World Radiocommunication Seminar highlights future communication technologies, Dec. 6, 2010 Formatting Mobile Broadband Availability Coverage Maps – BDC Help Center LTE Info Sheet Sept. 8,2010 Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	one of the frequency regions. Alternatively, the antenna system can be advantageously shaped to minimize the volume required within the MFWD 100 yet still achieve a certain RF performance.” ‘103 Patent 10:24–38; ‘200 Patent 10:53–67. • “An antenna system of the MFWD 100 of one embodiment of the invention has a structure able to support different radiation modes so that the antenna system can operate with good performance and reduced size in the communication standards allocated in multiple frequency bands within at least three different regions of the electromagnetic spectrum. Such an effect is achieved by appropriately shaping the structure of the antenna system in a way that different paths are provided to the electric currents that flow on the conductive parts of said structure of the antenna system, and/or to the equivalent magnetic currents on slots, apertures or openings within said structure, thereby exciting radiation modes for the multiple frequency bands of operation. In some cases the structure of an antenna system will comprise a first portion that provides a first path for the currents associated with a radiation mode in a first frequency band within a first region of the electromagnetic spectrum, a second portion that provides a second path for the currents associated with a radiation mode in a second frequency band within a second region of the electromagnetic spectrum and a third portion that provides a third	

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	path for the currents associated with a radiation mode in a third frequency band within a third region of the electromagnetic spectrum.” ’103 Patent 11:26–47; ’200 Patent 11:56–12:11. • “The resulting structure 1200 supports different radiation modes so as to operate in accordance with two mobile communication standards: GSM and UMTS. More specifically it operates in accordance with the GSM standard in the 900 MHz band (completely within the 810 MHz-960 MHz region of the spectrum), in the 1800 MHz band (completely within the 1710 MHz-1990 MHz region of the spectrum), and in the 1900 MHz band (also completely within the 1710 MHz-1990 MHz region of the spectrum). The UMTS standard makes use of a band completely within the 1900 MHz-2170 MHz region of the radio spectrum. Therefore, the antenna system operates in four (4) separate frequency bands within three (3) separate regions of the electromagnetic spectrum.” ’103 Patent 32:12–24; ’200 Patent 33:17–30. • “In one embodiment, the process to design an antenna system starts with a set of specifications 1601. A set of specifications includes a list of heterogeneous requirements that relate to mechanical and/or functional aspects of said antenna system. A typical set of specifications may comprise: ○ Dimensional information of the MFWD, and more particularly of the space	

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	available within the MFWD for the integration of an antenna system (data necessary to define the antenna box and the antenna rectangle) and of the ground-plane of the MFWD (data necessary to define the ground plane rectangle). ○ Communication standards operated by the MFWD, and some requirements on RF performance of the antenna system (such as for example, and without limitation, input impedance level, impedance bandwidth, gain, efficiency, and/or radiation pattern) and/or RF performance of the MFWD (such as for example, and without limitation, radiated power, received power and/or sensitivity). ● “In this particular example, the MFWD is intended to provide advanced functionality typical of a MMT device and/or a SMRT device. The MFWD must operate two mobile communication standards: GSM and UMTS. More specifically it operates the GSM standard in the 900 MHz band (completely within the 810 MHz-960 MHz region of the spectrum), in the 1800 MHz band (completely within the 1710 MHz 1990 MHz region of the spectrum), and in the 1900 MHz band (also completely within the 1710 MHz-1990 MHz region of the spectrum). The UMTS standard makes use of a band completely within the 1900 MHz-2170 MHz region of the	

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	spectrum. The MFWD comprises one RF transceiver to operate each mobile communication standard (i.e., two RF transceivers).” ‘103 Patent 35:48–61; ‘200 Patent 36:59–37:5. • “Referring now to FIG. 17, there is shown the progressive modification of the antenna contour as the structure of the antenna system through the different steps of the optimization process. As indicated by the designer of the MFWD, a feeding point to couple the RF transceiver that operates the GSM communication standard should be preferably located at point 1722, while a feeding point to couple the RF transceiver that operates the UMTS communication standard should be preferably located at point 1724. Furthermore, grounding points should be preferably located at points 1721 and 1723.” ‘103 Patent 37:33–43; ‘200 Patent 38:66–39:9. • “In the first iteration (step 1), a slot 1702 is practiced in the rectangular plate 1701, dividing said plate 1701 into two separate geometric elements: a larger antenna element 1711 and a smaller antenna element 1712, as shown in FIG. 17 b. The larger antenna element 1711 will be coupled to the RF transceiver that operates the GSM communication standard, while the smaller antenna element 1712 will be coupled to the RF transceiver that operates the UMTS communication standard.” ‘103 Patent 38:3–12; ‘200 Patent 39:37–46. • “Referring specifically to FIG. 19A, there is shown the VSWR of	

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	the antenna system referred to an impedance of 50 Ohms as a function of the frequency. Solid curve 1901 represents the VSWR of antenna element 1711 (i.e., the antenna element coupled to the RF transceiver that operates the GSM communication standard), while dashed curve 1902 represents the VSWR of antenna element 1712 (i.e., the antenna element coupled to the RF transceiver that operates the UMTS communication standard). The shaded regions 1903 and 1904 correspond to the mask of maximum VSWR allowed constructed from the functional specifications provided in Table 1. As it can be observed in FIG. 19A, the VSWR curves 1901, 1902 are below the mask 1903, 1904 for all frequencies within the frequency bands of operation of the antenna system.” ‘103 Patent 39:35–49; ‘200 Patent 41:3–17. • “The MFWD 100 according to one embodiment is preferably able to provide both voice and high-speed data transmission and receive services through at least one or more of said frequency regions in the spectrum. For that purpose, a MFWD will include the RF capabilities, antenna system and signal processing hardware to connect to a mobile network at a speed of preferably at least 350 Kbits/s, while in some embodiments the data transfer will be performed with at least 1 Mbit/s, 2 Mbit/s or 10 Mbit/s or beyond. For this purpose, a MFWD will preferably include at least 3G (such as for instance UMTS, UMTS-	

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	FDD, UMTS-TDD, W-CDMA, cdma2000, TD-SCDMA, Wideband CDMA) and/or 3.5G and/or 4G services (including for instance HSDPA, WiFi, WiMax, WiBro and other advanced services) in one or more of said frequency regions. In some embodiments a MFWD will include also 2G and 2.5G services such as GSM, GPRS, EDGE, TDMA, PCS, CDMA, cdmaOne. In some embodiments a MFWD will include 2G and or 2.5G services at one or both of the first two frequency regions (810-960 MHz and 1710-1990 MHz) and a 3G or a 4G service in the upper frequency region (1900-2170 MHz). In particular, some MFWD devices will provide 3 GSM/GPRS services (GSM900, GSM1800, GSM1900 or PCS) and UMTS/W-CDMA, while some others will provide 4 GSM/GPRS services (GSM850, GSM900, GSM1800, GSM1900 or PCS) and UMTS and/or W-CDMA to ensure seamless connectivity to multiple networks in several geographical domains such as for instance Europe and North America. In some embodiments, a MFWD will include 3G, 3.5G, 4G or a combination of such services in said three frequency regions.” ‘103 Patent 9:33–62; ‘200 Patent 9:59–10:23. • “A MFWD incorporating 3.5G or 4G features (i.e. comprising 3G and other advanced services such as for instance HSDPA, WiBro, WiFi, WiMAX, UWB or other high-speed wireless standards,	

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	hereinafter 4G services) might require operation in additional frequency bands corresponding to said 4G standards (for instance, bands within the frequency region 2-11 GHz and some of its sub-regions such as for instance 2-11 GHz, 3-10 GHz, 2.4-2.5 GHz and 5-6 GHz or some other bands). In some cases, to achieve a maximum volume compactness it would be advantageous that the same antenna system is capable of supporting the radiation modes corresponding to the additional frequency bands. .” ‘103 Patent 24:22–39; ‘200 Patent 25:14–32. <u>Extrinsic Evidence:</u> • Declaration of Dr. Long ¶ 36 • Telit LE910 Datasheet, FRACTUS-0015790 at 2 (listing 4G bands (MHz), including but not limited to B2(1900), B4(AWS1700), B13(700), B12/B13(700), B5(580))	
“receive signals from a 4G communication standard” • ‘200 Patent, claim 1	Fractus: Not indefinite. No construction necessary. Same evidence as “4G communication standard / communication standard(s)” <u>Extrinsic Evidence:</u> • Declaration of Dr. Long ¶ 37.	Defendants: Indefinite. <u>Intrinsic evidence:</u> ‘103 Patent, including, Abstract; Figs. 1-20; 3:21-29; 4:51-5:3; 6:22-29; 8:47-9:19; 9:26-10:10; 10:24-38; 24:22-67; 25:1-13; 32:11-36; 35:45-61; 41:20-44:46; and related disclosures. ‘200 Patent, including, Abstract; Figs. 1-20; 5:5-26; 5:30-6:56; 9:5-45; 9:59-11:13; 25: 15-26:5; 33:17-56; 35:64-37:5; 41:3-31; 42:55-45:3; and related disclosures. File Histories of the ‘200 Patent.

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		<u>Extrinsic Evidence:</u> Fractus' infringement contentions. VIVINT0002686-2797 Report ITU-R M.2134 Gupta, Baron, <i>Unpacking 3GPP Standards</i>, March 24, 2015 Krause, WWRF Future Standardization LTW, Oct. 2012 FCC-14-76A1 FCC-10-201A1_Rcd ITU World Radiocommunication Seminar highlights future communication technologies, Dec. 6, 2010 Formatting Mobile Broadband Availability Coverage Maps – BDC Help Center LTE Info Sheet Sept. 8, 2010 Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.
“complexity factor” • '103 Patent, claims 16, 20; • '200 Patent, claims 1, 6, 11	Fractus: Not indefinite. No construction necessary. Alternatively: “a numerical value calculated using a formula that parametrizes the level of complexity of an antenna that captures and characterizes certain aspects of the geometrical details of the antenna contour.”	Defendants: Indefinite. <u>Intrinsic Evidence:</u> '103 Patent, including, Abstract; Figs. 1-20; 5:5-6:3; 15:57-16:6; 16:28-22:54; 25: 31-26:7; 28:47-35:61; 37:1-38:67; 41: 20-44:46; and related disclosures.

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	<u>Intrinsic Evidence:</u> <i>'103 and '200 Patents Specification:</i> • “A multifunction wireless device having at least one of multimedia functionality and smartphone functionality, the multifunction wireless device including an upper body and a lower body, the upper body and the lower body being adapted to move relative to each other in at least one of a clamshell, a slide, and a twist manner. The multifunction wireless device further includes an antenna system disposed within at least one of the upper body and the lower body and having a shape with a level of complexity of an antenna contour defined by complexity factors F21 having a value of at least 1.05 and not greater than 1.80 and F32 having a value of at least 1.10 and not greater than 1.90.” ‘103 Patent 5:7–18; ‘200 Patent 5:30–41. • “A multifunction wireless device having at least one of multimedia and smartphone functionality, the multifunction wireless device including a microprocessor and operating system adapted to permit running of word-processing, spreadsheet, and slide software applications, and at least one memory interoperably coupled to the microprocessor, the at least one memory having a total capacity of at least 1 GB. The multifunction wireless device further includes an antenna system having a shape with a level of complexity of an antenna contour defined by complexity factor F21 having a value of at least	’200 Patent, including, Abstract; Figs. 1-20; 5:30-67; 16:64-23:40; 26:15-26:67; 29:45-40:35; 42:55-45:3; and related disclosures. File Histories of the ’200 and ’103 Patents. <u>Extrinsic Evidence:</u> Fractus’ infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	1.05 and not greater than 1.80 and by complexity factor F32 having a value of at least 1.10 and not greater than 1.90.” ‘103 Patent 5:19–31; ‘200 Patent 5:42–54. • “A multifunction wireless device having at least one of multimedia and smartphone functionality, the multifunction wireless device including a receiver of at least one of analog and digital sound signals, an image recording system comprising at least one of an image sensor having at least 2 Megapixels in size, a flash light, an optical zoom, and a digital zoom, and data storage means having a capacity of at least 1 GB. The multifunction wireless device further includes an antenna system having a shape with a level of complexity of an antenna contour defined by complexity factor F21 having a value of at least 1.05 and not greater than 1.80 and by complexity factor F32 having a value of at least 1.10 and not greater than 1.90.” ‘103 Patent 5:32–44; ‘200 Patent 5:55–67. • “FIG. 6A shows an example of a first grid to compute the complexity factors of an antenna contour; • FIG. 6B shows an example of a second grid to compute the complexity factors of an antenna contour; • FIG. 6C shows an example of a third grid to compute the complexity factors of an antenna contour; • FIG. 7 shows the two-dimensional representation of the F32 vs. F21 space;	

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	- FIG. 8A shows an example of an antenna contour inspired in a Hilbert curve under a first grid to compute the complexity factors of said antenna contour; - FIG. 8B shows the example of the antenna contour of FIG. 8a under a second grid to compute the complexity factors of said antenna contour; - FIG. 8C shows the example of the antenna contour of FIG. 8a under a third grid to compute the complexity factors of said antenna contour; - FIG. 9A shows an example of a quasi-rectangular antenna contour featuring a great degree of convolution in its perimeter under a first grid to compute the complexity factors of said antenna contour; - FIG. 9B shows the example of the quasi-rectangular antenna contour featuring a great degree of convolution of FIG. 9a under a second grid to compute the complexity factors of said antenna contour; - FIG. 9C shows the example of the quasi-rectangular antenna contour featuring a great degree of convolution of FIG. 9a under a third grid to compute the complexity factors of said antenna contour; - FIG. 10A shows an example of a triple branch antenna contour under a first grid to compute the complexity factors of said antenna contour; - FIG. 10B shows the example of the triple branch antenna contour of FIG. 10a under a second grid to	

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	compute the complexity factors of said antenna contour; • FIG. 10C shows the example of the triple branch antenna contour of FIG. 10a under a third grid to compute the complexity factors of said antenna contour;” • “FIG. 13A shows the antenna contour of FIG. 12a placed under a first grid to compute the complexity factors of said antenna contour; • FIG. 13B shows the antenna contour of FIG. 12a placed under a second grid to compute the complexity factors of said antenna contour; • FIG. 13C shows the antenna contour of FIG. 12a placed under a third grid to compute the complexity factors of said antenna contour; • FIG. 14A shows an antenna contour according to the present invention placed under a first grid to compute the complexity factors of said antenna contour; • FIG. 14B shows the antenna contour according to the present invention of FIG. 14 a placed under a second grid to compute the complexity factors of said antenna contour; • FIG. 14C shows the antenna contour according to the present invention of FIG. 14a placed under a third grid to compute the complexity factors of said antenna contour;” ‘103 Patent 6:62–7:58; ‘200 Patent 7:22–8:18. • “FIG. 18 is a complexity factor plain graphically illustrating the complexity factors of FIGS. 18A-	

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	18H;" '103 Patent 8:1–2; '200 Patent 8:28–29. • “In accordance with embodiments of the invention, the level of complexity of an antenna contour can be advantageously parameterized by means of two complexity factors, hereinafter referred to as F21 and F32, which capture and characterize certain aspects of the geometrical details of the antenna contour (such as for instance its edge-richness, angle-richness and/or discontinuity-richness) when viewed at different levels of scale. For the computation of F21 and F32 of a particular antenna, a first, a second, and a third grid (hereinafter called grid G1, grid G2 and grid G3 respectively) of substantially square or rectangular cells are placed on the antenna rectangle. The three grids are adaptive to the antenna rectangle. That is, the size and aspect ratio of the cells of each one of said three grids is determined by the size and aspect ratio of the antenna rectangle itself. The use of adaptive grids is advantageous because it provides a sufficient number of cells within the antenna rectangle to fully capture the geometrical features of the antenna contour at differing levels of detail.” '103 Patent 16:28–46; '200 Patent 16:64–17:15. • “The complexity factor F21 is computed by counting the number of cells N1 of the grid G1 that are at least partially inside the antenna rectangle and include at least a point of the antenna contour (in the	

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	present invention the boundary of the cell is also part of the cell), and the number of cells N2 of the grid G2 that are completely inside the antenna rectangle and include at least a point of the antenna contour, and then applying the following formula: $[F_{21} = -(\log(N_2) - \log(N_1))/\log(1/2)]$. Complexity factor F21 is predominantly characterized by capturing the complexity and degree of convolution of features of the antenna contour that appear when the contour is viewed at coarser levels of scale. As it is illustrated in the example of FIGS. 8A-C, the election of grid G1 801 and grid G2 802, and the fact that with grid G2 802 the antenna rectangle 800 is perfectly tessellated by an odd number of columns and an odd number of rows, results in a value of the factor F21 equal to one for an antenna contour shaped as the antenna rectangle 800. On the other hand, an antenna contour whose shape is inspired in a Hilbert curve that fills the antenna rectangle 800 features a value of the factor F21 smaller than two. Therefore the factor F21 is geared more towards assessing an overall complexity of an antenna contour (i.e., whether the degree of convolution of an antenna contour distinguishes sufficiently from a simple rectangular shape when looked at from a zoomed-out view), rather than estimating if the full complexity of an antenna contour (i.e., the complexity of the antenna contour when looked at from a zoomed-in view)	

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	approaches that of a highly-convoluted curve such as the Hilbert curve. Moreover, in some embodiments the factor F21 is related to the number of paths that a structure of the antenna system provides to electric currents and/or the equivalent magnetic currents to excite radiation modes (i.e., factor F21 tends to increase with the number of antenna portions within the structure of the antenna system and/or the number of antenna elements that form the antenna system). In general, the more frequency bands and/or radiation modes that need to be supported by the antenna structure of the MFWD 100, the higher the value of the factor F21 that needs to be attained by the antenna contour of the antenna system of the MFWD 100. A third grid (or grid G3) is readily obtained by subdividing each cell of grid G2 into four cells, with each of the cells having a cell width (W3) equal to one half ($\frac{1}{2}$) of the width of a cell of the second grid (W2) (i.e., $W3 = \frac{1}{2} \times W2$); and a cell height (H3) equal to one half ($\frac{1}{2}$) of the height of a cell of the second grid (H2) (i.e., $H3 = \frac{1}{2} \times H2$). Therefore, since each cell of the grid G2 is replaced with 2-by-2 cells of the grid G3, then 18 by (4n+2) cells of grid G3 are thus required to tessellate completely the antenna rectangle.” ’103 Patent 18:37–19:25; ’200 Patent 19:13–20:4. • “The complexity factor F32 is computed by counting the number of cells N2 of grid G2 that are	

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	completely inside the antenna rectangle and include at least a point of the antenna contour, and the number of cells N3 of the grid G3 that are completely inside the antenna rectangle and include at least a point of the antenna contour, and applying then the following formula: $[F_{32} = -(\log(N_3) - \log(N_2))/\log(1/2)]$. Complexity factor F32 is predominantly characterized by capturing the complexity and degree of convolution of features of the antenna contour that appear when the contour is viewed at finer levels of scale. As it is illustrated in the example of FIGS. 8A-C, the election of grid G2 802 and grid G3 803 is such that an antenna contour whose shape is inspired in a Hilbert curve that fills the antenna rectangle 800 features a value of the factor F32 equal to two. On the other hand, an antenna contour shaped as the antenna rectangle 800 features a value of the factor F32 larger than one. Therefore the factor F32 is geared more towards evaluating the full complexity of an antenna contour (i.e., whether the degree of convolution of an antenna contour tends to approach that of a highly-convoluted curve such as the Hilbert curve), rather than discerning if said antenna contour is substantially different from a rectangular shape. Moreover, the factor F32 is in some embodiments related to the degree of miniaturization achieved by the antenna system. In general, the smaller the antenna box of the MFWD 100, the higher the value of	

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	the factor F32 that needs to be attained by the antenna contour of the antenna system of the MFWD 100.” ‘103 Patent 19:26–59; ‘200 Patent 20:5–39. • “The complexity factors F21 and F32 span a two-dimensional space on which the antenna contour of the antenna system of the MFWD 100 is mapped as a single point with coordinates (F21, F32). Such a mapping can be advantageously used to guide the design of the antenna system by tailoring the degree of convolution of the antenna contour until some preferred values of the factors F21 and F32 are attained, so that the resulting antenna system: (a) provides the required number of frequency bands in which the MFWD operates; (b) meets MFWD size and/or integration constraints; and/or (c) enhances the RF performance of the antenna system and/or that of the MFWD in at least one of the frequency bands of operation.” ‘103 Patent 19:60–20:5; ‘200 Patent 20:40–52. • “In a preferred embodiment of the present invention, the MFWD 100 comprises an antenna system whose antenna contour features a complexity factor F21 larger than one and a complexity factor F32 larger than one. In a preferred embodiment, the MFWD 100 comprises an antenna system whose antenna contour features a complexity factor F21 larger than or equal to 1.1 and a complexity factor F32 larger than or equal to 1.1.	

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	In some examples the antenna contour features a complexity factor F32 larger than a certain minimum value in order to achieve some degree of miniaturization. An antenna contour with a complexity factor F32 approximately equal to two, despite achieving substantial size reduction, may not be preferred for the MFWD 100 of the present invention as the antenna system is likely to have reduced capability to operate in multiple frequency bands and/or limited RF performance. Therefore in some examples of embodiments of the present invention the antenna contour features a complexity factor F32 smaller than a certain maximum value in order to achieve enhanced RF performance. In some cases of embodiments of the present invention the antenna contour features a complexity factor F32 larger than said minimum value but smaller than said maximum value.” ‘103 Patent 20:6–25; ‘200 Patent 20:53–21:10. • “Said minimum and maximum values for the complexity factor F32 can be selected from the list of values comprising: 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, 1.60, 1.65, 1.70, 1.75, 1.80, 1.85, and 1.90. Similarly, in some examples an antenna contour advantageously features a complexity factor F21 larger than a lower bound and/or smaller than an upper bound. The lower and upper bounds for the complexity factor F21 can be selected from the list of	

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	comprising: 1.05, 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, 1.60, 1.65, 1.70, 1.75, and 1.80.” ‘103 Patent 20:26–38; ‘200 Patent 21:11–21. • “The complexity factors F21 and F32 have turned out to be relevant parameters that allow for an effective antenna design. Evaluation of those parameters give good hints on possible changes of antennas in order to obtain improved antennas. In some cases the parameters F21 and F32 allow for easy identification of unsuitable antennas. Further those parameters may also be used in numerical optimization algorithms as target values or to define target intervals in order to speed up such algorithms.” ‘103 Patent 20:39–47; ‘200 Patent 21:22–31. • “In the following paragraphs some parameter ranges for F21 and F32 which have turned out to be particularly advantageous or useful are summarized. It has been found that for MFWDs it is particularly useful to have a value of F21 larger than 1.43, 1.45, 1.47 or even preferably greater than 1.50. Such values in this complexity factor translate into a richer frequency response of the antenna which allows for more possible resonant frequencies and more frequency bands with better bandwidths or a combination of those effects. Furthermore, for SMRT or MMT, design demands may be different since those devices are usually larger and a reduction of	

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	the antenna size is not of such utmost importance, but energy consumption may be important since those devices have to operate to provide many different functionalities. For those devices a complexity factor F21 of only more than 1.39, preferably 1.41 or most preferred more than 1.43 turns out to be advantageous.” ‘103 Patent 20:48–65; ‘200 Patent 21:32–49. • “For those antennas which in their physical properties come quite close to patch antennas namely those with an overlap between the antenna and the ground-plane (patch-like antennas), a value of F21 being higher than 1.45, 1.47, 1.50, or 1.60 turns out to be a good measure for an antenna to provide an expected improved bandwidth or gain with respect to a patch antenna without any complexity in at least one of the frequency bands. This region for F21 further turns out to be useful for an MFWD with two or more RF transceivers. With a lower value it will be difficult to sufficiently isolate the two RF transceivers against each other. By the complexity factor F21 being more than 1.45, 1.47 or 1.50 the two RF transceivers can be electrically separated sufficiently, e.g. by connecting them to two antenna portions which are not in direct electrical contact. The last mentioned range is also equally suitable for a MFWD with two, three or more antenna elements. Those elements may be convoluted into each other in order to occupy less space which translates into a high value of F21.	

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	A MFWD with an antenna with a complexity factor of F32 being larger than 1.55, 1.57 or 1.60 is advantageous. Such a high value of F32 provides an additional factor for tuning the frequency of high frequency bands without changing the gross geometry for low frequency bands. For this range of F32 it turns out that the parameter F21 being lower than 1.41, 1.39, 1.37, or 1.35 is advantageous since for a high value of F32 which provides some miniaturization, F21 may be low in particular to avoid an antenna with too many separate portions or antenna arms since such independent portions are difficult to physically secure with a device in order to achieve proper mechanical robustness. For a SMRT or MMT device a value of F32 being larger than 1.50, 1.52, 1.55 or 1.60 is desirable. The phones which usually operate in high frequency bands such as UMTS and/or a wireless connectivity at a frequency of around 2.4 GHz a higher value of F32 can be used to appropriately adapt the antenna to a desired resonance frequency and/or bandwidth in those bands.” ‘103 Patent 21:25–62; ‘200 Patent 22:9–47. • “For antennas which are overlapping with the ground plane of a PCB of the MFWD with at least 50% or 100%, it is possible to achieve appropriate antenna performance even if the value of F21 is smaller than e.g. 1.42, 1.40 or 1.38 in cases that the complexity	

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	factor F32 is more than 1.55. Such edges, curves or steps in the border which lead to a high value of F32, increase efficiency and gain since they lead to strong reorientations of current. This may compensate for lower values of F21, in particular for antennas of patch-like geometry (i.e. those where the antenna overlaps 100% with the ground plane of a PCB of the MFWD). Equally for MFWDs with two or more RF transceivers, efficient antennas are possible for values of F21 being lower than 1.40, 1.38 or 1.35 in cases that the complexity factor F32 is larger than 1.50, 1.52, 1.53, 1.57 or 1.60. Appropriate separation of the two RF transceivers is difficult with a low value of F21. It may still be possible, however, with a high complexity value of F32, which enables some kind of compensation for a low value of F21. In some embodiments, when a high level of complexity is sought it might be necessary to design an antenna system whose structure comprises 2, 3 or more antenna elements. Such complexity may be achieved at a coarser and/or finer level of detail. When a high level of complexity is sought in a coarser level of detail, a high value of F21 might be required, namely more than 1.43, 1.45, 1.47, or 1.50. When a high level of complexity is sought in a finer level of detail, a high value of F32 might be required, namely more than 1.61, 1.63, 1.65 or 1.70.” ‘103 Patent 22:26–54; ‘200 Patent 23:12–40.	

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	• “In other cases, achieving good isolation between the frequency bands of the 4G services and the frequency bands of the rest of services (3G and below) is preferred to compactness. In those cases the 4G antenna (i.e. the one or more additional antenna covering one or more of the 4G services) will preferably be separated as much as possible from the antenna box. Generally the longer side of the antenna rectangle is placed alongside a short edge of the ground plane rectangle. In some cases it would be advantageous to place the 4G antenna substantially close to the edge that is opposite to the shorter edge. In other cases it would be advantageous to place the 4G antenna substantially close to an edge that is adjacent to the shorter edge. Therefore since the MFWDs physical dimensions are usually predefined, the separation between antennas can be further increased by reducing the shorter side of the antenna rectangle and thus increasing its aspect ratio. As a consequence, for those devices, it may be desirable to have a value of F32 higher than 1.35, 1.50, 1.60, 1.65 or 1.75. When the complexity factor F21 is in the lower half of the typical range, for example when F21 is smaller than 1.40, it may be advantageous to have a value of F32 higher than 1.35. On the other hand when the complexity factor F21 is in the upper half of its typical range, for example when F21 is larger than 1.45, it may be advantageous to have a value of F32 higher than a minimum value	

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	that can be selected from the list of values comprising: 1.10, 1.15, 1.20, 1.25, 1.30, 1.35, 1.40, 1.45, 1.50, 1.55, 1.60, 1.65, 1.70, 1.75, 1.80, 1.85, and 1.90.” ‘103 Patent 24:40–67; ‘200 Patent 25:33–60. • “In other examples in which the antenna rectangle of an antenna system is in the projection of the ground plane rectangle of a MFWD in an area of less than 10%, 20% or 30% of the antenna rectangle, the antenna contour of the antenna system preferably features a complexity factor F21 larger than 1.20, 1.30, 1.40 or 1.50. In still other examples in which the antenna rectangle of an antenna system is in the projection of the ground plane rectangle of a MFWD in an area larger than 80%, 90% or 95% of said antenna rectangle, the antenna contour of the antenna system preferably features a complexity factor F21 smaller 1.30, 1.35, 1.40 or 1.45.” ‘103 Patent 25:31–41; ‘200 Patent 26:23–34. • “Another aspect of the integration of an antenna system within a MFWD is the positioning of the antenna system with respect to the one or more bodies comprised in the MFWD. An antenna system can be integrated either in the top part of the body of a MFWD (usually, above and/or behind a display), or in the bottom part of a body of the MFWD (usually, below and/or behind a keypad). In some examples, an antenna system integrated within the bottom part of as body of a MFWD features advantageously an antenna	

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	contour with a complexity factor F21 smaller than 1.45 and a complexity factor F32 smaller than 1.50, since generally there is quite a bit more space available in such a part of the device. In some other examples, the antenna contour preferably features a factor F21 larger than 1.45 and/or a factor F32 larger than 1.75. In some examples, an antenna system integrated on the top part of the body of a MFWD advantageously features an antenna contour with a complexity factor F21 smaller than 1.30, 1.25, or 1.20. In some other examples, the antenna contour preferably features a factor F21 larger than 1.45, 1.50 or 1.55. In some cases, a two-body MFWD (such as for instance a clamshell or a flip-phone, a twist device, or a slider device) integrates the antenna system in the vicinity of the hinge that allows rotation of at least one of the two bodies. In such cases, the antenna contour of the antenna system preferably features a complexity factor F21 larger than 1.20 and/or a complexity factor F32 larger than or equal to 1.55. Further of advantage for a general trade off between multiple parameters are values of a complexity factor of F21 being more than 1.52 and less than 1.65 and/or a complexity factor F32 being more than 1.55 and less than 1.70." '103 Patent 25:42–26:6; '200 Patent 26:35–67. • "FIG. 6A-6C represents, respectively examples of a first grid	

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	601, a second grid 602 and a third grid 603 used for the computation of the complexity factors F21 and F32 of an antenna contour that fits in an antenna rectangle 600. The antenna rectangle 600 has a long side 603 and a short side 604.” ‘103 Patent 28:47–51; ‘200 Patent 29:45–50. • “Referring now to FIG. 7 there is shown a graphical representation of the two-dimensional space 700 defined by the complexity factors F21 and F32 for an illustrative antenna (not shown). The antenna contour of the illustrative antenna system of a MFWD is represented as a bullet 701 of coordinates (F21, F32) in the two-dimensional space 700.” • “FIGS. 8A-8C provide examples to illustrate the complexity factors that feature two radically different antennas: (1) A solid planar rectangular antenna that occupies the entire area of an antenna rectangle 800 for a MFWD (not specifically shown); and (2) an antenna whose contour is inspired in a Hilbert curve 810 that fills the available space within the antenna rectangle 800 (the antenna structure shown in the rectangle 800 of each of FIGS. 8A-8C). These two antenna examples, although not advantageous to provide the multiple frequency band behavior required for the antenna system of a MFWD, help to show the relevance and characteristics of the two complexity factors F21 and F32.” ‘103 Patent 29:25–36; ‘200 Patent 30:24–35.	

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	“In FIG. 8A, there are fifteen (15) cells of the first grid 801 at least partially inside the antenna rectangle 800 and that include at least a point of the antenna contour of antenna 810 (i.e., $N_1=15$). In FIG. 8B, there are forty-five (45) cells of the second grid 802 completely inside the antenna rectangle 800 and that include at least a point of the antenna contour of the antenna 810 (i.e., $N_2=45$). Finally in FIG. 8C, there are one hundred eighty (180) cells of the third grid 803 completely inside the antenna rectangle 800 and that include at least a point of the antenna contour of the antenna 810 (i.e., $N_3=180$). Therefore, in the present example, an antenna whose contour is inspired in the Hilbert curve 810 shown within the antenna space 800 of FIGS. 8A-8C features $F_{21}=1.58$ (i.e., smaller than 2.00) and $F_{32}=2.00$. On the other hand if the process of counting the cells in each of the three grids is repeated for a planar rectangular antenna whose contour fills the entire rectangular space of the antenna rectangle 800 (not actually shown) then $N_1=12$, $N_2=24$ and $N_3=52$, which results in $F_{21}=1.00$ and $F_{32}=1.12$ (i.e., larger than 1.00). These results illustrate that complexity factor F_{21} is geared more towards discerning if the antenna contour of a particular antenna system distinguishes sufficiently from a simple planar rectangular antenna rather than capturing the complete intricacy of said antenna contour, while	

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	complexity factor F32 is predominantly directed towards capturing whether the degree of complexity of the antenna contour approaches to that of a highly-convoluted curve such as a Hilbert curve.” ‘103 Patent 29:45–30:5; ‘200 Patent 30:44–31:5. • “FIGS. 9A-9C and 10A-10C provide two examples illustrating the complexity factors that characterize a quasi-rectangular antenna 910 having a highly convoluted perimeter and a triple branch antenna 1010, respectively. These two exemplary antennas help to show the relevance of the two complexity factors.” ‘103 Patent 30:5–11; ‘200 Patent 31:6–12. • “FIG. 11 is a graphical presentation that maps the values of the complexity factors F21 and F32 of the exemplary antennas of FIGS. 6, 8, 9, and 10. In FIG. 11 the horizontal axis represents increasing values of F21 while the vertical axis represents increasing values of F32. The exemplary simple planar, rectangular antenna discussed above in connection with FIG. 6, occupies the entire area of an antenna rectangle 800 and is characterized by a pair of complexity factors F21=1.00 and F32=1112 that are mapped as bullet 1102 in FIG. 11. The complexity factors for the antenna whose contour is discussed above in connection with FIG. 8, and that is inspired in a Hilbert curve 810 are F21=1.58 and F32=2.00 and is mapped onto FIG. 11 as bullet 1101. The quasi-rectangular antenna, discussed above in	

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	connection with FIG. 9, and having a highly convoluted perimeter of 910 is characterized by complexity factors $F21=1.00$ and $F32=2.00$ and is mapped onto FIG. 11 as bullet 1103. Bullet 1104 represents the pair of complexity factors $F21=1.77$ and $F32=1.04$ for the exemplary triple branch antenna 1010 discussed above in connection with FIG. 10. These antenna examples help to show the value and antenna characteristics represented by the two complexity factors. $F21$ and $F32$ Further, FIG. 11 and the bullets 1001-1004 illustrate how a two dimensional graphical space 700 might be used for antenna system design.” ‘103 Patent 30:66–31:22; ‘200 Patent 32:1–26 • “An antenna designer can see that the complexity factors $F21$ and $F32$, as represented and characterized by the antennas on FIGS. 6, 8, 9 and 10 and the illustrated graph of FIG. 11 are very useful tools for modern antenna design for MFWD and similar devices. Use of these tools in accordance with the invention yields antenna designs, as well as MFWD devices having antennas, with enhanced performance characteristics.” ‘103 Patent 31:5864; ‘200 Patent 32:63–33:3. • “In FIGS. 13A-13B, the antenna contour of the structure of the antenna system 1200 is placed under a first grid 1301, a second grid 1302, and a third grid 1303 for the computation of the complexity factors of said structure 1200.”	

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	'103 Patent 33:5–8; '200 Patent 34:13–16. • “The complexity factor F21 for the antenna shown in FIGS. 12A, 13A and 13B is computed as $F_{21} = -(\log(38) - \log(13)) / \log(1/2) = 1.55$ while the complexity factor F32 is obtained as $F_{32} = -(\log(114) - \log(38)) / \log(1/2) = 1.58$. Therefore, the exemplary structure of antenna system for a MFWD 1200 shown in 12A, 13A and 13B is characterized advantageously by complexity factors $F_{21} = 1.55$ and $F_{32} = 1.58$.” '103 Patent 33:27–44; '200 Patent 34:35–52. • “FIGS. 14A-14C show, respectively, another exemplary antenna 1410 inside the antenna rectangle 1400 under a first grid 1401, a second grid 1402, and a third grid 1403 for the computation of the complexity factors of the antenna 1410. In this example, the antenna rectangle 1400 may be tessellated with nine (9) columns and five (5) rows of cells of the second grid 1402 (FIG. 14B) as well as with nine (9) columns and seven (7) rows of cells of said second grid (not depicted) since in both cases the aspect ratio is at its closest to one. A second grid 1402 with nine (9) columns and five (5) rows of cells has been selected since the aspect ratio for grid 1402 is bigger than 1. The antenna 1410 has a feeding point 1411, located substantially close to the bottom left corner of the antenna rectangle 1405 (being thus the feeding point corner).” '103 Patent 33:45–58; '200 Patent 34:53–67.	

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	• “The complexity factor F21 is for the antenna shown in FIGS. 14A-14C computed as $F_{21} = -(\log(42) - \log(15))/\log(1/2) = 1.49$ while the complexity factor F32 is obtained as $F_{32} = -(\log(142) - \log(42))/\log(1/2) = 1.76$. Therefore, the example antenna 1410 for a MFWD features advantageously complexity factors $F_{21} = 1.49$ and $F_{32} = 1.76$.” ‘103 Patent 34:9–24; ‘200 Patent 35:18–34. • “The antenna complexity contour of the antenna structure 1200, FIGS. 12A, 13A and 13B is mapped in the graphical representation of FIG. 15 as a bullet 1501 with coordinates ($F_{21} = 1.55$ or $F_{32} = 1.58$). The antenna 1410 of FIGS. 14A-14C is mapped on the graph of FIG. 15 as a bullet 1502 with coordinates ($F_{21} = 1.49$ or $F_{32} = 1.76$). Those two examples show cases where intermediate values of F21 and F32 are used. For intermediate values the value of F21 of the structure 1200 is relatively high and in case of the structure 1400 the value of F32 is relatively high.” ‘103 Patent 34:25–34; ‘200 Patent 35:35–44. • “Referring now to FIGS. 16-19, there is shown one example of optimizing the geometry of an antenna system to obtain a superior performance for MFWDs. In that sense, complexity factors F21 and F32, as described above, are useful in guiding the optimization process of the structure of an antenna system to reach a target region of the (F_{21}, F_{32}) plane, as it is depicted in the flowchart 1600 in	

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	FIG. 16.” ‘103 Patent 34:35–41; ‘200 Patent 35:45–51. • “Therefore, once a set of specifications has been compiled, one embodiment of the design method of the present invention translates the set of specifications into a target region of the (F21, F32) plane 1602. In some examples, the target region is defined by a minimum and/or a maximum value of factor F21 (denoted by F21 min and F21 max in FIG. 16), and/or a minimum and/or a maximum value of factor F32 (denoted by F21 min F21 max in FIG. 16). It will then be advantageous in order to benefit from a superior RF performance of the antenna system and/or a superior RF performance of the MFWD to shape the structure of the antenna system so that its antenna contour features complexity factors within the target region of the (F21, F32) plane. Starting from an initial structure of an antenna system 1603, whose antenna contour features complexity factors F21 0 and F32 0), most likely outside the target region of the (F21, F32) plane, an antenna system designer may need to gradually modify the structure of antenna system 1605 (such as, for instance, creating slots, apertures and/or openings within said structure; or bending and/or folding said structure) to adjust the complexity factors of its antenna contour. This process can be performed in an iterative way, verifying after each step whether factors F21 1 and F31 2 are within	

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	the target region of the (F21, F32) plane 1604. Depending on the current values of the complexity factors after step “i” of this iterative process, an antenna system designer can apply changes to the structure of the antenna system at step “i+1” to correct the value of one, or both, complexity factors in a particular direction of the (F21, F32) plane. The design process ends 1606 when a structure of the antenna system has an antenna contour featuring complexity factors within the target region of the (F21, F32) plane (denoted by F21* and F32* in FIG. 16).” ‘103 Patent 35:10–44; ‘200 Patent 36:21–54. • “In conclusion, it will be advantageous to shape the structure of the antenna 35 system in such a way that its antenna contour features complexity factor F21 higher than 1.50 and F32 higher than 1.56, thus defining a target region 1800 in the upper right part of the (F21, F32) plane in FIG. 18. Referring now to FIG. 17, there is shown the progressive modification of the antenna contour as the structure of the antenna system through the different steps of the optimization process. As indicated by the designer of the MFWD, a feeding point to couple the RF transceiver that operates the GSM communication standard should be preferably located at point 1722, while a feeding point to couple the RF transceiver that operates the UMTS communication standard should be preferably located at point 1724. Furthermore,	

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	grounding points should be preferably located at points 1721 and 1723. Table 2 lists for each step the number of cells of the first, second and third grids considered for the computation of the complexity factors of the antenna contour, 15 and the values of said complexity factors F21, F32.” ‘103 Patent 37:28–47; ‘200 Patent 38:61–39:14. • “As a starting point (step 0), the structure of the antenna system is simply a rectangular plate 1701 occupying the entire antenna rectangle 1210 and placed at the maximum distance allowed above the ground plane layer 1220 (see FIG. 17 a). In this case the antenna contour is equal to the antenna rectangle 1210, and features complexity factors F21=1.00 and F32=1.12 (represented as point 1801 in FIG. 18), obviously outside the target region 1800.” ‘103 Patent 37:62–38:2; ‘200 Patent 39:29–37. • “From Table 2 it can be seen that the complexity factor F21 has been augmented to 1.51 in recognition of the improvement in the multiple frequency band and/or multiple radiation mode behavior of the structure shown in FIG. 17D. The convoluted shape of slot 1704 contributes also to an increase of complexity factor F32, reaching the value of 1.48. After step 3, the antenna contour corresponds to point 1804 on the (F21, F32) plane of FIG. 18. It can be noticed that while F21 is already above the minimum value	

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	of 1.50, F32 has not reached the minimum value of 1.56 yet. In order to increase the value of F32 (step 4), three small slots 1705, 1706, 1707, are created in the structure of the antenna system, in particular in the antenna element 1711 (see FIG. 17E). Slots 1706 and 1707 are connected to slot 1702, introduced in the structure to separate the larger antenna element 1711 from the 15 smaller antenna element 1712. The slots 1705, 1706, 1707 are effective in providing a more winding path for the electrical currents flowing on the arms of antenna element 1711, hence increasing the degree of miniaturization of the resulting antenna system. At this stage the antenna contour features complexity factors $F21=1.55$ and $F32=1.57$ and maps into point 1805 on the (F21, F32) plane of FIG. 18, clearly within the target region 1800.” ‘103 Patent 38:44–67; ‘200 Patent 40:11–35. • “As can be seen from the various examples and explanations above the use of the complexity factor F21 and F32 in accordance with the principles of the present invention are very useful in the design of MFWD devices and, in particular, multiband antennas for such devices. The choice of certain complexity factor ranges to optimize both the miniaturization of the antenna as well as the multiband and RF performance characteristics, all in accordance with the principles of the invention, should be clear to one of ordinary skill in the art from the above	

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	explanations.” ‘103 Patent 41:3–13; ‘200 Patent 42:40–49. <i>‘103 Patent File History</i> • “The non-anticipated and non-obvious level of complexity defined by complexity factor F21 is geared towards an assessment of the number of paths that the antenna system provides to electric currents and/or the equivalent magnetic currents to excite radiation modes. The formula and method for computing complexity factor F21 are relevant in the design of antenna systems according to a set of specifications such as, for instance, space available within the multifunction wireless device for the integration of an antenna system and of the ground-plane of the device, information of the functionality envisioned for a given multifunction device (smartphone and multimedia functionalities for instance), and, among others, the requirements on RF performance of the antenna system and the communication standards that are to be operated by the multifunction wireless device. The latter defines which frequency bands are to be operated and, thus, the wide-band or multi-band behavior of the antenna system. Therefore complexity factor F21 becomes advantageous in the design of the antenna system for shaping the antenna elements through slots, gaps or apertures being created within the plates, peripheral parts being removed from the plate, parts	

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	of said plate being folded or bended and/or additional conducting parts being added that defines the geometrical characteristics, namely the internal and external perimeters, of the resulting antenna system. For the reasons set forth, Applicant respectfully submits that the values set for complexity factors F21 and F32 are non- obvious." FRAC-ADT-00000678-79.	
"coupled through a close proximity region" '604 Patent claims 1, 13	Fractus: Not indefinite. No construction necessary. <u>Intrinsic Evidence:</u> <i>'604 Specification:</i> "The antennas according to the present invention include at least two radiating structures or arms, said two arms being coupled through a specific region of one or both of the arms called the proximity region or close proximity region." 1:14-21. "There exists on the prior-art some examples of antennas formed with more than one radiating structure, said structures being electromagnetically coupled to form a single radiating device. One of the first examples would be the Yagi-Uda antenna (see FIG. 1, Drawing 3). Said antenna consists of an active dipole structure, said active dipole structure being fed through a conventional feeding network typically connected at its mid-point, said dipole being coupled to a series of parasitic dipoles of different lengths, said parasitic dipoles being parallel to the active dipole. The skilled in the	Defendants: Indefinite. <u>Intrinsic evidence:</u> '604 Patent, including, Abstract, Figs. 1-17; 1:14-2:53; 2:57-5:12; 5:15-6:34; 6:39-8:3; 8:21-60; 9:8-10:31; 10:44-64; 11:5-14:40; and all related disclosures. File History of the '604 Patent. <u>Extrinsic Evidence:</u> Fractus' infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	art will notice that the present invention is essentially different from the Yagi-Uda antenna for several reasons: first of all, because in the Yagi-Uda antenna the distance between any pair of dipoles is generally constant, that is all dipoles are parallel and no proximity region is included to strengthen the coupling between dipoles. The object of such a coupled parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, while in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size yet providing a broadband or multiband behavior.” 1:22–42. • “Another prior-art examples of antennas including two radiating structures coupled together are stacked microstrip patch antennas (“Miniature Wideband Stacked Microstrip Patch Antenna Based on the Sierpinski Fractal Geometry”, by Anguera, Puente, Borja, and Romeu. IEEE Antennas and Propagation Society International Symposium, Salt Lake City, USA, July 2000). In such an arrangement, an active microstrip patch of arbitrary shape placed over a ground-plane is coupled to a passive parasitic patch placed on top of said active patch. It will be noticed that said active and parasitic patches keep a constant distance between them and are not specifically coupled through a specific proximity region on any of the two patches which were closer	

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	the adjacent patch. Such a stacked microstrip patch antenna configuration provides a broadband behavior, but it does not feature a close proximity region as described in the present invention and it does not feature a highly reduced size, since the patches are typically sized to match a half-wavelength inside the dielectric substrate of the patch, while in the present invention the antennas feature a characteristic small size below a quarter wavelength. A prior art example of monopole and PIFA antennas which are coupled together to feature a broadband behavior are described in "Realization of Dual-Frequency and Wide-Band VSWR Performances Using Normal-Mode Helical and Inverted-F Antennas", by Nakano, Ikeda, Suzuki, Mimaki, and Yamauchi, IEEE Transactions on Antennas and Propagation, Vol. 46, No 6, June 1998. Again, those examples are clearly different from the antennas described in the present invention because in all of said prior-art arrangements the active elements and the parasitic ones are parallel to each other and do not get the benefit of the close proximity region as disclosed in the present invention, which enhances the broadband behavior while contributing to the antenna miniaturization. There are some examples of structures in the prior art that include several radiating structures that are not parallel to each other. An example is the V-dipole (see for instance "Antenna Theory,	

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	Analysis and Design”, by Constantine Balanis, second edition) wherein there is a minimum distance between the two arms at the vertex of the V-shape, but it should be noticed that such a vertex is the feeding point of the structure and does not form a coupling proximity region between said arms as disclosed in the present invention. In the present invention, the feeding point is specifically excluded from the close proximity region since it does not contribute to a size reduction and/or multiband or broadband behavior as it is intended here. To form a dipole according to the present invention, at least one arm of the dipole needs to be folded such that said folded arm approaches the other arm to form the close proximity region.” 1:42–2:26. • “Other prior-art examples of antennas with multiple radiating arms are multibranch structures (see for instance “Multiband Properties of a Fractal Tree Antenna Generated by Electrochemical Deposition”, by Puente, Claret, Sagues, Romeu, L{acute over (p)}ez-Salvans, and Pous. IEEE Electronics Letters, vol. 32, No. 5, pp. 2298-2299, December 1996). Again those examples are essentially different to the present invention in which all radiating arms are interconnected through direct ohmic contact to a common conducting structure, while in the present invention at least two of the radiating arms of the antenna must	

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	be disconnected and coupled only through said close proximity region. The skilled in the art will notice that the present invention can be combined with many prior-art antenna configurations to provide new antenna arrangements with enhanced features. In particular, it should be clear that the shape of any of the radiating arms can take many forms provided that at least two arms are included, and said arms include said close proximity region between them. In particular, in several embodiments one or several of the arms according to the present invention take the form of a Multilevel Antenna as described in the Patent Publication No. WO01/22528, a Space-Filling Antenna as described in the Patent Publication No. WO01/54225 or any other complex shape such as meander and zigzag curves. Also, in some embodiments, at least one of the arms approaches an ideal fractal curve by truncating the fractal to a finite number of iterations.” 2:27–54. • “The present invention consists of an antenna comprising at least two radiating structures, said radiating structures taking the form of two arms, said arms being made of or limited by a conductor, superconductor or semiconductor material, said two arms being coupled to each other through a region on first and second arms such that the combined structure of the coupled two-arms forms a small antenna with a broadband behavior, a multiband behavior or a	

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	combination of both effects. According to the present invention, the coupling between the two radiating arms is obtained by means of the shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna. Drawings 4 and 5 from FIG. 2 describe examples of antenna devices as described in the present invention. In the particular example of Drawing 4, arms (110) and (111) are L-shaped and coupled through a close proximity region (200). In this case, the antenna is mounted on a ground-plane (112) and it is fed at one of the tips (102) of arm (110), while arm (111) is directly connected to ground (103). Although in a very basic configuration, this example contains the essence of the invention (the two arms or radiating structures coupled through a close proximity region (200), defined by folded parts (108) and (109) from arms (110) and (111)). In the particular example of	

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	Drawing 5, it can be seen that the position of the proximity region (201) can be placed in other locations. Arm (100) is straight, whereas arm (113) has been folded. The antenna system is mounted on a ground-plane (112) and it is fed at one of the tips (102) or arm (100), whereas arm (113) is connected to ground (103). In both drawings 4 and 5 it can be seen that distance W_s is smaller than distance W_d. Other many embodiments and configurations are allowed within the scope and spirit of the present invention, as it is described in the preferred embodiments.” 2:57–3:30. • “One important aspect of the present invention is that no contact point exists between the two radiating arms defining the antenna. Said two arms form two separated radiating elements, which are coupled by the characteristic close proximity region, but no ohmic contact between said two arms is formed. This specifically excludes from the present invention any antenna formed by a single radiating multibranch structure where two or several of the radiating arms on said multibranch structure can be coupled through a proximity region. The difference between the present invention and said multibranch structures is obvious, since in a multibranch structure all radiating arms or branches are connected in direct ohmic contact to a single conducting structure, while the present invention is specifically made of at least two separated	

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	radiating structures with no direct contact among them.” 4:1–16. • “It can be noticed that the scope of the present invention is not limited to structure formed by two radiating arms. Three or more radiating arms can be included within the invention as long as at least two of them define a close proximity region as described above. In some embodiments, multiple arms are coupled together through a single close proximity region. In other embodiments, the some of the several arms are coupled together through several proximity regions.” 4:28–35 • “Depending on the arrangement and application, the arms of the present invention can take the form of any of the prior art antennas, including monopoles, dipoles, planar inverted-F (PIFA) and inverted-F (IFA) structures, microstrip structures, and so on. Therefore, the invention is not limited to the aforementioned antennas. The antenna could be of any other type as long as the antenna includes at least two radiating arms or structures, and that those arms define a close proximity region where the distance between arms reaches a minimum value.” 4:59–67. • “FIG. 2 shows two basic structures for what is covered with this invention. Drawing 4 shows two arms, one of them is fed, and the other one is directly connected to ground. It can be seen that there is a close proximity region between them. Both arms are folded in this example. Drawing 5 shows another	

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	configuration for the two arms, wherein the arm that is fed is straight, whereas the parasitic arm is folded so as to form a close proximity region with said first arm. FIG. 3 shows several basic examples of different configurations for coupled antennas, where the arms that are connected to the feeding point (active arms) are straight, whereas the parasitic arms are folded so as to form a close proximity region with the active arms. FIG. 5 shows that not only the parasitic arms can be folded so as to form a close proximity region, but also the active arms, that is, the arms that are connected to ground plane. Basic configurations are shown in this figure.” 5:29–49. • “FIG. 7 shows that several parasitic arms (that is, arms that are not connected to the feeding port) can be placed within the same structure, as long as there is a close proximity region as defined in the object of the invention. FIG. 8 shows different configurations of arms formed by space-filling curves. As in previous examples, no matter how the arms are built, the close proximity region is well defined.” 5:56–63. • “FIG. 11 shows that any shape of the arm can be used, as long as the coupled antennas are connected through a close proximity region. FIG. 12 shows a series of complex examples of coupled antennas. Drawings 60 and 61 show that arms can also be formed by planar structures. Drawing 62	

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	shows an active arm formed by a multilevel structure. Drawing 63 shows a spiral active arm surrounding the parasitic arm. Drawing 64 shows another example of planar arms folded. Not only linear or planar structures are covered within the scope of the present invention, as seen in Drawing 65, where two 3D arms are positioned so as to form a close proximity region. FIG. 13 shows that not only monopoles can feature a close proximity region, but also slot antennas, such as the ones showed in Drawings 66 and 67.” 6:4–18. • “FIG. 17, Drawing 74 shows a PIFA structure that is also covered within the scope of the present invention, since it features a close proximity region between the two arms (in this case, two planar patches) of the structure. Drawings 75, 76, and 77 show a series of dipole structures (balanced feeding structure) that also feature a close proximity region.” 6:29–34. • “Drawing 1 from FIG. 1 shows in a manner already known in prior-art an antenna system formed by two monopoles, one acting as the active monopole (100) and the other acting as the parasitic monopole (101). The feed point (102), represented with a circle in all the drawings in the present invention, can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane, and the inner conductor of which is coupled to the radiating conductive element (100). Parasitic element (101) is	

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	connected to ground plane through (103). In this configuration, there is no close proximity region, since both (100) and (101) are in parallel. The radiating conductive element (100) is usually shaped in prior art like a straight wire, but several other shapes can be found in other patents or scientific articles. Shape and dimensions of radiating element (100) and parasitic element (101) will contribute in determining the operating frequency of the overall antenna system. Drawing 2 from FIG. 1 shows also in a manner known in prior-art an antenna system formed by a radiating element (100) and several parasitic monopoles (104). In this configuration, there is no close proximity region, since both the radiating element (100) and the parasitic elements (104) are in parallel. Drawing 3 from FIG. 1 shows a prior-art configuration known as Yagi-Uda. With this structure, the distance between any pair of dipoles is generally constant, that is, all the dipoles (105, 106, 107) are parallel and no proximity region is included to strength the coupling between dipoles. The object of such a parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, whereas in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size yet providing a broadband or multiband behavior.	

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	Unlike the prior art structures illustrated in FIG. 1, the newly disclosed coupled antenna system shown in FIG. 2, Drawing 4, is composed by a radiating element (110) connected to a feeding point (represented by (102)) and a parasitic element (111) connected to the ground plane (112) through (103). It is clear in this configuration the close proximity region (200) between folded subpart arms (108) and (109). That is, $W_s < W_d$. Feeding point (102) can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane (112), and the inner conductor of which is coupled to the radiating conductive element (110). Shape and dimensions of radiating element (110) and parasitic element (111) will contribute in determining the operating frequency of the overall antenna system. For the sake of clarity but without loss of generality, a particular case is showed in Drawing 5. It is composed by a radiating element (100) connected to a feeding point (102), and a parasitic element (113) connected to the ground plane (112) through (103). It is clear in this configuration also that the close proximity region (201) between (100) and (113) contributes to the enhanced performance of the antenna system, and that $W_s < W_d$. It is clear to those skilled in the art that these configurations in FIG. 2 could have been any other type with any size, and being coupled in any other	

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	manner as long as the close proximity region is formed, as it will be seen in the following preferred embodiments. For the sake of clarity, the resulting monopole structures are lying on a common flat ground plane, but other conformal configurations upon curved or bent surfaces for both the coupled antennas and the ground planes could have been used as well. The ground-plane (112) being showed in the drawing is just an example, but several other ground plane embodiments known in the art or from previous patents could have been used, such as multilevel or space-filling ground planes, or Electromagnetic Band-Gap (EBG) ground planes, or Photonic Band-Gap (PBG) ground planes, or high-impedance (Hi-Z) ground planes. The ground-plane can be disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by using a conductive ink. In some preferred embodiments, such as the ones being showed in FIG. 3, only the parasitic elements (114, 115, 116, 117, 118, 119) are folded so as to form a close proximity region between radiating elements (100) and parasitic elements (114, 115, 116, 117, 118, 119). Basic configurations (Drawings 6 to 11) are being illustrated in this Figure, where folding of the parasitic elements (114, 115, 116, 117, 118, 119) is formed by 90-degree angles. The described embodiments of this figure are presented by way	

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	of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle.” 6:51–8:3. • “In some preferred embodiments, such as the ones being showed in FIG. 5, both the parasitic elements (121, 122, 123, 125, 127, 129) and the radiating/active elements (120, 124, 126, 128) are folded so as to form a close proximity region between said radiating elements (120, 124, 126, 128) and said parasitic elements (121, 122, 123, 125, 127, 129). Basic configurations (Drawings 18 to 23) are being illustrated in this figure, where folding of the parasitic elements (121, 122, 123, 125, 127, 129) and radiating elements (120, 124, 126, 128) is formed by 90-degree angles. The described embodiments of this figure are presented by way of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle. In some preferred embodiments, loop configurations for the coupled antennas further	

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	help matching the operating frequencies of the antenna system, such as the ones showed in Drawings 27, 28, and 29 in FIG. 6. From these drawings it can be seen that the overall shape of the antenna system forms an open loop, yet still being within the scope of the present invention without departing from the close proximity region principle. To illustrate that several modifications of coupled antenna systems can be done based on the same principle and spirit of the present invention, other preferred embodiment examples are shown in FIG. 7. Drawing 30 shows a structure where two parasitic elements (135, 136) are included, and a close proximity region is being formed between the active element and the parasitic subsystem. Drawings 31 to 35 show other preferred configurations where several parasitic elements with different shapes have been placed in different locations and distribution.” 8:21–60. • “FIG. 12 shows that not only linear structures can be adapted to meet the close proximity region principle defined in the scope of this invention. Drawing 60 shows an example of two planar elements (143, 144). Drawing 62 shows an example of a multilevel structure acting as the radiating element. Drawing 63 shows a spiral active arm surrounding the parasitic arm. Drawing 64 shows another example of planar arms folded. Not only linear or planar structures are covered within the scope of the	

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	present invention, as seen in Drawing 65, where two 3D arms are positioned so as to form a close proximity region. FIG. 13 shows that not only monopoles or dipoles can feature a close proximity region, but also slot antennas, such as the ones showed in Drawings 66 and 67. Both drawings are being composed by a conventional solid surface ground-plane (151) that has been cut-out so as to have some slots on it (152, 156, 158). The feedpoint (155) can be implemented in several ways, such as a coaxial cable, the sheath (153) of which is connected to the external part of (151), and the inner conductor (154) of the coaxial cable is coupled to the inner radiating conductive element, as shown in Drawing 66. In the case of Drawing 67, the inner conductor of the coaxial cable would be connected to (157).” 9:31–53. • “FIG. 17, Drawing 74 shows a PIFA structure that is being composed by an active element formed by ground plane (176), a feeding point (177) coupled somewhere on the patch (178) depending upon the desired input impedance, a grounding or shorting point connection (175), and a radiator element (178). Also, the system is being formed by a parasitic element (179) that is connected to ground plane as well (181). In Drawing 74 it can be clearly seen that the close proximity region is formed by elements (178) and (179). PIFA antennas have become a hot topic	

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	lately due to having a form that can be integrated into the per se known type of handset cabinets. 10:18-28. • “The essential part of the present invention is the shape of the proximity close region, which contributes to reducing the size with respect to prior art configurations, as well as enhancing antenna bandwidth, VSWR, and radiation efficiency.” 10:57-60. <i>'604 Patent File History</i> • “Claims 20-55 stand rejected under 35 U.S.C. § 112, first and second paragraphs. In response, Applicant has amended independent claim 20 to comply with 35 U.S.C. § 112. In addition, Applicant respectfully submits that claims 20-55 are fully supported by the written description thereby complying with the written description requirement. Applicant respectfully submits that support for claims 20-55 may be found throughout the specification and particularly on paragraphs 0009, 0023, 0044, 0047-0048, 0050, 0055, and 0064 of the published application. For example, paragraph 0009 of the published application recites “The present invention consists of an antenna comprising at least two radiating structures, said radiating structures taking the form of two arms, said arms being made of or limited by a conductor, superconductor or semiconductor material, said two arms being coupled to each other through a region on first and second arms such that the combined structure of the coupled	

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	two-arms forms a small antenna with a broadband behavior, a multiband behavior or a combination of both effects. According to the present invention, the coupling between the two radiating arms is obtained by means of the shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna.”” FRAC-VIVINT-00002866–67. • “Paragraph 0047 of the published application recites "Drawing 3 from FIG. 1 shows a prior-art configuration known as Yagi-Uda. With this structure, the distance between any pair of dipoles is generally constant, that is, all the dipoles (105, 106, 107) are parallel and no proximity region is included to strength the coupling between dipoles. The object of such a parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, whereas in the present invention the radiating arms are arranged together with the close proximity	

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	region to reduce the antenna size yet providing a broadband or multiband behavior.”” FRAC-VIVINT-00002867–68. • “Paragraph 0048 of the published application recites "Unlike the prior art structures illustrated in FIG. 1, the newly disclosed coupled antenna system shown in FIG. 2, Drawing 4, is composed by a radiating element (110) connected to a feeding point (represented by (102)) and a parasitic element (111) connected to the ground plane (112) through (103). It is clear in this configuration the close proximity region (200) between folded subpart arms (108) and (109). That is, $W_s < W_d$. Feeding point (102) can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane (112), and the inner conductor of which is coupled to the radiating conductive element (110). Shape and dimensions of radiating element (110) and parasitic element (111) will contribute in determining the operating frequency of the overall antenna system. For the sake of clarity but without loss of generality, a particular case is showed in Drawing 5. It is composed by a radiating element (100) connected to a feeding point (102), and a parasitic element (113) connected to the ground plane (112) through (103). It is clear in this configuration also that the close proximity region (201) between (100) and (113) contributes to the enhanced performance of the antenna system,	

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	and that $W_s < W_d$. It is clear to those skilled in the art that these configurations in FIG. 2 could have been any other type with any size, and being coupled in any other manner as long as the close proximity region is formed, as it will be seen in the following preferred embodiments. For the sake of clarity, the resulting monopole structures are lying on a common flat ground plane, but other conformal configurations upon curved or bent surfaces for both the coupled antennas and the ground planes could have been used as well. The ground-plane (112) being showed in the drawing is just an example, but several other ground plane embodiments known in the art or from previous patents could have been used, such as multilevel or space-filling ground planes, or Electromagnetic Band-Gap (EBG) ground planes, or Photonic Band-Gap (PBG) ground planes, or high impedance (Hi-Z) ground planes. The ground-plane can be disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by using a conductive ink." FRAC-VIVINT-00002868. • "Paragraph 0064 of the published application recites "FIG. 17, Drawing 7 4 shows a PIP A structure that is being composed by an active element formed by ground plane (176), a feeding point (177) coupled somewhere on the patch (178) depending upon the desired input impedance, a grounding or shorting point	

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	connection (175), and a radiator element (178). Also, the system is being formed by a parasitic element (179) that is connected to ground plane as well (181). In Drawing 74 it can be clearly seen that the close proximity region is formed by elements (178) and (179). PIFA antennas have become a hot topic lately due to having a form that can be integrated into the per se known type of handset cabinets. Preferably, for this type of antenna system, the antenna, the ground-plane or both are disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques as used to produce PCBs, or by printing the antenna and the ground-plane onto the substrate using a conductive ink. A low-loss dielectric substrate (such as glass-fibre, a Teflon substrate such as Cuclad® or other commercial materials such as Rogers® 4003 well-known in the art) can be placed between said patches and ground-plane. Other dielectric materials with similar properties may be substituted above without departing from the intent of the present invention. As an alternative way to etching the antenna and the ground-plane out of copper or any other metal, it is also possible to manufacture the antenna system by printing it using conductive ink. The antenna feeding scheme can be taken to be any of the well-known schemes used in prior art patch or PIFA antennas as well, for instance: a coaxial cable with the outer conductor connected to the ground-	

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	plane and the inner conductor connected to the patch at the desired input resistance point; a microstrip transmission line sharing the same ground-plane as the antenna with the strip capacitively coupled to the patch and located at a distance below the patch, or in another embodiment with the strip placed below the ground plane and coupled to the patch through a slot, and even a microstrip transmission line with the strip co-planar to the patch. All these mechanisms are well known from prior art and do not constitute an essential part of the present invention. The essential part of the present invention is the shape of the proximity close region, which contributes to reducing the size with respect to prior art configurations, as well as enhancing antenna bandwidth, VSWR, and radiation efficiency." Applicant respectfully submits that by taking into account the above-identified sections of the present application, a person of ordinary skill in the art receives the teaching that key elements to achieve a multiband behavior, a broadband behavior or a combination of both effects are a first radiating arm, a second radiating arm and a close proximity region. Thus, a person of ordinary skill in the art, after reading the present application understands that, to obtain the multiband behavior, the first radiating arm, the second radiating arm and the close proximity region have to be configured. For example, a length and size of several-coupled arms together with	

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	a spacing and size of the proximity region and/or the shape and dimensions of the first and second radiating elements have to be adjusted to obtain the multiband behavior.” FRAC-VIVINT-00002869–72. <u>Extrinsic Evidence:</u> • Declaration of Dr. Long ¶ 38. • “couple . . . v.t. . . . b. to bring (two electric circuits or circuit components) close enough to permit an exchange of electromagnetic energy.” The Random House Dictionary of the English Language, 463 (2nd Ed. 2001)	
“close proximity region” • ’604 Patent, claims 1, 3, 13; • ’138 Patent, claims 9, 15; • ’770 Patent, claims 8, 13, 14	Fractus: Not indefinite. No construction necessary. Same evidence as “coupled through a close proximity region.” Alternatively: “a region between two radiating arms in which at least one portion on each arm is placed to allow electromagnetic fields in one arm being transferred to the other (excluding the feeding port) and the distance between the two arms is not constant throughout the entirety of the arms.” <u>Intrinsic Evidence:</u> <i>’138 Patent Specification</i> • “The antennas according to the present invention include at least two radiating structures or arms, said two arms being coupled through a specific region of one or both of the arms called the proximity region or close proximity region.” 1:22–26.	Defendants: Indefinite. <u>Intrinsic evidence:</u> ’604 Patent, including, Abstract, Figs. 1-17; 1:14-2:53; 2:57-5:12; 5:15-6:34; 6:60-8:3; 8:21-60; 9:30-10:31; 10:57-60; 11:5-14:40; and all related disclosures. ’138 Patent, including, Abstract, Figs. 1-17; 1:30-4:44; 5:1-6:46; 6:50-11:6; 11:18-14:36; and all related disclosures. ’770 Patent, including, Abstract, Figs. 1-17; 1:30-4:46; 5:3-6:49; 6:53-11:9; 11:21-14:29; and all related disclosures. ’138 Patent Prosecution History, Amendment, June 21, 2016 File Histories of the ’604, ’138, and ’770 Patents.

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	• “There exists on the prior-art some examples of antennas formed with more than one radiating structure, said structures being electromagnetically coupled to form a single radiating device. One of the first examples would be the Yagi-Uda antenna (see FIG. 1, Drawing 3). Said antenna consists of an active dipole structure, said active dipole structure being fed through a conventional feeding network typically connected at its mid-point, said dipole being coupled to a series of parasitic dipoles of different lengths, said parasitic dipoles being parallel to the active dipole. The skilled in the art will notice that the present invention is essentially different from the Yagi-Uda antenna for several reasons: first of all, because in the Yagi-Uda antenna the distance between any pair of dipoles is generally constant, that is all dipoles are parallel and no proximity region is included to strengthen the coupling between dipoles. The object of such a coupled parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, while in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size yet providing a broadband or multiband behavior.” 1:30–50. • “Another prior-art examples of antennas including two radiating structures coupled together are stacked microstrip patch antennas (“Miniature Wideband Stacked Microstrip Patch Antenna Based on	<u>Extrinsic Evidence:</u> Fractus' infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	the Sierpinski Fractal Geometry”, by Anguera, Puente, Borja, and Romeu. IEEE Antennas and Propagation Society International Symposium, Salt Lake City, USA, July 2000). In such an arrangement, an active microstrip patch of arbitrary shape placed over a ground-plane is coupled to a passive parasitic patch placed on top of said active patch. It will be noticed that said active and parasitic patches keep a constant distance between them and are not specifically coupled through a specific proximity region on any of the two patches which were closer the adjacent patch. Such a stacked microstrip patch antenna configuration provides a broadband behavior, but it is does not feature a close proximity region as described in the present invention and it does not feature a highly reduced size, since the patches are typically sized to match a half-wavelength inside the dielectric substrate of the patch, while in the present invention the antennas feature a characteristic small size below a quarter wavelength. ○ A prior art example of monopole and PIFA antennas which are coupled together to feature a broadband behavior are described in “Realization of Dual-Frequency and Wide-Band VSWR Performances Using Normal-Mode Helical and Inverted-F Antennas”, by Nakano, Ikeda, Suzuki, Mimaki, and Yamauchi, IEEE Transactions on	

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	Antennas and Propagation, Vol. 46, No 6, June 1998. Again, those examples are clearly different from the antennas described in the present invention because in all of said prior-art arrangements the active elements and the parasitic ones are parallel to each other and do not get the benefit of the close proximity region as disclosed in the present invention, which enhances the broadband behavior while contributing to the antenna miniaturization. ○ There are some examples of structures in the prior art that include several radiating structures that are not parallel to each other. An example is the V-dipole (see for instance “Antenna Theory, Analysis and Design”, by Constantine Balanis, second edition) wherein there is a minimum distance between the two arms at the vertex of the V-shape, but it should be noticed that such a vertex is the feeding point of the structure and does not form a coupling proximity region between said arms as disclosed in the present invention. In the present invention, the feeding point is specifically excluded from the close proximity region since it does not contribute to a size reduction	

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	and/or multiband or broadband behavior as it is intended here. To form a dipole according to the present invention, at least one arm of the dipole needs to be folded such that said folded arm approaches the other arm to form the close proximity region.” 1:51–2:34. • “Other prior-art examples of antennas with multiple radiating arms are multibranch structures (see for instance “Multiband Properties of a Fractal Tree Antenna Generated by Electrochemical Deposition”, by Puente, Claret, Sagues, Romeu, L{acute over (p)}ez-Salvans, and Pous. IEEE Electronics Letters, vol. 32, No. 5, pp. 2298-2299, December 1996). Again those examples are essentially different to the present invention in which all radiating arms are interconnected through direct ohmic contact to a common conducting structure, while in the present invention at least two of the radiating arms of the antenna must be disconnected and coupled only through said close proximity region. The skilled in the art will notice that the present invention can be combined with many prior-art antenna configurations to provide new antenna arrangements with enhanced features. In particular, it should be clear that the shape of any of the radiating arms can take many forms provided that at least two arms are included, and said arms include said close proximity region between them. In particular, in several embodiments one or	

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	several of the arms according to the present invention take the form of a Multilevel Antenna as described in the Patent Publication No. WO01/22528, a Space-Filling Antenna as described in the Patent Publication No. WO01/54225 or any other complex shape such as meander and zigzag curves. Also, in some embodiments, at least one of the arms approaches an ideal fractal curve by truncating the fractal to a finite number of iterations.” 2:35–61. • “According to the present invention, the coupling between the two radiating arms is obtained by means of the shape and spatial arrangement of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna. FIGS. 2A and 2B describe examples of antenna devices as described in the present invention. In the particular example of FIG. 2A, arms (110) and (111) are L-shaped and coupled through a close proximity region (200).	

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	In this case, the antenna is mounted on a ground-plane (112) and it is fed at one of the tips (102) of arm (110), while arm (111) is directly connected to ground (103). Although in a very basic configuration, this example contains the essence of the invention (the two arms or radiating structures coupled through a close proximity region (200), defined by folded parts (108) and (109) from arms (110) and (111). In the particular example of FIG. 2B, it can be seen that the position of the proximity region (201) can be placed in other locations. Arm (100) is straight, whereas arm (113) has been folded. The antenna system is mounted on a ground-plane (112) and it is fed at one of the tips (102) or arm (100), whereas arm (113) is connected to ground (103). In both FIGS. 2A and 2B it can be seen that distance W_s is smaller than distance W_d. Other many embodiments and configurations are allowed within the scope and spirit of the present invention, as it is described in the preferred embodiments.” 3:6–39. • “One important aspect of the present invention is that no contact point exists between the two radiating arms defining the antenna. Said two arms form two separated radiating elements, which are coupled by the characteristic close proximity region, but no ohmic contact between said two arms is formed. This specifically excludes from the present invention any antenna formed by a single radiating multibranch structure	

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	where two or several of the radiating arms on said multibranch structure can be coupled through a proximity region. The difference between the present invention and said multibranch structures is obvious, since in a multibranch structure all radiating arms or branches are connected in direct ohmic contact to a single conducting structure, while the present invention is specifically made of at least two separated radiating structures with no direct contact among them.” 4:10–25. • “It can be noticed that the scope of the present invention is not limited to structure formed by two radiating arms. Three or more radiating arms can be included within the invention as long as at least two of them define a close proximity region as described above. In some embodiments, multiple arms are coupled together through a single close proximity region. In other embodiments, the some of the several arms are coupled together through several proximity regions.” 4:37–46. • “Depending on the arrangement and application, the arms of the present invention can take the form of any of the prior art antennas, including monopoles, dipoles, planar inverted-F (PIFA) and inverted-F (IFA) structures, microstrip structures, and so on. Therefore, the invention is not limited to the aforementioned antennas. The antenna could be of any other type as long as the antenna includes at least two radiating arms or structures, and	

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	that those arms define a close proximity region where the distance between arms reaches a minimum value.” 5:1–10. • “FIGS. 2A and 2B show two basic structures for what is covered with this invention. FIG. 2A shows two arms, one of them is fed, and the other one is directly connected to ground. It can be seen that there is a close proximity region between them. Both arms are folded in this example. FIG. 2B shows another configuration for the two arms, wherein the arm that is fed is straight, whereas the parasitic arm is folded so as to form a close proximity region with said first arm. FIGS. 3A to 3F show several basic examples of different configurations for coupled antennas, where the arms that are connected to the feeding point (active arms) are straight, whereas the parasitic arms are folded so as to form a close proximity region with the active arms.” 5:39–52. • “FIGS. 5A to 5F shows that not only the parasitic arms can be folded so as to form a close proximity region, but also the active arms, that is, the arms that are connected to ground plane. Basic configurations are shown in these figures.” 5:57–60. • “FIGS. 7A to 7F show that several parasitic arms (that is, arms that are not connected to the feeding port) can be placed within the same structure, as long as there is a close proximity region as defined in the object of the invention.	

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	FIGS. 8A to 8F show different configurations of arms formed by space-filling curves. As in previous examples, no matter how the arms are built, the close proximity region is well defined.” 6:1–8. • “FIGS. 11A to 11F show that any shape of the arm can be used, as long as the coupled antennas are connected through a close proximity region. FIGS. 12A to 12F show a series of complex examples of coupled antennas. FIGS. 12A and 12B show that arms can also be formed by planar structures. FIG. 12C shows an active arm formed by a multilevel structure. FIG. 12D shows a spiral active arm surrounding the parasitic arm. FIG. 12E shows another example of planar arms folded. Not only linear or planar structures are covered within the scope of the present invention, as seen in FIG. 12F, where two 3D arms are positioned so as to form a close proximity region. FIGS. 13A and 13B show that not only monopoles can feature a close proximity region, but also slot antennas, such as the ones showed in FIGS. 13A and 13B.” 6:16–30. • “FIG. 17A shows a PIFA structure that is also covered within the scope of the present invention, since it features a close proximity region between the two arms (in this case, two planar patches) of the structure. FIGS. 17B to 17D show a series of dipole structures (balanced feeding structure) that	

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	also feature a close proximity region.” 6:41–46. • “FIG. 1A shows in a manner already known in prior-art an antenna system formed by two monopoles, one acting as the active monopole (100) and the other acting as the parasitic monopole (101). The feed point (102), represented with a circle in all the drawings in the present invention, can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane, and the inner conductor of which is coupled to the radiating conductive element (100). Parasitic element (101) is connected to ground plane through (103). In this configuration, there is no close proximity region, since both (100) and (101) are in parallel. The radiating conductive element (100) is usually shaped in prior art like a straight wire, but several other shapes can be found in other patents or scientific articles. Shape and dimensions of radiating element (100) and parasitic element (101) will contribute in determining the operating frequency of the overall antenna system. FIG. 1B shows also in a manner known in prior-art an antenna system formed by a radiating element (100) and several parasitic monopoles (104). In this configuration, there is no close proximity region, since both the radiating element (100) and the parasitic elements (104) are in parallel.	

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	FIG. 1C shows a prior-art configuration known as Yagi-Uda. With this structure, the distance between any pair of dipoles is generally constant, that is, all the dipoles (105, 106, 107) are parallel and no proximity region is included to strength the coupling between dipoles. The object of such a parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, whereas in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size yet providing a broadband or multiband behavior. Unlike the prior art structures illustrated in FIG. 1A to 1C, the newly disclosed coupled antenna system shown in FIG. 2A is composed by a radiating element (110) connected to a feeding point (represented by (102)) and a parasitic element (111) connected to the ground plane (112) through (103). It is clear in this configuration the close proximity region (200) between folded subpart arms (108) and (109). That is, $W_s < W_d$. Feeding point (102) can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane (112), and the inner conductor of which is coupled to the radiating conductive element (110). Shape and dimensions of radiating element (110) and parasitic element (111) will contribute in determining the operating frequency of the overall antenna system. For the sake of	

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	clarity but without loss of generality, a particular case is showed in FIG. 2B. It is composed by a radiating element (100) connected to a feeding point (102), and a parasitic element (113) connected to the ground plane (112) through (103). It is clear in this configuration also that the close proximity region (201) between (100) and (113) contributes to the enhanced performance of the antenna system, and that $W_s < W_d$. It is clear to those skilled in the art that these configurations in FIGS. 2A and 2B could have been any other type with any size, and being coupled in any other manner as long as the close proximity region is formed, as it will be seen in the following preferred embodiments. For the sake of clarity, the resulting monopole structures are lying on a common flat ground plane, but other conformal configurations upon curved or bent surfaces for both the coupled antennas and the ground planes could have been used as well. The ground-plane (112) being showed in the drawing is just an example, but several other ground plane embodiments known in the art or from previous patents could have been used, such as multilevel or space-filling ground planes, or Electromagnetic Band-Gap (EBG) ground planes, or Photonic Band-Gap (PBG) ground planes, or high-impedance (Hi-Z) ground planes. The ground-plane can be disposed on a dielectric substrate. This may be achieved, for instance, by etching techniques	

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	as used to produce PCBs, or by using a conductive ink. In some preferred embodiments, such as the ones being showed in FIGS. 3A to 3F, only the parasitic elements (114, 115, 116, 117, 118, 119) are folded so as to form a close proximity region between radiating elements (100) and parasitic elements (114, 115, 116, 117, 118, 119). Basic configurations (FIGS. 3A to 3F) are being illustrated in these figures, where folding of the parasitic elements (114, 115, 116, 117, 118, 119) is formed by 90-degree angles. The described embodiments of these figures are presented by way of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle.” 6:62–8:17. • “In some preferred embodiments, such as the ones being showed in FIGS. 5A to 5F, both the parasitic elements (121, 122, 123, 125, 127, 129) and the radiating/active elements (120, 124, 126, 128) are folded so as to form a close proximity region between said radiating elements (120, 124, 126, 128) and said parasitic elements (121, 122, 123, 125, 127, 129). Basic configurations (FIGS. 5A to 5F) are being illustrated in these figures, where folding of the parasitic elements (121, 122, 123,	

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	125, 127, 129) and radiating elements (120, 124, 126, 128) is formed by 90-degree angles. The described embodiments of these figures are presented by way of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle.” 8:35–51. • “In some preferred embodiments, loop configurations for the coupled antennas further help matching the operating frequencies of the antenna system, such as the ones showed in FIGS. 6D, 6E and 6F. From these drawings it can be seen that the overall shape of the antenna system forms an open loop, yet still being within the scope of the present invention without departing from the close proximity region principle. To illustrate that several modifications of coupled antenna systems can be done based on the same principle and spirit of the present invention, other preferred embodiment examples are shown in FIGS. 7A to 7F. FIG. 7A shows a structure where two parasitic elements (135, 136) are included, and a close proximity region is being formed between the active element and the parasitic subsystem. FIGS. 7B to 7F show other preferred configurations where several parasitic elements	

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	with different shapes have been placed in different locations and distribution.” 8:58–9:8. • “FIGS. 12A to 12F show that not only linear structures can be adapted to meet the close proximity region principle defined in the scope of this invention. FIG. 12A shows an example of two planar elements (143, 144). FIG. 12C shows an example of a multilevel structure acting as the radiating element. FIG. 12D shows a spiral active arm surrounding the parasitic arm. FIG. 12E shows another example of planar arms folded. Not only linear or planar structures are covered within the scope of the present invention, as seen in FIG. 12F, where two 3D arms are positioned so as to form a close proximity region. FIGS. 13A and 13B show that not only monopoles or dipoles can feature a close proximity region, but also slot antennas, such as the ones showed in FIGS. 13A and 13B. Both drawings are being composed by a conventional solid surface ground-plane (151) that has been cut-out so as to have some slots on it (152, 156, 158). The feed point (155) can be implemented in several ways, such as a coaxial cable, the sheath (153) of which is connected to the external part of (151), and the inner conductor (154) of the coaxial cable is coupled to the inner radiating conductive element, as shown in FIG. 13A. In the case of FIG. 13B, the inner conductor of the coaxial cable would be connected to (157).” 9:45–67.	

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	“FIG. 17A shows a PIFA structure that is being composed by an active element formed by ground plane (176), a feeding point (177) coupled somewhere on the patch (178) depending upon the desired input impedance, a grounding or shorting point connection (175), and a radiator element (178). Also, the system is being formed by a parasitic element (179) that is connected to ground plane as well (181). In FIG. 17A it can be clearly seen that the close proximity region is formed by elements (178) and (179).” 10:31–39. <i>'770 Patent Specification</i> “The antennas according to the present invention include at least two radiating structures or arms, said two arms being coupled through a specific region of one or both of the arms called the proximity region or close proximity region.” 1:24–28. “There exists on the prior-art some examples of antennas formed with more than one radiating structure, said structures being electromagnetically coupled to form a single radiating device. One of the first examples would be the Yagi-Uda antenna (see FIG. 1, Drawing 3). Said antenna consists of an active dipole structure, said active dipole structure being fed through a conventional feeding network typically connected at its mid-point, said dipole being coupled to a series of parasitic dipoles of different lengths, said parasitic dipoles being parallel to the active dipole. The skilled in the art will notice that the	

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	present invention is essentially different from the Yagi-Uda antenna for several reasons: first of all, because in the Yagi-Uda antenna the distance between any pair of dipoles is generally constant, that is all dipoles are parallel and no proximity region is included to strengthen the coupling between dipoles. The object of such a coupled parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, while in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size yet providing a broadband or multiband behavior.” 1:31–52. • “Another prior-art examples of antennas including two radiating structures coupled together are stacked microstrip patch antennas (“Miniature Wideband Stacked Microstrip Patch Antenna Based on the Sierpinski Fractal Geometry”, by Anguera, Puente, Borja, and Romeu. IEEE Antennas and Propagation Society International Symposium, Salt Lake City, USA, July 2000). In such an arrangement, an active microstrip patch of arbitrary shape placed over a ground-plane is coupled to a passive parasitic patch placed on top of said active patch. It will be noticed that said active and parasitic patches keep a constant distance between them and are not specifically coupled through a specific proximity region on any of the two patches which were closer the adjacent patch. Such a stacked	

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	microstrip patch antenna configuration provides a broadband behavior, but it does not feature a close proximity region as described in the present invention and it does not feature a highly reduced size, since the patches are typically sized to match a half-wavelength inside the dielectric substrate of the patch, while in the present invention the antennas feature a characteristic small size below a quarter wavelength. ○ A prior art example of monopole and PIFA antennas which are coupled together to feature a broadband behavior are described in “Realization of Dual-Frequency and Wide-Band VSWR Performances Using Normal-Mode Helical and Inverted-F Antennas”, by Nakano, Ikeda, Suzuki, Mimaki, and Yamauchi, IEEE Transactions on Antennas and Propagation, Vol. 46, No 6, June 1998. Again, those examples are clearly different from the antennas described in the present invention because in all of said prior-art arrangements the active elements and the parasitic ones are parallel to each other and do not get the benefit of the close proximity region as disclosed in the present invention, which enhances the broadband behavior while contributing to the antenna miniaturization.	

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	○ There are some examples of structures in the prior art that include several radiating structures that are not parallel to each other. An example is the V-dipole (see for instance “Antenna Theory, Analysis and Design”, by Constantine Balanis, second edition) wherein there is a minimum distance between the two arms at the vertex of the V-shape, but it should be noticed that such a vertex is the feeding point of the structure and does not form a coupling proximity region between said arms as disclosed in the present invention. In the present invention, the feeding point is specifically excluded from the close proximity region since it does not contribute to a size reduction and/or multiband or broadband behavior as it is intended here. To form a dipole according to the present invention, at least one arm of the dipole needs to be folded such that said folded arm approaches the other arm to form the close proximity region.” 1:53–2:35. • “Other prior-art examples of antennas with multiple radiating arms are multibranch structures (see for instance “Multiband Properties of a Fractal Tree Antenna Generated by Electrochemical Deposition”, by Puente, Claret, Sagues, Romeu,	

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	L{acute over (p)}ez-Salvans, and Pous. IEEE Electronics Letters, vol. 32, No. 5, pp. 2298-2299, December 1996). Again those examples are essentially different to the present invention in which all radiating arms are interconnected through direct ohmic contact to a common conducting structure, while in the present invention at least two of the radiating arms of the antenna must be disconnected and coupled only through said close proximity region. The skilled in the art will notice that the present invention can be combined with many prior-art antenna configurations to provide new antenna arrangements with enhanced features. In particular, it should be clear that the shape of any of the radiating arms can take many forms provided that at least two arms are included, and said arms include said close proximity region between them. In particular, in several embodiments one or several of the arms according to the present invention take the form of a Multilevel Antenna as described in the Patent Publication No. WO01/22528, a Space-Filling Antenna as described in the Patent Publication No. WO01/54225 or any other complex shape such as meander and zigzag curves. Also, in some embodiments, at least one of the arms approaches an ideal fractal curve by truncating the fractal to a finite number of iterations.” 2:36–62. • “According to the present invention, the coupling between the two radiating arms is obtained by means of the shape and spatial arrangement	

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	of said two arms, in which at least one portion on each arm is placed in close proximity to each other (for instance, at a distance smaller than a tenth of the longest free-space operating wavelength) to allow electromagnetic fields in one arm being transferred to the other through said specific close proximity regions. Said proximity regions are located at a distance from the feeding port of the antenna (for instance a distance larger than 1/40 of the free-space longest operating wavelength) and specifically exclude said feeding port of the antenna. ○ FIGS. 2A and 2B describe examples of antenna devices as described in the present invention. In the particular example of FIG. 2A, arms (110) and (111) are L-shaped and coupled through a close proximity region (200). ○ In this case, the antenna is mounted on a ground-plane (112) and it is fed at one of the tips (102) of arm (110), while arm (111) is directly connected to ground (103). Although in a very basic configuration, this example contains the essence of the invention (the two arms or radiating structures coupled through a close proximity region (200), defined by folded parts (108) and (109) from arms (110) and (111). In the particular example of FIG. 2B, it can be seen that the position of the proximity	

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	region (201) can be placed in other locations. Arm (100) is straight, whereas arm (113) has been folded. The antenna system is mounted on a ground-plane (112) and it is fed at one of the tips (102) or arm (100), whereas arm (113) is connected to ground (103). In both FIGS. 2A and 2B it can be seen that distance W_s is smaller than distance W_d. Other many embodiments and configurations are allowed within the scope and spirit of the present invention, as it is described in the preferred embodiments.” 3:7–40. • “One important aspect of the present invention is that no contact point exists between the two radiating arms defining the antenna. Said two arms form two separated radiating elements, which are coupled by the characteristic close proximity region, but no ohmic contact between said two arms is formed. This specifically excludes from the present invention any antenna formed by a single radiating multibranch structure where two or several of the radiating arms on said multibranch structure can be coupled through a proximity region. The difference between the present invention and said multibranch structures is obvious, since in a multibranch structure all radiating arms or branches are connected in direct ohmic contact to a single conducting structure, while the present invention is specifically made of at least two separated	

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	radiating structures with no direct contact among them.” 4:12–27. • “It can be noticed that the scope of the present invention is not limited to structure formed by two radiating arms. Three or more radiating arms can be included within the invention as long as at least two of them define a close proximity region as described above. In some embodiments, multiple arms are coupled together through a single close proximity region. In other embodiments, the some of the several arms are coupled together through several proximity regions.” 4:39–46. • “Depending on the arrangement and application, the arms of the present invention can take the form of any of the prior art antennas, including monopoles, dipoles, planar inverted-F (PIFA) and inverted-F (IFA) structures, microstrip structures, and so on. Therefore, the invention is not limited to the aforementioned antennas. The antenna could be of any other type as long as the antenna includes at least two radiating arms or structures, and that those arms define a close proximity region where the distance between arms reaches a minimum value.” 5:3–12. • “FIGS. 2A and 2B show two basic structures for what is covered with this invention. FIG. 2A shows two arms, one of them is fed, and the other one is directly connected to ground. It can be seen that there is a close proximity region between them. Both arms are folded in this example. FIG. 2B shows another configuration for the two arms,	

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	wherein the arm that is fed is straight, whereas the parasitic arm is folded so as to form a close proximity region with said first arm. FIGS. 3A to 3F show several basic examples of different configurations for coupled antennas, where the arms that are connected to the feeding point (active arms) are straight, whereas the parasitic arms are folded so as to form a close proximity region with the active arms.” 5:42–55. • “FIGS. 5A to 5F shows that not only the parasitic arms can be folded so as to form a close proximity region, but also the active arms, that is, the arms that are connected to ground plane. Basic configurations are shown in these figures.” 5:60–63. • “FIGS. 7A to 7F show that several parasitic arms (that is, arms that are not connected to the feeding port) can be placed within the same structure, as long as there is a close proximity region as defined in the object of the invention. FIGS. 8A to 8F show different configurations of arms formed by space-filling curves. As in previous examples, no matter how the arms are built, the close proximity region is well defined.” 6:4–11. • “FIGS. 11A to 11F show that any shape of the arm can be used, as long as the coupled antennas are connected through a close proximity region. FIGS. 12A to 12F show a series of complex examples of coupled antennas. FIGS. 12A and 12B show that arms can also be formed by	

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	planar structures. FIG. 12C shows an active arm formed by a multilevel structure. FIG. 12D shows a spiral active arm surrounding the parasitic arm. FIG. 12E shows another example of planar arms folded. Not only linear or planar structures are covered within the scope of the present invention, as seen in FIG. 12F, where two 3D arms are positioned so as to form a close proximity region. FIGS. 13A and 13B show that not only monopoles can feature a close proximity region, but also slot antennas, such as the ones showed in FIGS. 13A and 13B.” 6:19–33. • “FIG. 17A shows a PIFA structure that is also covered within the scope of the present invention, since it features a close proximity region between the two arms (in this case, two planar patches) of the structure. FIGS. 17B to 17D show a series of dipole structures (balanced feeding structure) that also feature a close proximity region.” 6:44–49. • “FIG. 1A shows in a manner already known in prior-art an antenna system formed by two monopoles, one acting as the active monopole (100) and the other acting as the parasitic monopole (101). The feed point (102), represented with a circle in all the drawings in the present invention, can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane, and the inner conductor of which is coupled to	

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	the radiating conductive element (100). Parasitic element (101) is connected to ground plane through (103). In this configuration, there is no close proximity region, since both (100) and (101) are in parallel. The radiating conductive element (100) is usually shaped in prior art like a straight wire, but several other shapes can be found in other patents or scientific articles. Shape and dimensions of radiating element (100) and parasitic element (101) will contribute in determining the operating frequency of the overall antenna system. FIG. 1B shows also in a manner known in prior-art an antenna system formed by a radiating element (100) and several parasitic monopoles (104). In this configuration, there is no close proximity region, since both the radiating element (100) and the parasitic elements (104) are in parallel. FIG. 1C shows a prior-art configuration known as Yagi-Uda. With this structure, the distance between any pair of dipoles is generally constant, that is, all the dipoles (105, 106, 107) are parallel and no proximity region is included to strength the coupling between dipoles. The object of such a parallel dipole arrangement in the Yagi-Uda antenna is to provide an end-fire, directive radiation pattern, whereas in the present invention the radiating arms are arranged together with the close proximity region to reduce the antenna size	

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	yet providing a broadband or multiband behavior. Unlike the prior art structures illustrated in FIG. 1A to 1C, the newly disclosed coupled antenna system shown in FIG. 2A is composed by a radiating element (110) connected to a feeding point (represented by (102)) and a parasitic element (111) connected to the ground plane (112) through (103). It is clear in this configuration the close proximity region (200) between folded subpart arms (108) and (109). That is, $W_s < W_d$. Feeding point (102) can be implemented in several ways, such a coaxial cable, the sheath of which is coupled to the ground plane (112), and the inner conductor of which is coupled to the radiating conductive element (110). Shape and dimensions of radiating element (110) and parasitic element (111) will contribute in determining the operating frequency of the overall antenna system. For the sake of clarity but without loss of generality, a particular case is showed in FIG. 2B. It is composed by a radiating element (100) connected to a feeding point (102), and a parasitic element (113) connected to the ground plane (112) through (103). It is clear in this configuration also that the close proximity region (201) between (100) and (113) contributes to the enhanced performance of the antenna system, and that $W_s < W_d$. It is clear to those skilled in the art that these configurations in FIGS. 2A and 2B	

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	could have been any other type with any size, and being coupled in any other manner as long as the close proximity region is formed, as it will be seen in the following preferred embodiments.” 6:65–7:57. • “In some preferred embodiments, such as the ones being showed in FIGS. 3A to 3F, only the parasitic elements (114, 115, 116, 117, 118, 119) are folded so as to form a close proximity region between radiating elements (100) and parasitic elements (114, 115, 116, 117, 118, 119). Basic configurations (FIGS. 3A to 3F) are being illustrated in these figures, where folding of the parasitic elements (114, 115, 116, 117, 118, 119) is formed by 90-degree angles. The described embodiments of these figures are presented by way of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle.” 8:5–20. • “In some preferred embodiments, such as the ones being showed in FIGS. 5A to 5F, both the parasitic elements (121, 122, 123, 125, 127, 129) and the radiating/active elements (120, 124, 126, 128) are folded so as to form a close proximity region between said radiating elements (120, 124, 126, 128) and said parasitic elements	

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	(121, 122, 123, 125, 127, 129). Basic configurations (FIGS. 5A to 5F) are being illustrated in these figures, where folding of the parasitic elements (121, 122, 123, 125, 127, 129) and radiating elements (120, 124, 126, 128) is formed by 90-degree angles. The described embodiments of these figures are presented by way of example only and do not limit the invention. Having illustrated and described the principles of the invention in several preferred embodiments thereof, it should be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from the close proximity region principle.” 8:38–54. • “In some preferred embodiments, loop configurations for the coupled antennas further help matching the operating frequencies of the antenna system, such as the ones showed in FIGS. 6D, 6E and 6F. From these drawings it can be seen that the overall shape of the antenna system forms an open loop, yet still being within the scope of the present invention without departing from the close proximity region principle. To illustrate that several modifications of coupled antenna systems can be done based on the same principle and spirit of the present invention, other preferred embodiment examples are shown in FIGS. 7A to 7F. FIG. 7A shows a structure where two parasitic elements (135, 136) are included, and a close proximity region is	

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	being formed between the active element and the parasitic subsystem. FIGS. 7B to 7F show other preferred configurations where several parasitic elements with different shapes have been placed in different locations and distribution.” 8:61–9:10. • “FIGS. 12A to 12F show that not only linear structures can be adapted to meet the close proximity region principle defined in the scope of this invention. FIG. 12A shows an example of two planar elements (143, 144). FIG. 12C shows an example of a multilevel structure acting as the radiating element. FIG. 12D shows a spiral active arm surrounding the parasitic arm. FIG. 12E shows another example of planar arms folded. Not only linear or planar structures are covered within the scope of the present invention, as seen in FIG. 12F, where two 3D arms are positioned so as to form a close proximity region. FIGS. 13A and 13B show that not only monopoles or dipoles can feature a close proximity region, but also slot antennas, such as the ones showed in FIGS. 13A and 13B. Both drawings are being composed by a conventional solid surface ground-plane (151) that has been cut-out so as to have some slots on it (152, 156, 158). The feed point (155) can be implemented in several ways, such as a coaxial cable, the sheath (153) of which is connected to the external part of (151), and the inner conductor (154) of the coaxial cable is coupled to the inner radiating	

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	conductive element, as shown in FIG. 13A. In the case of FIG. 13B, the inner conductor of the coaxial cable would be connected to (157).” 9:48–10:3. • “FIG. 17A shows a PIFA structure that is being composed by an active element formed by ground plane (176), a feeding point (177) coupled somewhere on the patch (178) depending upon the desired input impedance, a grounding or shorting point connection (175), and a radiator element (178). Also, the system is being formed by a parasitic element (179) that is connected to ground plane as well (181). In FIG. 17A it can be clearly seen that the close proximity region is formed by elements (178) and (179).” 10:34–42. <u>Extrinsic Evidence:</u> • Declaration of Dr. Long ¶ 38.	
“perimeter” • ‘092 Patent claims 1, 11, 12, 26; • ‘103 Patent claim 12; • ‘200 Patent claims 1, 3, 6, 9, 11	Fractus: No construction necessary. <u>Intrinsic Evidence:</u> <i>Specification (‘092 patent):</i> • “For the mentioned multifrequency behaviour, said hole in a monopole or dipole antenna features an area of at least a 20% of the area included inside the external perimeter of the radiating element of said antenna.” 2:9-12. • Figures 1, 3, 9-10 and supporting text. <i>Specification (‘103 and ‘200 patents):</i> • Figures 3, 9A-9C, 10A-10C, 12A, 17 and supporting text. • “Resulting antenna system can operate in multiple frequency	Defendants: “the continuous line forming the boundary of a closed geometric figure.” <u>Intrinsic Evidence:</u> ’092 Patent, including, Abstract; Figs. 1-10; 1:64-2:27; 2:31-3:32; 3:63-4:13; 4:63-8:14; and all related disclosures. ’200 Patent, including, Abstract; Figs. 1-20; 5:30-67; 15:19-25; 18:27-65; 27:24-31; 27:57-28: 3; 28:8-28; 31:20-39; 32:1-47; 33:65-34:7; 40:1-11; 42:56-45:3; and all related disclosures. ’103 Patent, including, Abstract, Figs. 1-20; 14:42-59; 17:54-18:24; 26:57-27:29; 30:6-38; 31:66-32:67; 38:34-43; 41: 20-44:46; and related disclosures.

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	bands. In particular, two apertures 302 and 303 with closed perimeters have been created in the antenna element 300. Additionally, the antenna element 300 also features an opening 304 that increases the number of segments that form the perimeter of the antenna element 300.” ‘103 26:62-27:1; ‘200 27:62-67. • “The antenna contour of the antenna system is a set of joint and/or disjoint segments comprising: the perimeter of one or more antenna elements placed in the antenna rectangle, the perimeter of closed slots and/or closed apertures defined within the antenna elements, and/or the orthogonal projection onto the antenna rectangle of perimeters of antenna elements, or perimeters of or parts of antenna elements that are placed in the antenna box but not in the antenna rectangle. the perimeter of closed slots and/or closed apertures defined within the antenna elements, and/or the orthogonal projection onto the antenna rectangle of perimeters of antenna elements, or perimeters of or parts of antenna elements that are placed in the antenna box but not in the antenna rectangle. The antenna contour, i.e., its peripheral both internally and externally, can comprise straight segments, curved segments or a combination thereof. Not all the segments that form the antenna contour need to be connected	File Histories of the ‘200, ‘103, and ‘092 Patents. <u>Extrinsic Evidence:</u> Fractus’ infringement contentions. POCKET OXFORD ENGLISH DICTIONARY, p. 667 (10th Ed. 2005) (defining “[p]erimeter” as “1 the outermost parts or boundary of an area or object. 2 the continuous line forming the boundary of a closed figure.”). McGraw Scientific & Technical Dictionary Definition: “the total length of a closed curve; for example, the perimeter of a polygon is the total length of its sides.” Webster’s Third New International Dictionary: “the boundary of a closed plane figure; the sum of the lengths of the line segments forming a polygon” Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	(i.e., to be joined). In some cases, the antenna contour comprises two, three, four or more disjointed Subsets of segments. A subset of segments is defined by one single segment or by a plurality of connected segments. In other cases, the entire set of segments that form the antenna contour are connected together defining a single set of joined segments (i.e., the antenna contour has only one subset of segments).” ‘103 14:49-15:3; ‘200 15:16-37. “The antenna contour 350 comprises three disjointed sub sets of segments: (a) a first subset is formed by the segments of the perimeter 357 (which includes both external segments of the antenna element 300 and those segments added to said antenna element by the opening 304) and the group of segments 356 corresponding to the orthogonal projection of part 306 of the antenna element 300; (b) a second subset is formed by the segments 352 associated to the perimeter of aperture 302; and (c) a third subset is formed by the segments 353 associated to the perimeter of aperture 303. Note that in this example, part 305 of the antenna element 300 has an orthogonal projection that completely matches a segment of the perimeter 357, and therefore does not increase the number of segments of the antenna contour 350.” ‘103 27:9-22; ‘200 28:8-21.	

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	“In the next iteration (step 3) a second slot is introduced in the structure of the antenna system (FIG. 17D). Slot 1704 is practiced in antenna element 1711 with the main purpose of creating different paths for the currents flowing on said antenna element, so that it can support several radiation modes. The slot 1704 intersects the perimeter of the antenna element 1711 and has two closed ends: a first end 1730 near the left side of the antenna rectangle, and a second end 1731. As a result, the antenna element 1711 comprises a first arm 1732, a second arm 1733, and a third arm 1734.” ‘103 38:34-43; ‘200 40:1-10. <i>’103 File History</i> • “Therefore, complexity factor F21 becomes advantageous in the design of the antenna system for shaping the antenna elements through slots, gaps or apertures being created within the plates, peripheral parts being removed from the plate, parts of the plate being folded or bent and/or additional conducting parts being added that defines the geometrical characteristics, namely, the internal and external perimeters, of the resulting antenna system.” FRAC-ADT-00000640-641. <u>Extrinsic Evidence:</u> • Declaration of S. ¶ 39. • POCKET OXFORD ENGLISH DICTIONARY, p. 667 (10th	

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	Ed. 2005) (defining "[p]erimeter" as "1 the outermost parts or boundary of an area or object.)	
"wireless device" • '092 Patent all asserted claims; • '103 Patent all asserted claims; • '200 Patent all asserted claims	Fractus: No construction necessary. <u>Intrinsic Evidence</u> <i>Specifications ('103 & '200 patents):</i> • "Additionally, every platform of a wireless device is different in terms of form factor, market and technical requirements and functionality which requires different antennas for each device." '103 4:47-50; '200 5:1-4. • "The present invention is related to a portable multifunction wireless device (MFWD) and in particular to a handheld multifunction wireless device. In some embodiments, the MFWD will take the form of a handheld multimedia terminal (MMT) including wireless connectivity to mobile networks. In some embodiments, the MFWD will take the form of a handheld device combining personal computer capabilities, mobile data and Voice services into a single unit (Smartphone, SMRT), while in others the MFWD will combine both multimedia and smartphone capabilities (MMT+SMRT). It is an object of the present invention to provide wireless connectivity to an MFWD that takes the form of a handheld multimedia terminal (MMT)." 103 5:45-57; '200 6:1-14.	Defendants: A device with the ability to transmit and receive voice, data, or video signals through the radio spectrum that does not require a physical wire to operate adapted to permit running of word-processing, spreadsheet, and slide software applications. Alternatively, the plain and ordinary meaning, which is a device that does not require a physical wire to operate while being carried or moved. <u>Intrinsic Evidence:</u> '092 Patent, including, Abstract; Figs. 1-10; 4:63-8:14; and all related disclosures. '200 Patent, including, Abstract; Figs. 1-20; 1:29-5:27; 5:1-26; 5:30-6:56; 8:21-24; 8:39-63; 9:5-51; 10:24-53; 42:56-45:3; and all related disclosures. '103 Patent, including, Abstract, Figs. 1-20; 1:19-3:29; 5:7-6:29; 7:60-63; 8:13-37; 9:63-10:24; 41:20-44:46; and related disclosures. File Histories of the '200, '103, and '092 Patents. <u>Extrinsic Evidence:</u> Fractus' infringement contentions. Newtons Telecom Dictionary: "without wires. Any system of transmitting and receiving information without wires."

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	• “Additionally, antennas in some embodiments are required to be multi-band antennas and to cover different frequency bands and/or different communication system bands. Beyond that, some of the bands have to be particularly broad like the UMTS band which has a bandwidth of 12.2%. For a good wireless connection, high gain and efficiency are further required. Other more common design demands for antennas are the voltage standing wave ratio (VSWR) and the impedance which is typically about 50 ohms.” ‘103 1:51-59; ‘200 1:51-2:5. • “In every MFWD, the choice of the antenna, its placement in the device and its interaction with the surrounding elements of the device will have an impact on the overall wireless connection performance making its selection non-trivial and subject to constraints due to particular target use, user and market segments for every device.” ‘103 2:46-51; ‘200 2:62-67. • “In some embodiments of the invention, the MFWD 100 includes wireless connectivity to other wireless devices or networks through a wireless system such as for instance WiFi (IEEE802.11 standards), Bluetooth, ZigBee, UWB in some additional frequency regions such as for instance an ISM band (for instance around	Webster's Third New International Dictionary: “wireless – having no wire or wires.” Wiley Electrical and Electronics Engineering Dictionary: “wireless device – a device that communicates in a wireless manner” Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	430 MHz or 868 MHz, or within 902-928 MHz or in the 2400-2480 MHz range, or in the 5.1-5.9 GHz frequency range or a combination of them) and/or within a ultra wide-band range (UWB) such as the 3-5 GHz or 3-11 GHz frequency range. In some embodiments of the invention, the MFWD 100 provides voice over IP services (VoIP) through a wireless connection using one or more wireless standards such as WiFi, WiMax and WiBro, within the 2-11 GHz frequency region or in particular the 2.3-2.4 GHz frequency region. The MFWD 100 may have a bar shape, which means that it is given by a single body. It may also have a two-body structure such as a clamshell, flip or slider structure. It may further or additionally have a twist structure in which a body portion e.g. with a screen can be twisted (rotated with two or more axes of rotation which are preferably not parallel). The MFWD 100 may operate simultaneous in two or more wireless services (e.g. a short range wireless connectivity service and a mobile telephone service, a geolocalization service and a mobile telephone service, etc.). For any wireless service, more than one antenna (system) may be provided in order to obtain a diversity system and/or a multiple input/multiple output system.”	

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	'103 9:63-10:23; '200 10:24-52.. • "A MFWD incorporating 3.5G or 4G features (i.e. comprising 3G and other advanced services such as for instance HSDPA, WiBro, WiFi, WiMAX, UWB or other high-speed wireless standards, hereinafter 4G services) might require operation in additional frequency bands corresponding to said 4G standards (for instance, bands within the frequency region 2-11 GHZ and some of its sub-regions such as for instance 2-11 GHZ, 3-10 GHZ, 2.4-2.5 GHZ and 5-6 GHz or some other bands)." '103 24:22-30; '200 25:14-22. <u>Extrinsic Evidence:</u> • Declaration of S. Long ¶ 40. • The Random House Dictionary of the English Language, xiv (2nd Ed. 2001): "wireless, + n. any system or device, as a cellular phone, for transmitting messages or signals by electromagnetic waves."	
"handheld multifunction wireless device" • '103 Patent all asserted claims	Fractus: No construction necessary. <u>Intrinsic Evidence</u> • All evidence cited above for "wireless device." <i>File History</i> • "The device can be a handheld device, such as a handset for cellular telecommunication. It can also be any other kind of portable device including signal processing circuitry, such as a portable	Defendants: A device with the ability to transmit and receive voice, data, or video signals through the radio spectrum that does not require a physical wire to operate adapted to permit running of word-processing, spreadsheet, and slide software applications. Alternatively, plain and ordinary meaning, which is a device designed to be held and operated in the hand that does not require a physical wire

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	computer with means for wireless communication, etc." FRAC-ADT-00000710. <u>Extrinsic Evidence:</u> • Declaration of S. Long ¶ 40. • The Random House Dictionary of the English Language, 866 (2nd Ed. 2001): "Hand-held 1. Held in the hand or hands: <i>a hand-held torch</i>. 2. Small enough to be used or operated while being held in the hand or hands: <i>a hand-held hair drier</i>. -n. 3. Something small enough to be used or operated while held in the hand or hands: <i>She traded in her bulky old movie camera for a hand-held.</i>"	to operate while being carried or moved. <u>Intrinsic evidence:</u> '103 Patent, including, Abstract, Figs. 1-20; 1:19-3:29; 5:7-6:29; 7:60-63; 8:13-37; 9:63-10:24; 17:54-18:23; 41:20-44:46; and related disclosures. File History of the '103 Patent. <u>Extrinsic Evidence:</u> Fractus' infringement contentions. Newtons Telecom Dictionary: "without wires. Any system of transmitting and receiving information without wires." Webster's Third New International Dictionary: "wireless – having no wire or wires." Wiley Electrical and Electronics Engineering Dictionary: "wireless device - a device that communicates in a wireless manner" Wiley Electrical and Electronics Engineering Dictionary: "handheld device – a device, such as a PDA or handheld PC, which is small enough to hold in a hand or place in a pocket." Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.
"mobile communication device" • '887 Patent, all asserted claims;	Fractus: No construction necessary. <u>Intrinsic Evidence</u> <u>Specifications ('365 and '887 Patents)</u> • Figures 10-14, and supporting text.	Defendants: A device with the ability to transmit and receive voice, data, or video signals through the radio spectrum that does not require a physical wire to operate adapted to permit voice communication capabilities, on board sensors that

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'365 Patent, all asserted claims	"This invention relates generally to the field of multi-band monopole internal and external antennas. More specifically, multi-band monopole antennas are provided that are particularly well-suited for use in mobile communications devices, such as Personal Digital Assistants, cellular telephones, and pagers." '365 1:17-22; '887 1:27-31. - Operationally, the first and second radiating arms 12, 14 are each tuned to a different frequency band or bands, resulting in a dual-band or multi-band antenna. The antenna 10 may be tuned to the desired dual-band operating frequencies of a mobile communications device by pre-selecting the total conductor length of each of the radiating arms 12, 14. For example, in the illustrated embodiment, the first radiating arm 12 may be tuned to operate in a lower frequency band or groups of bands, such as PDC (800 MHz), CDMA (800 MHz), GSM (850 MHz), GSM (900 MHz), GPS, or some other desired frequency band. Similarly, the second radiating arm 14 may be tuned to operate in a higher frequency band or group of bands, such as GPS, PDC (1500MHz), GSM (1800 MHz), Korean PCS, CDMA/PCS (1900 MHz), CDMA2000/UMTS, IEEE 802.11 (2.4 GHz), IEEE 802.16	allow the device to capture (e.g., photograph, video, record, or determine location) information, and/or built-in features for synchronizing local data with remote locations. <u>Intrinsic Evidence:</u> '365 Patent, including, Abstract, all Figs., and all related disclosures. "Such an antenna housing could be affixed, for example, to a candy bar type mobile communication device, to a clam-shell type mobile communication device, to a gaming device, or to a PDA." '365 Patent, 9:67-10:3 '887 Patent, including, all Figs, and all related disclosures. File Histories of the '887, and '365 Patents. <u>Extrinsic Evidence:</u> Fractus' infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	(Wi-MAX), or some other desired frequency band. It should be understood that, in some embodiments, the lower frequency band of the first radiating arm 12 may overlap the higher frequency band of the second radiating arm 14, resulting in a single broader band. It should also be understood that the multi-band antenna 10 may be expanded to include further frequency bands by adding additional radiating arms. For example, a third radiating arm could be added to the antenna 10 to form a tri-band antenna.” ’365 patent 3:41-64; ’887 patent 3:34-56. • Claim 45 of the ’365 patent • Claim 6 of the ’887 patent <i>Specification (’365 Patent):</i> • “FIG. 24 shows an example of an antenna housing that any one of the antennas described above could be fitted within. Such an antenna housing could be affixed, for example, to a candy bar type mobile communication device, to a clam-shell type mobile communication device, to a gaming device, or to a PDA.” ’365 9:65-10:3 <u>Extrinsic Evidence:</u> • Declaration of S. Long ¶ 40. • The Random House Dictionary of the English Language, 1235 (2nd Ed. 2001) • “Communication <i>n.</i> 1. The act or process of communicating; fact of being communicated. 2. The	

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	imparting or interchange of thoughts, opinions, or information by speech, writing, or signs. 3. Something imparted, interchanged, or transmitted. 4. A document or message imparting news, views, information, etc. 5. Passage, or an opportunity or means of passage between places. 6. communications a. means of sending messages, orders, etc., including telephone, telegraph, radio, and television.” The Random House Dictionary of the English Language, 414 (2nd Ed. 2001)	
“wireless portable device” • ‘604 Patent, all asserted claims	Fractus: No construction necessary. <u>Intrinsic Evidence</u> <u>Specification</u> (<i>’604</i>) • “It will be clear that depending on the antenna embodiment included in the present invention, the resulting antenna would be suitable for several environments. In particular, the antennas can be integrated in handheld terminals (cellular or cord less telephones, PDAs, electronic pagers, electronic games, or remote controls), in cellular or wireless access points (for instance for coverage in micro-cells or pico-cells for systems such as AMPS, GSM850, GSM900, GSM1800, UMTS, PCS1900, DCS, DECT, WLAN, in car antennas, in integrated circuit packages or semiconductor devices, in multichip modules, and so on.” 5:1-11. • Figure 15 and supporting text.	Defendants: A device with the ability to transmit and receive voice, data, or video signals through the radio spectrum that does not require a physical wire to operate adapted to permit voice communication capabilities, on board sensors that allow the device to capture (e.g., photograph, video, record, or determine location) information, and/or built-in features for synchronizing local data with remote locations. Alternatively, the plain and ordinary meaning, which is a device that does not require a physical wire to operate while being easily carried or moved from one location to another. <u>Intrinsic Evidence:</u> ’604 Patent, including, Abstract, Figs. 1-17, 5:1-12; 11:5-14:40; and all related disclosures. File History of the ’604 Patent. <u>Extrinsic Evidence:</u>

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	<u>Extrinsic Evidence:</u> • Declaration of S. Long ¶ 40. • The Random House Dictionary of the English Language, xiv (2nd Ed. 2001): “wireless, + n. any system or device, as a cellular phone, for transmitting messages or signals by electromagnetic waves.” • “portable: able to be easily carried or moved, especially because being of a lighter and smaller version than usual” New Oxford Dictionary of English (1st ed. 1998) • “portable: 1. capable of being transported or conveyed: a portable stage. 2. Easily carried or conveyed by hand: a portable typewriter.” The Random House Dictionary of the English Language, 1507 (2nd Ed. 2001)	Fractus' infringement contentions. Newtons Telecom Dictionary: Portable - “A one-piece, self-contained cellular telephone-easily carried in a brief case or purse. Portables normally have a built-in antenna and rechargeable battery and operate with six-tenths of one watt (0.6 watt) of power. Car cellular phones operate with three watts.” Webster's Third New International Dictionary: “Portable – capable of being carried: easily or conveniently transported: light or manageable enough to be readily moved.” Newtons Telecom Dictionary: “without wires. Any system of transmitting and receiving information without wires.” <u>Extrinsic Evidence:</u> Fractus' infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.
“common conductor” • '887 Patent, claims 1, 14; • '365 Patent, claims 1, 37	Fractus: No construction necessary. <u>Intrinsic Evidence</u> <i>Specifications ('365 and '887 Patents)</i> • Figures 1-9 and supporting text • Referring now to the drawing figures, FIG. 1 is a top view of an exemplary multi-band monopole antenna 10 for a mobile communications device. The multi-band monopole antenna 10 includes a first radiating arm 12 and a second radiating arm 14 that are both coupled to a feeding port 17	Defendants: A contiguous conductive element having at least a first and second radiating arm each originating from discrete points along the perimeter of the contiguous conductive element. <u>Intrinsic Evidence:</u> '887 Patent, including, all Figs, and all related disclosures. “The common conductor 16 extends horizontally (as viewed in FIG. 1) beyond the second radiating arm 14,

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	through a common conductor 16. The antenna 10 also includes a substrate material 18 on which the antenna structure 12, 14, 16 is fabricated, such as a dielectric substrate, a flex-film substrate, or some other type of suitable substrate material. The antenna structure 12, 14, 16 is preferably patterned from a conductive material. Such as a metallic thick film paste that is printed and cured on the Substrate material 18, but may alternatively be fabricated using other known fabrication techniques.” ‘365 2:54-67; ‘887 2:47-60. • “As noted above, the common conductor 16 of the antenna 10 couples the feeding port 17 to the first and second radiating arms 12, 14. The common conductor 16 extends horizontally (as viewed in FIG. 1) beyond the second radiating arm 14, and may be folded in a perpendicular direction (perpendicularly into the page), as shown in FIG. 10, in order to couple the feeding port 17 to communications circuitry in a mobile communications device.” ‘365 3:33-40; ‘887 3:26-33. • “FIGS. 3-9 illustrate several alternative multi-band mono pole antenna configurations 50, 70, 80,90,93,95.97. Similar to the antennas 10, 30 shown in FIGS. 1 and 2, the multi-band monopole antenna 50 illustrated in FIG.3 includes a common	and may be folded in a perpendicular direction (perpendicularly into the page), as shown in FIG. 10, in order to couple the feeding port 17 to communications circuitry in a mobile communications device.” ‘887 Patent, 3:27-34. ’365 Patent, including, all Figs, and all related disclosures. File Histories of the ‘887, and ‘365 Patents. <u>Extrinsic Evidence:</u> Fractus’ infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	conductor 52 coupled to a first radiating arm 54 and a second radiating arm 56. The common conductor 52 includes a feeding port 62 on a linear portion of the common conductor 52 that extends horizontally (as viewed in FIG. 3) away from the radiating arms 54, 56, and that may be folded in a perpendicular direction (perpendicularly into the page) in order to couple the feeding port 62 to communications circuitry in a mobile communications device.” ‘365 4:4-15; ‘887 3:63-4:7.. • “In order to further reduce electromagnetic interference or electromagnetic coupling from the ground plane 106, the feeding point 104 is located at a position on the circuit board 102 adjacent to a corner of the ground plane 106. The antenna 10 is preferably coupled to the feeding point 104 by folding a portion of the common conductor 16 perpendicularly towards the plane of the circuit board 102 and coupling the feeding port 17 of the antenna 10 to the feeding point 104 of the circuit board 102. The feeding port 17 of the antenna 10 may, for example, be coupled to the feeding point 104 using a commercially available connector, by bonding the feeding port 17 directly to the feeding point 104, or by some other suitable coupling means, such as for example a built-in or Surface mounted	

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	spring contact. In other embodiments, however, the feeding port 17 of the antenna 10 may be coupled to the feeding point 104 by some means other than folding the common conductor 16.” ‘365 5:10-26; ‘887 5:3–17. <u>Extrinsic Evidence:</u> • Declaration of S. Long ¶ 41.	
“grid-dimension curve” • ‘365 Patent, claims 1, 2, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 20, 22, 23, 31, 32, 33, 35, 36, 37, 41, 43, 44	Fractus: Not indefinite. “A curve which is not self-similar, which possesses a geometry having a grid dimension that is greater than one (1), and, if the curve has any periodicity, the period is defined by a non-periodic curve that includes at least ten connected segments in which no two adjacent and connected segments define a longer straight segment.” <u>Intrinsic Evidence:</u> <i>Specification (‘365 Patent):</i> • “A conductor with multiple branches can have a linear branch and a space-filling or grid dimension branch.” Abstract. • Figures 16-19, and supporting text. • “Examples of grid dimension curves are shown in FIGS. 16 to 19.” 6:58–59. • “For the purposes of this application, the term grid dimension curve is used to describe a curve geometry having a grid dimension that is greater than one (1). The larger the grid dimension, the higher the degree of miniaturization that may be achieved by the grid dimension	Defendants: Indefinite. <u>Intrinsic Evidence:</u> ‘365 Patent, including, all Figs, and all related disclosures. File History of the ‘365 Patent. <u>Extrinsic Evidence:</u> Fractus’ infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.

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	curve in terms of an antenna operating at a specific frequency or wavelength. In addition, a grid dimension curve may, in some cases, also meet the requirements of a space-filling curve, as defined above. Therefore, for the purposes of this application a space filling curve is one type of grid dimension curve. FIG.16 shows an exemplary two-dimensional antenna 260 forming a grid dimension curve with a grid dimension of approximately two (2). FIG. 17 shows the antenna 260 of FIG. 16 enclosed in a first grid 270 having thirty-two (32) square cells, each with length L1. FIG. 18 shows the same antenna 260 enclosed in a second grid 280 having one hundred twenty-eight (128) Square cells, each with a length L2. The length (L1) of each square cell in the first grid 270 is twice the length (L2) of each square cell in the second grid 280 ($L2=2 \times L1$). An examination of FIGS. 17 and 18 reveals that at least a portion of the antenna 260 is enclosed within every square cell in both the first and second grids 270, 280. Therefore, the value of N1 in the above grid dimension (Dg) equation is thirty-two (32) (i.e., the total number of cells in the first grid 270), and the value of N2 is one hundred twenty-eight (128) (i.e., the total number of cells in the second grid 280). Using the above equation, the grid dimension of the antenna 260 may be calculated as follows: $-\log(128) - \log(32) / \log(2 \times L1) - \log(L1)$	

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	For a more accurate calculation of the grid dimension, the number of square cells may be increased up to a maximum amount. The maximum number of cells in a grid is dependent upon the resolution of the curve. As the number of cells approaches the maximum, the grid dimension calculation becomes more accurate. If a grid having more than the maximum number of cells is selected, however, then the accuracy of the grid dimension calculation begins to decrease. Typically, the maximum number of cells in a grid is one thousand (1000). For example, FIG. 19 shows the same antenna 260 enclosed in a third grid 290 with five hundred twelve (512) square cells, each having a length L3. The length (L3) of the cells in the third grid 290 is one half the length (L2) of the cells in the second grid 280, shown in FIG. 18. As noted above, a portion of the antenna 260 is enclosed within every square cell in the second grid 280, thus the value of N for the second grid 280 is one hundred twenty-eight (128). An examination of FIG. 19, however, reveals that the antenna 260 is enclosed within only five hundred nine (509) of the five hundred twelve (512) cells in the third grid 290. Therefore, the value of N for the third grid 290 is five hundred nine (509). Using FIGS. 18 and 19, a more accurate value for the grid dimension (Dg) of the antenna 260 may be calculated as follows: - $\log(509) - \log(128) / \log(2 \times L2) - \log(L2) \sim 1.9915''$ 7:16-8:10	

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	• “In addition to space-filling curves, the curves described herein can also be grid dimension curves. Examples of grid dimension curves are shown in FIGS. 16 to 19. The grid dimension of a curve may be calculated as follows. A first grid having square cells of length L1 is positioned over the geometry of the curve, such that the grid completely covers the curve. The number of cells (N1) in the first grid that enclose at least a portion of the curve are counted. Next, a second grid having square cells of length L2 is similarly positioned to completely cover the geometry of the curve, and the number of cells (N2) in the second grid that enclose at least a portion of the curve are counted. In addition, the first and second grids should be positioned within a minimum rectangular area enclosing the curve. Such that no entire row or column on the perimeter of one of the grids fails to enclose at least a portion of the curve. The first grid should include at least twenty-five cells, and the second grid should include four times the number of cells as the first grid. Thus, the length (L2) of each square cell in the second grid should be one-half the length (L1) of each square cell in the first grid. The grid dimension (Dg) may then be calculated with the following equation:- $\log(N2) - \log(N1) / \log(L2) - \log(L1)$” 6:51–7:15. • “The multi-band monopole antennas 70, 80, 90 illustrated in FIGS. 4-6 are similar to the antenna 50 shown in FIG. 3, except each includes a differently-patterned	

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	meandering portion 72, 82, 92 in the first radiating arm 54. For example, the meandering portion 92 of the multi-band antenna 90 shown in FIG. 6 meets the definition of a space-filling curve, as described above. The meandering portions 58, 72, 82 illustrated in FIGS. 3-5, however, each include differently-shaped periodic curves that do not meet the requirements of a space filling curve.” 4:31–40.	
“space-filling curve” • ‘887 Patent, claims 1, 2, 4, 5, 7, 14, 16, 18	Fractus: “A curve characterized by at least ten segments which are shorter than a tenth of a free space operating wavelength, connected in such a way that each segment forms an angle with its adjacent segments, that is, no pair of adjacent segments define a longer straight segment, and, if the curve has any periodicity, the period is defined by a non-periodic curve comprising at least ten connected segments in which no pair of adjacent segments of the connected segments defines a longer straight segment.” <u>Intrinsic Evidence:</u> <i>Specification (’887 Patent):</i> • “A space-filling curve is characterized by at least ten segments which are connected in such a way that each segment forms an angle with its adjacent segments, that is, no pair of adjacent segments define a larger straight segment. It should be understood, however, that the meandering section 20 may include other space-filling curves than that	Defendants: A curve that fills a unit square having at least ten non-self-intersecting segments forming a right angle with its respective adjacent segments. <u>Intrinsic Evidence:</u> ’887 Patent, including, all Figs, and all related disclosures. “the space-filling curve comprises at least ten segments that are shorter than a tenth of a free-space operating wavelength of the multiband antenna, each of the segments being connected to its neighboring segments at an angle such that no pair of adjacent segments defines a longer straight segment, wherein any periodicity of the space-filling curve along a fixed straight direction of space involves a periodic structure having a period defined by a non-periodic curve comprising at least ten connected segments in which no pair of adjacent ones of the connected segments defines a longer straight segment.” ’887 Patent, claims 1, 10. File History of the ’887 Patent.

Term, Patent(s), & Claim Number(s) ²	Fractus' Proposed Construction and Evidence	Defendants' Proposed Construction and Evidence
	shown in FIG. 1, or may optionally be arranged in an alternative meandering geometry. FIGS. 2-6, for example, illustrate antenna structures having meandering sections formed from several alternative geometries. The use of shape-filling curves to form antenna structures is described in greater detail in the co-owned PCT Application WO 01/54225, entitled Space Filling Miniature Antennas, which is hereby incorporated into the present application by reference.” 3:3-16. • Figures 1 and 3-6 and supporting text. • “FIG. 6 meets the definition of a space-filling curve, as described above. The meandering portions 58, 72, 82 illustrated in FIGS. 3-5, however, each include differently-shaped periodic curves that do not meet the requirements of a space filling curve.” 4:29-33. • claim 1, col 6:59–col. 7:4; claim 10, col. 7:57–col. 8:2 (periodicity and one-tenth wavelength requirements).	<u>Extrinsic Evidence:</u> Fractus' infringement contentions. Any intrinsic or extrinsic evidence that Fractus relies upon including any testimony or declaration by Dr. Stuart Long.