

LG ELECTRONICS, INC.,
Petitioner

v.

CONSTELLATION DESIGNS, LLC,
Patent Owner

IPR2023-00319 (U.S. Patent No. 10,693,700)

Patent Owner's Demonstrative Exhibit

Petition Hinges On Petitioner's Challenge To Priority

The '700 patent states that it is a continuation of the '777 patent (aka Barsoum). Ex. 1001 code (63). Petitioner challenges this claim to priority, arguing that features of the challenged claims do not have written description support in Barsoum. Pet. 2–19. Patent Owner disagrees. Prelim. Resp. 35–58. All three references (Barsoum, ATSC322, ATSC327) relied on by Petitioner are only prior art to the '700 patent if the '700 patent cannot claim priority to Barsoum.

Paper No. 10 (Institution Decision) at 10

Only Claims 5, 15, and 25 Are At Issue

Ground	Claims	Prior Art Basis
1A	2-3, 12-13, 22-23	§103 – '777 patent in view of ATSC322
1B	5, 15, 25	§103 – '777 patent in view of ATSC327

A Single Limitation Remains At Issue

Claim 5

5. The communication system of claim 1, wherein each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001 ('700 Patent), Claim 5

PTAB Has Already Rejected Petitioner's Argument

Decision Denying Institution of IPR

Claim 6 recites:

The communication system of claim 1, wherein:

the non uniform symbol constellation is selected from a plurality of unequally spaced symbol constellations; and

each of the plurality of unequally spaced symbol constellations is characterized by the assignment of labels and spacing of the constellation points such that each of the plurality of unequally spaced symbol constellations is capable of providing greater parallel decoding capacity when operated at a symbol constellation operating SNR than the other plurality of unequally spaced symbol constellations when operated at the same SNR.

Ex. 1001, 15:51–62. Claims 16 and 27 are substantially similar. *Id.* at 18:49–59, 22:3–13.

LG Electronics, Inc., v. Constellation Designs, LLC, IPR2023-00320, Paper No. 11 (Decision Denying Institution of IPR) at 4

PTAB Has Already Rejected Petitioner's Argument

Decision Denying Institution of IPR

We agree. Patent Owner correctly points to the specific examples of Figures 11b, 13b, 15b, and 17b as each showing a plurality of constellations, each optimized for a particular SNR that provide a greater parallel decoding capacity at that specific SNR than the other symbol constellations in the plurality. *Id.* at 75. More specifically, Figure 13b shows five constellations (i.e. a plurality), each optimized for a particular identified SNR that will perform better at that particular SNR than the other constellations which have not been optimized at that particular SNR. *Id.* at 76–77.

For these reasons, we determine that Petitioner has not shown that claims 6, 16, and 27 lack written description support in Barsoum.

LG Electronics, Inc., v. Constellation Designs, LLC, IPR2023-00320, Paper No. 11 (Decision Denying Institution of IPR) at 8-9

Institution Decision Preliminarily Rejected Petitioner's Argument

7:26–29, 8:47–56). We agree. Patent Owner correctly points to the specific examples of Figures 11b, 13b, 15b, and 17b as each showing a plurality of constellations, each optimized for a particular SNR that provide a greater parallel decoding capacity at that specific SNR than the other symbol constellations in the plurality. *Id.* 56–58. More specifically, Figure 13b shows five constellations (i.e. a plurality), each optimized for a particular identified SNR that will perform better at that particular SNR than the other constellations, which have not been optimized at that particular SNR. *Id.* at 57–58.

For these reasons, we preliminarily determine that Petitioner has not shown that claims 5, 15, and 25 lack written description support in Barsoum.

Paper No. 10 (Institution Decision) at 15

PTAB's Previous Decisions Rejecting Petitioner's Arguments Were Correct

1

Petitioner's Rejected Original Petition Theories

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Petitioner's New, Untimely, and Incorrect Reply Brief
Theories

PTAB's Previous Decisions Rejecting Petitioner's Arguments Were Correct

1

Petitioner's Rejected Original Petition Theories

2

Petitioner's New, Untimely, and Incorrect Reply Brief
Theories

Original Petition Theories

Petition for IPR

This limitation defines a very specific relative relationship between two groupings of non-uniform spaced constellations that is not supported by the '777 Patent specification. LGE-1003, ¶[73]. In particular, claim 5 recites an observation of a relative relationship between a first group of *non-uniform multidimensional symbol constellations*³ to a second group of other symbol constellations⁴ when the two groups are *operated at the same SNR*. LGE1003, ¶[73].

Paper No. 3 (Petition for IPR) at 13-14

Claim 5

5. The communication system of claim 1, wherein each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001 ('700 Patent), Claim 5

Original Petition Theories

Petition for IPR

d_{min}, the written description of the '777 patent explains how to optimize a nonuniform constellation so that it can be capable of having a greater capacity such as a greater parallel decoding capacity. LGE1015, 6:13-22; LGE1003, ¶[77].

Turning to claim 5, the Barsoum Patents fail to disclose that each of the plurality of different non-uniform multidimensional symbol constellations have been optimized to be capable of having greater parallel decoding capacity. LGE1003, ¶[78]. Indeed, neither the language of claim 5 nor the language of parent claim 1 indicate that each of the plurality of different non-uniform multidimensional symbol constellations have been optimized for parallel decoding capacity.

Paper No. 3 (Petition for IPR) at 16

Claim 5

5. The communication system of claim 1, wherein each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001 ('700 Patent), Claim 5

Institution Decision Correctly Rejected Petitioner's Argument

Decision Granting Institution of IPR

Patent Owner disagrees, arguing that the teachings related to optimizing a constellation for capacity at a first SNR also teach that other constellations optimized for a different SNR will not provide the same benefits at the first SNR. Prelim. Resp. 55–56 (citing Ex. 1015, 4:62–5:11, 7:26–29, 8:47–56). We agree. Patent Owner correctly points to the specific examples of Figures 11b, 13b, 15b, and 17b as each showing a plurality of constellations, each optimized for a particular SNR that provide a greater parallel decoding capacity at that specific SNR than the other symbol constellations in the plurality. *Id.* 56–58. More specifically, Figure 13b shows five constellations (i.e. a plurality), each optimized for a particular identified SNR that will perform better at that particular SNR than the other constellations, which have not been optimized at that particular SNR. *Id.* at 57–58.

For these reasons, we preliminarily determine that Petitioner has not shown that claims 5, 15, and 25 lack written description support in Barsoum.

Paper No. 10 (Institution Decision) at 15

PTAB's Previous Decisions Rejecting Petitioner's Arguments Were Correct

1

Petitioner's Rejected Original Petition Theories

2

Petitioner's New, Untimely, and Incorrect Reply Brief
Theories

Petitioner Abandoned Its Original Petition Theories

After the Institution and Disclaimer, Petitioner's Reply:

- **DOES NOT** mention either theory
- **DOES NOT** cite to original Hochwald Petition Declaration
- **DOES NOT** address or rely on any Barsoum passages addressed and relied on in the Petition

Petitioner's New Untimely Reply Theory

Petition

$d_{\min}$, the written description of the '777 patent **explains how to optimize a nonuniform constellation so that it can be capable** of having a greater capacity such as a **greater parallel decoding capacity**. LGE1015, 6:13-22; LGE1003, ¶[77].

Paper No. 3 (Petition for IPR) at 16

Claim 5 is not supported by the written description of the '777 patent because **“[n]ot all” of the plurality of** different non-uniform multidimensional symbol constellations are **capable of providing a greater parallel decoding capacity at a specific SNR** than the **other symbol constellations in the plurality of multidimensional symbol constellations** recited by claim 5. Thus, claim 5 is not entitled to the priority date of the '777 patent. LGE1003, ¶[79].

Paper No. 3 (Petition for IPR) at 17

Petitioner's New Untimely Reply Theory Is Baseless

Petitioner's new theory requires it to prove **all three** of the following:

1. Optimization:

that although the claims do not mention or describe “optimizing”, the alleged missing optimization is an element of claims 5, 15, and 25

2. Barsoum's First Approach:

that such optimization is not disclosed by Barsoum's disclosed first approach, “optimizing a multidimensional QAM constellation [by] directly optimiz[ing] over each degree of freedom” (Paper No. 13 (Petitioner's Reply) at 2)

3. Barsoum's Second Approach:

that such optimization is not disclosed by Barsoum's disclosed second approach, which “is to first optimize a PAM constellation, then apply that PAM constellation to both of the in-phase and quadrature components” (Paper No. 13 (Petitioner's Reply) at 2-3)

**Petitioner Has Not
Established That “optimizing”
is an Element of Claims 5, 15, and 25**

Claims Do Not Require “optimizing”

Claim 5

5. The communication system of claim 1, wherein each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001 ('700 Patent), Claim 5

Optimizing Cannot Be Read Into The Claims



There is a “heavy presumption” that claims should be construed according to its ordinary meaning.

E.g., Starhome GmbH v. AT&T Mobility LLC, 743 F.3d 849, 857 (Fed. Cir. 2014);
Hill-Rom Servs., Inc. v. Stryker Corp., 755 F.3d 1367, 1371 (Fed. Cir. 2014).



Because of this presumption, claims may be construed contrary to their ordinary meaning only by proving a clear and unequivocal special definition or disavowal.

E.g., Aventis Pharma S.A. v. Hospira, Inc., 675 F.3d 1324, 1330 (Fed. Cir. 2012);
Hill-Rom, 755 F.3d at 1371; *Phillips v. AWH Corp.*, 415 F.3d 1303, 1315-16 (Fed. Cir. 2005) (en banc).

Petitioner Never Argued or Established The Required Special Definition or Disavowal

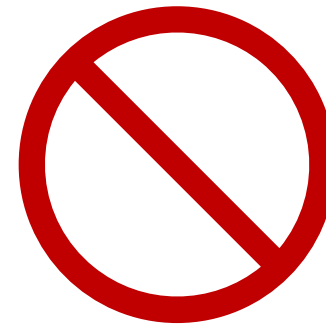
Petition

IV. CLAIM CONSTRUCTION

Petitioner submits no claim constructions are necessary. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017). Petitioner reserves the right to respond to any constructions offered/adopted by Patent Owner or the Board. LGE1003, ¶[42].

Paper No. 3 (Petition for IPR) at 28

Petitioner Reply



See generally Paper No. 13 (Petitioner's Reply)

Petitioner Has Not Established Lack of Priority

***Petitioner cannot establish lack of priority and unpatentability because
its new theory hinges on an incorrect and unsupported claim construction***

Petitioner Failed To Establish Lack Of Priority In Light of Barsoum's First Disclosed Approach

Barsoum's First Approach

'777 Patent

N-Dimensional Constellation Optimization

Rather than designing constellations in 1-D (PAM for instance) and then extending to 2-D (QAM), it is possible to take direct advantage in the optimization step of the additional degree of freedom presented by an extra spatial dimension. In general it is possible to design N-dimensional constellations and associated labelings. The complexity of the optimization step grows exponentially in the number of dimensions as does the complexity of the resulting receiver de-mapper. Such constructions constitute embodiments of the invention and simply require more 'run-time' to produce.

Ex. 1015 ('777 Patent) at 12:38-48

Petitioner's New Argument On Barsoum's First Approach

Petitioner's argument that Barsoum's First Approach does not adequately disclose optimizing parallel decoding capacity should not prevail because:

- The claims require “greater” PDC, not optimized PDC, and Petitioner failed to allege or establish that Barsoum's First Approach does not describe and result in “greater” PDC
- Even if claims required optimized, Petitioner does not dispute that the First Approach discloses optimizing PDC
- Petitioner's complaint that Barsoum does not provide details concerning the First Approach is irrelevant and baseless

Paper No. 14 (Patent Owner Sur-Reply) at 13-17

Petitioner's First Approach Argument Is Irrelevant

- No argument that this approach fails to disclose “greater parallel decoding capacity”
- Argument that this approach does not adequately describe optimizing parallel decoding capacity is irrelevant

Claim 5

5. The communication system of claim 1, wherein each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001 ('700 Patent), Claim 5

Petitioner's First Approach Argument Concerns Only a Lack of “details”

- Petition ignored this first approach
- Petitioner's Reply devotes less than a page to this (fatal) disclosure:

Petitioner's Reply

With respect to the first approach, the '700 patent is devoid of any details for directly optimizing each degree of freedom. In fact, the '700 patent explicitly notes that “[t]he *complexity of the optimization step grows exponentially* in the number of dimensions as does the complexity of the resulting receiver de-mapper.”² LGE1001, 13:1-11. The '700 patent provides no details of the additional complexity of the receiver demapper or other details of the complex optimization steps. Patent Owner points to one paragraph to argue that this first approach is supported (*see* LGE1001, 13:1-11), but this paragraph fails to describe or explain whether the optimization is for uniform or non-uniform multi-dimensional constellations, and whether there is any difference in optimizing the two types of constellations. Thus, such disclosure cannot be relied upon as written description support for feature [5], which is directed to “non-uniform multidimensional symbol constellations.” LGE1029, ¶¶0006-0007.

Paper No. 13 (Petitioner's Reply) at 3

Petitioner's First Approach Argument Concedes It Discloses The Allegedly Missing Optimization

- Petitioner does not argue (much less establish) that Barsoum's first approach fails to describe optimizing a multi-dimensional QAMs

N-Dimensional Constellation Optimization

Rather than designing constellations in 1-D (PAM for instance) and then extending to 2-D (QAM), it is possible to take direct advantage in the optimization step of the additional degree of freedom presented by an extra spatial dimension. In general it is possible to design N-dimensional constellations and associated labelings. The complexity of the optimization step grows exponentially in the number of dimensions as does the complexity of the resulting receiver de-mapper. Such constructions constitute embodiments of the invention and simply require more 'run-time' to produce.

Ex. 1015 ('777 Patent) at 12:38-48

Petitioner's Complaint That The First Approach Lacks “details” Is Irrelevant

- Petitioner cites no precedent or reasons requiring such details
- Precedent does **not** require such details:



Thus, we have explained, “written description is about whether the skilled reader of the patent disclosure can recognize that what was claimed corresponds to what was described; it is not about whether the patentee has proven to the skilled reader that the invention works, or how to make it work, which is an enablement issue.” *Alcon Research Ltd. v. Barr Labs., Inc.*, 745 F.3d 1180, 1191 (Fed. Cir. 2014).

Centrak, INC. v. Sonitor Technologies, INC., 915 F.3d 1360, 1366 (Fed. Cir. 2019)

Petitioner's Complaint That The First Approach Lacks “details” Is Baseless

Barsoum ('777 Patent, Ex. 1015) provides details concerning:

- A flow diagram for an exemplary optimization process (Figure 5; 7:10-8:23)
- Using unconstrained or constrained non-linear optimization (8:34-37)
- Possible objective functions for optimization (8:37-40, 49-56)
- Varying point locations (8:41-42, 49-56)
- Running the optimization process iteratively (8:49-56)
- Various possible optimization constraints (2:37-41, 2:56-3:8, 8:19-29, 8:58-9:2)

Petitioner's Only Specific Complaint Concerning An Alleged Missing Detail Is Baseless

Petitioner's Reply

of the receiver demapper or other details of the complex optimization steps. Patent Owner points to one paragraph to argue that this first approach is supported (*see* LGE1001, 13:1-11), but this paragraph fails to describe or explain whether the optimization is for uniform or non-uniform multi-dimensional constellations, and whether there is any difference in optimizing the two types of constellations. Thus, such disclosure cannot be relied upon as written description support for feature [5], which is directed to “non-uniform multidimensional symbol constellations.” LGE1029, ¶¶0006-0007.

Paper No. 13 (Petitioner's Reply) at 3

'777 Patent

N-Dimensional Constellation Optimization

Rather than designing constellations in 1-D (PAM for instance) and then extending to 2-D (QAM), it is possible to take direct advantage in the optimization step of the additional degree of freedom presented by an extra spatial dimension. In general it is possible to design N-dimensional constellations and associated labelings. The complexity of the optimization step grows exponentially in the number of dimensions as does the complexity of the resulting receiver de-mapper. Such constructions constitute embodiments of the invention and simply require more ‘run-time’ to produce.

Ex. 1015 ('777 Patent) at 12:38-48

Petitioner's Complaints Are Contradicted By Its Own Petition

Petition

In addition, a POSITA would have understood the '777 patent as explaining that operations can be performed on a non-uniform constellation so that the non-uniform constellation *can be optimized* for joint capacity optimization or parallel decoding optimization in order to have greater capacity. LGE1015 6:13-22; LGE1003, ¶[77]. Thus, though some non-uniform constellations do not have a greater capacity than other constellations maximized for $d_{\min}$, the written description of the '777 patent *explains how to optimize a nonuniform constellation so that it can be capable* of having a greater capacity such as a greater parallel decoding capacity. LGE1015, 6:13-22; LGE1003, ¶[77].

Paper No. 3 (Petition for IPR) at 16

Petition

Indeed, the '777 patent explains that “it is possible to take direct advantage in the optimization step of the additional degree of freedom presented by an extra spatial dimension.” LGE1015, 12:39-42.

Paper No. 3 (Petition for IPR) at 52

Petitioner Has Not Established Lack of Priority

Petitioner cannot establish lack of priority and unpatentability because

***its new theory hinges on its irrelevant and unproven assertion that
Barsoum's first approach does not adequately describe
optimizing a non-uniform multi-dimensional constellation***

Petitioner Failed To Establish Lack Of Priority In Light of Barsoum's Second Disclosed Approach

Barsoum's Second Approach

'777 Patent

Geometrically Shaped QAM Constellations

Quadrature amplitude modulation (QAM) constellations can be constructed by orthogonalizing PAM constellations into QAM inphase and quadrature components. Constellations constructed in this way can be attractive in many applications because they have low-complexity demappers.

In FIG. 21 we provide an example of a Quadrature Amplitude Modulation constellation constructed from a Pulse Amplitude Modulation constellation. The illustrated embodiment was constructed using a PAM-8 constellation optimized for PD capacity at user bit rate per dimension of 1.5 bits (corresponds to an SNR of 9.0 dB) (see FIG. 13b). The label-point pairs in this PAM-8 constellation are $\{(000, -1.72), (001, -0.81), (010, 1.72), (011, -0.62), (100, 0.62), (101, 0.02), (110, 0.81), (111, -0.02)\}$. Examination of FIG. 21 shows that the QAM constellation construction is achieved by replicating a complete set of PAM-8 points in the quadrature dimension for each of the 8 PAM-8 points in the in-phase dimension. Labeling is achieved by assigning the PAM-8 labels to the LSB range on the in-phase dimension and to the MSB range on the quadrature dimension. The resulting 8×8 outer product forms a highly structured QAM-64 for which very low-complexity de-mappers can be constructed. Due to the orthogonality of the in-phase and quadrature components the capacity characteristics of the resulting QAM-64 constellation are identical to that of the PAM-8 constellation on a per-dimension basis.

Ex. 1015 ('777 Patent) at 12:11-37

Petitioner's New Argument On Barsoum's Second Approach

Petitioner's argument that Barsoum's Second Approach does not optimize parallel decoding capacity should not prevail because:

- The claims require “greater” PDC, not optimized PDC, and Petitioner failed to allege or establish that Barsoum's Second Approach does not describe and result in “greater” PDC
- Even if claims required optimized, the Second Approach results in “optimized” PDC under the only “optimized” definition before the Board
- Petitioner's argument is based on a misreading of *Fuentes*, a new untimely reference first submitted with its Reply

Paper No. 14 (Patent Owner Sur-Reply) at 17-27

Petitioner's Second Approach Argument Is Irrelevant

- No argument that this approach fails to disclose “greater parallel decoding capacity”
- Argument that this approach does not describe optimizing parallel decoding capacity is irrelevant

Claim 5

5. The communication system of claim 1, wherein each of the plurality of different non-uniform multidimensional symbol constellations is capable of providing a greater parallel decoding capacity at a specific SNR than the other symbol constellations in the plurality of multidimensional symbol constellations at the same SNR.

Ex. 1001 ('700 Patent), Claim 5

Petitioner Never Disputed That Barsoum's Second Approach Optimizes Under The Only "optimize" Definition Before The Board

Under the only definition before the Board, "**optimization**" **requires**:

- Choosing an objective function (such as a system's capacity)
- Repeatedly (iteratively) changing variables such as constellation locations and labels
- Until an optimized solution for the objective function is achieved

Petitioner Never Disputed That Barsoum's Second Approach Optimizes Under The Only "optimize" Definition Before The Board

The only definition before the Board:

Declaration Of Giuseppe Caire

53. In general, optimization requires choosing an objective function (such as a system's capacity) and then repeatedly (iteratively) changing variables (such as constellation locations and labels) until an optimized solution for the objective function is achieved. (EX2008 at 20).

Ex. 2001 (Caire Declaration) ¶53

Petitioner Never Disputed That Barsoum's Second Approach Optimizes Under The Only "optimize" Definition Before The Board

As described in the '700 Patent (Ex. 1001), an "optimized solution" can be a constellation that results in :

- A given capacity (2:51-55)
- An improved and maximized capacity (3:4-12)
- Converged performances, i.e., additional iterations of the process do not result in a meaningful performance improvement (8:12-29)

Paper No. 14 (Patent Owner Sur-Reply) at 18-19

Petitioner Never Disputed That Barsoum's Second Approach Optimizes Under The Only "optimize" Definition Before The Board

No dispute that Barsoum's Second Approach results in "optimization" under this definition:

- an objective function is chosen (capacity)
- variables are changed (locations in a first dimension)
- an optimized solution for the objective function is achieved (the resulting QAM achieves improved capacity because of the varied location in the first dimension)

Paper No. 14 (Patent Owner Sur-Reply) at 18-20

Petitioner Never Disputed That Barsoum's Second Approach Optimizes Under The Only "optimize" Definition Before The Board

Barsoum describes that its Second Approach results in QAMs with improved capacity characteristics:

Geometrically Shaped QAM Constellations

Quadrature amplitude modulation (QAM) constellations can be constructed by orthogonalizing PAM constellations into QAM inphase and quadrature components. Constellations constructed in this way can be attractive in many applications because they have low-complexity demappers.

In FIG. 21 we provide an example of a Quadrature Amplitude Modulation constellation constructed from a Pulse Amplitude Modulation constellation. The illustrated embodiment was constructed using a PAM-8 constellation optimized for PD capacity at user bit rate per dimension of 1.5 bits (corresponds to an SNR of 9.0 dB) (see FIG. 13b). The label-point pairs in this PAM-8 constellation are {(000, -1.72), (001, -0.81), (010, 1.72), (011, -0.62), (100, 0.62), (101, 0.02), (110, 0.81), (111, -0.02)}. Examination of FIG. 21 shows that the QAM constellation construction is achieved by replicating a complete set of PAM-8 points in the quadrature dimension for each of the 8 PAM-8 points in the in-phase dimension. Labeling is achieved by assigning the PAM-8 labels to the LSB range on the in-phase dimension and to the MSB range on the quadrature dimension. The resulting 8x8 outer product forms a highly structured QAM-64 for which very low-complexity de-mappers can be constructed. Due to the orthogonality of the in-phase and quadrature components the capacity characteristics of the resulting QAM-64 constellation are identical to that of the PAM-8 constellation on a per-dimension basis.

Ex. 1015 ('777 Patent) at 12:11-37

Petitioner Never Disputed That Barsoum's Second Approach Optimizes Under The Only "optimize" Definition Before The Board

Dr. Caire confirmed that Barsoum's Second Approach results in QAMs with improved capacity characteristics:

Second Declaration Of Giuseppe Caire

19. An optimized PAM (e.g., a PAM-8 as disclosed in FIG. 13b), provides a certain capacity, which at certain SNRs provides a greater capacity than an equally spaced PAM. When the unequally spaced PAM is orthogonalized into a QAM and labeled according to the approach described in Barsoum, that resulting QAM will have the same capacity on a per-dimension basis. Because the QAM has twice the dimensions (2-dimensions) of the PAM (1-dimension), the QAM will have twice the capacity. Similarly, this logic applies to an equally spaced PAM, and an equally spaced QAM, which is an orthogonalized equally spaced PAM. Thus, if the unequally spaced PAM is optimized, it will provide a greater capacity than an equally spaced PAM. If a QAM is created by orthogonalizing that unequally spaced and optimized PAM, it will necessarily result in an optimized QAM because that QAM will necessarily have a greater capacity than the equally spaced QAM.

Ex. 2025 (Second Caire Declaration) ¶19

Petitioner's Attempt To Contradict Barsoum With *Fuentes* Is Baseless

Petitioner's Reply

Indeed, the notion that 1D and 2D symbol constellations do not necessarily have the same characteristics is well understood and known in the art. Dr. Hochwald, with reference to the *Fuentes* reference, explains that single dimension and multidimensional constellations do not have the same capacity characteristics.

* * *

Thus, *Fuentes* explains that a 1D-NUC (Non-Uniform Constellation) and 2D-NUC do not necessarily have capacity characteristics when 1D constellations and 2D constellations (as a whole) are compared. Indeed, *Fuentes* teaches that the opposite is true and that SNR and capacities of 1D and 2D constellations can be different.

Paper No. 13 (Petitioner's Reply) at 7-8

Petitioner's Attempt To Contradict Barsoum With *Fuentes* Is Baseless

Second Declaration Of Giuseppe Caire

20. Petitioner cites a new document, *Fuentes*, in support of its assertion that 1-dimensional and 2-dimensional constellations have different capacities. (Petitioner Reply 7-9). Petitioner argues that it is necessarily incorrect that the capacity characteristics of a PAM and a QAM are the same and relies on *Fuentes*' comparison of "1D-NUCs" and "2D-NUCs" to support this proposition. (Petitioner Reply at 6-7). But Petitioner fundamentally misunderstands the disclosure of *Fuentes*.

21. *Fuentes* uses the term "1D NUCs" to describe QAMs created by optimizing the in-phase component location in 1 dimension and then orthogonalizing those locations to the quadrature component (the second dimension). (EX1030 19-20, 62-63). *Fuentes* uses the term "2D NUCs" to describe a QAM created by directly optimizing both the in-phase and quadrature components of a single sector and imposing a symmetry constraint around the in-phase and quadrature axes. (EX1030 19-20, 62-63). Importantly, the "1D NUCs" of *Fuentes* are not 1 dimensional PAM constellations.

Ex. 2025 (Second Caire Declaration) ¶¶20-21

Petitioner's Attempt To Contradict Barsoum With *Fuentes* Is Baseless

Petitioner's Sur-Reply

A quick look at Fuentes' FIG. 1.2 makes it apparent that the 1D-64NUC (center/orange) is a two-dimensional constellation. However, it is referred to as a 1D constellation because it is formed by optimizing a 1D constellation, orthogonalizing the 1D constellation, and creating the resulting 64NUC constellation which has the same capacity characteristics on a per dimension basis as a 1D constellation—similar to the orthogonalized 2D constellations described in the '777 patent.

Paper 20 (Petitioner's Sur-Reply) at 3

Petitioner's Attempt To Contradict Barsoum With *Fuentes* Is Baseless

Fuentes

unconstrained Shannon limit. With NUCs, the constellation symbols are optimized by means of signal shaping techniques to provide an improved performance compared to uniform QAM constellations. These constellations are designed for a particular SNR and channel model. As stated before, NUCs are categorized into two different groups: 1D-NUCs and 2D-NUCs. 1D-NUCs

Assuming a uniform 16QAM with positions $\{-3, -1, +1, +3\}$ on each axis, prior to power normalization, then it is possible to optimize a 1D-16NUC with positions $\{-a_1, -1, +1, +a_1\}$, using a single parameter a_1 . For example, Figure

Ex. 1030 (Fuentes) at 19

Ex. 1030 (Fuentes) at 63

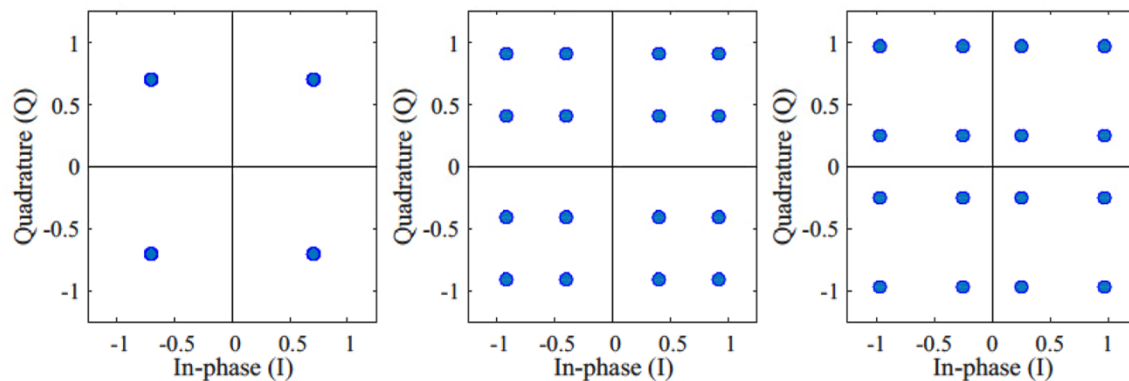


Figure 3.4: Different one-dimensional 16NUCs, optimized for SNRs of 0, 3 and 6 dB, for AWGN and i.i.d. Rayleigh channels.

Ex. 1030 (Fuentes) at 66 (Fig. 3.4)

Petitioner Has Not Established Lack of Priority

Petitioner cannot establish lack of priority and unpatentability because

***its new theory hinges on its irrelevant and unproven assertion that
Barsoum's second approach does not describe
optimizing a non-uniform multi-dimensional constellation***

PTAB's Previous Decisions Rejecting Petitioner's Arguments Were Correct

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Petitioner's Rejected Original Petition Theories

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Petitioner's New, Untimely, and Incorrect Reply Brief Theories