

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

LG ELECTRONICS, INC.,
Petitioner,

v.

CONSTELLATION DESIGNS, LLC,
Patent Owner.

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

PATENT OWNER'S SUR-REPLY TO PETITIONER'S REPLY

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<i>Samsung Elecs. Am., Inc. v. Prisua Eng'g Corp.</i> , 948 F.3d 1342 (Fed Cir. 2020)	3
<i>Starhome GmbH v. AT&T Mobility LLC</i> , 743 F.3d 849 (Fed. Cir. 2014)	12
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TABLE OF EXHIBITS

Exhibit	Description
2001	Declaration of Dr. Giuseppe Caire
2002	RESERVED
2003	U. Madhow, <i>Fundamentals of Digital Communication</i> , Cambridge University Press 2008
2004	R.G. Gallager, <i>Principles of Digital Communication</i> , Cambridge University Press 2008
2005	Eroz et al., <i>New DVB-S2X constellations for improved performance on the satellite channel</i> , Int. J. Satell. Commun. Network 2016; 34:351–360, Published online 14 September 2015 in Wiley Online Library (wileyonlinelibrary.com)
2006	RESERVED
2007	N.S. Login et al., <i>Non-Uniform Constellations for ATSC 3.0</i> , IEEE Transactions on Broadcasting, Vol. 62, No. 1, March 2016
2008	P. Gill, W. Murry, M. Wright, <i>Practical Optimization</i> , Emerald Group Publishing Limited (1982)
2009	RESERVED
2010	RESERVED
2011	RESERVED
2012	Curriculum Vitae and Publication List of Dr. Giuseppe Caire
2013	RESERVED
2014	RESERVED
2015	Giuseppe Caire, Giorgio Taricco, and Ezio Biglieri, <i>Bit-Interleaved Coded Modulation</i> , IEEE Transactions of Information Theory, vol. 44, no. 3, May 1998 (“Caire”)
2016	RESERVED
2017	RESERVED
2018	Board’s June 26, 2023 Email Authorizing Patent Owner Submission Of Limited <i>Fintiv</i> Paper
2019	District Court’s 05-03-2023 Third Amended Docket Control Order-Jury Selection set for 7-5-2023 09-00AM
2020	Petitioner-Defendant LGs June 28 2023 Email Identifying Final Election Of Invalidity Theories And Prior Art In District Court
2021	LG’s 03-14-2023 Final Election of Asserted Prior Art for District Court
2022	District Court’s 04-04-2022 Docket Control Order

Exhibit	Description
2023	District Court's 02-28-2023 Markman Order
2024	Statutory Disclaimer of Claims 2-3, 12-13, and 22-23 of US Patent No. 10,693,700
2025	Second Declaration of Dr. DiGiuseppe Caire

I. Introduction

Petitioner's Reply only confirms that its Petition fails to prove that claims 5, 15, and 25 are unpatentable, abandoning wholly the theories of the Petition (which the Board has now already rejected twice) and replacing them with untimely new theories that are both improper and baseless.

Each of challenged claims 5, 15, and 25 recites a communication system having a plurality of constellations, where each constellation is capable of providing greater parallel decoding capacity at a specific signal-to-noise ratio (SNR) than the other constellations in the plurality:

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 other symbol constellations in the plurality of* multidimensional symbol constellations at the same SNR.

(Ex. 1001, '700 Patent, at claims 5, 15, and 25).¹

Each Petition Ground against these claims hinge on Petitioner's argument that the claims "cannot claim priority to Barsoum." (Institution Decision at 10; 16-17). But the Board has now twice rejected the Petition's theory and arguments on this issue. (Institution Decision at 14-15; *LG Electronics, Inc. v. Constellation Designs, LLC*, IPR2023-00320, Paper 11 at 7-9 (PTAB July 18, 2023) (Decision Denying Institution)).

¹ Unless otherwise noted, all emphases in this response are added.

Accordingly, Petitioner has abandoned its previous theories and now presents a new ‘lack of priority’ theory in its Reply, one that relies on a new 30-page expert declaration and two new exhibits. Specifically, Petitioner now argues for the first time that Barsoum does not provide the necessary written description for claims 5, 15, and 25 because the claims require optimization of the claimed “non-uniform multidimensional symbol constellations” and Barsoum supposedly does not describe optimizing any multidimensional QAMs.

This new theory is untimely and thus cannot be considered in this IPR—as PTAB emphasizes in its Trial Practice Guide, “Petitioner may not submit new evidence or argument in reply that it could have presented earlier, e.g., to make out a *prima facie* case of unpatentability.” PTAB Consolidated Trial Practice Guide, 73 (Nov. 2019).

The new theory is also baseless. Petitioner provides no claim construction analysis or evidence supporting its argument that claims 5, 15, and 25 require optimization of the claimed “non-uniform multidimensional symbol constellations.” Petitioner cannot because the clear and explicit limitations of these claims include no such requirement.

Nor is there a basis for Petitioner’s new theory that Barsoum supposedly does not describe optimizing a multidimensional QAM. To the contrary, Barsoum teaches such optimization in at least two different passages, and the Petition itself

admitted that Barsoum “*explains how to optimize a non-uniform constellation so that it can be capable of* having a greater capacity such as parallel decoding capacity.” (Petition at 6) (emphasis in original).

II. Petitioner’s Reply Impermissibly Introduces New Argument and Evidence

The entire Petitioner Reply and accompanying exhibits raise theories that are “meaningfully distinct” from those in the Petition, and, accordingly, the Board must disregard the new theories and cannot find claims 5, 15, and 25 unpatentable based on any theory in the Petitioner Reply.

A. The Board Cannot Find Claims Unpatentable Based on New Theories Not Presented in the Petition

The Federal Circuit and the Board prohibit Petitioner from raising new theories of unpatentability in its Reply, and the Board cannot find claims unpatentable based on theories not presented in the Petition. “The petition . . . defines the scope of an IPR proceeding, and nothing in the IPR statute permits the Board to expand that scope in its final written decision.” *Samsung Elecs. Am., Inc. v. Prisua Eng’g Corp.*, 948 F.3d 1342, 1351 (Fed Cir. 2020); *Koninklijke Phillips N.V. v. Google LLC*, 948 F.3d 1330, 1336 (Fed. Cir. 2020). This is because “[a]ny marked departure from the grounds identified with particularity in the petition would impose ‘unfair surprise’ on the patent owner and, consequently, violate both the APA and the IPR statute. *Corephotonics, Ltd. v. Apple Inc.*, 84 F.4th 990, 1002 (Fed. Cir.

2023) (citing *Arthrex Inc. v. Smith & Nephew, Inc.*, 935 F.3d 1319, 1328 (Fed. Cir. 2019)). Accordingly, the Board may not find claims unpatentable in an IPR based on theories that were not asserted in the Petition.

This “newness” prohibition applies “even if the new theory is responsive to the patent owner’s response or the Board’s institution decision.” *Id.* at 1008 (citing *Wasica Fin. GmbH v. Cont’l Auto. Sys., Inc.*, 853 F.3d 1272, 1286 (Fed. Cir. 2017)).

Further, Petitioner is prohibited from raising new arguments even if those arguments rely on previously uncited embodiments or disclosures within an existing reference. *Ariosa Diagnostics v. Verinata Health, Inc.*, 805 F.3d 1359, 1367-68 (Fed. Cir. 2015). While petitioner can properly expand on previously raised arguments, it may not raise “meaningfully distinct contentions” from those set forth in the Petition. *Id.* at 1367.

B. In Petitioner’s Reply, It Drops Its Twice-Rejected Petition Theories Regarding Lack of Priority

The Petition devoted just six pages to Petitioner’s arguments concerning the lack of priority for claims 5, 15, and 25, relying on the Declaration of Dr. Bertrand Hochwald to present two theories.

First, the Petition asserts that Barsoum does not provide sufficient written description of “a very specific relative relationship between two groupings of non-uniform spaced constellations.” (Petition at 13-15). The Petition addressed only one

Barsoum disclosure for this argument, arguing that Barsoum “at best, only describes determining a relative relationship between a geometrically shaped (i.e. unequally spaced) constellation and a constellation optimized for $d_{\min}$.” (Petition at 14).

Second, the Petition asserts that Barsoum does not provide sufficient describe that *all* of the plurality non-uniform multidimensional (“QAM”) 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. (Petition at 17). While conceding that Barsoum teaches “how to optimize a non-uniform constellation so that it can be capable of having a greater capacity such as a greater parallel decoding capacity,” the Petition argued this was insufficient because the Petition did not describe that “each” of the plurality of non-uniform multidimensional symbol constellations were so optimized. (Petition at 16) (emphasis in Petition). In doing so, the Petition repeatedly relied on and addressed only a single Barsoum passage, describing that “not all geometrically shaped constellations have a greater capacity than that of a constellation maximized for $d_{\min}$.” (Petition at 15-18).

The Board has now twice rejected these theories, both in its Institution Decision in this IPR and in the Decision Denying Institution in IPR2023-00320, which concerned and addressed these same Petitioner arguments and theories. (Institution Decision at 14-15; *LG Electronics, Inc. v. Constellation Designs, LLC*,

IPR2023-00320, Paper 11 at 7-9 (PTAB July 18, 2023) (Decision Denying Institution). Each time, the Board agreed that, contrary to these Petition theories, the Barsoum “teachings related to optimizing a constellation 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.” (E.g., Institution Decision at 15). As the Board explained:

Patent Owner correctly points to the specific examples of [Barsoum’s] 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*. ... 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.

(Institution Decision at 15).

As a result, Petitioner has now completely abandoned its two Petition theories. Petitioner’s Reply does not mention them, does not cite to the original Hochwald declaration for support, and does not address or rely on the Barsoum passages previously addressed and relied on in the Petition.

C. Petitioner’s Reply Improperly Introduces A New Theory, New Arguments, And New Evidence

1. Petitioner’s Reply Presents A New Theory and Arguments

Instead, Petitioner’s Reply presents a brand-new theory. The Petition previously acknowledged that Barsoum taught optimization and never disputed or

argued that Barsoum did not teach optimizing at least some non-uniform QAM constellations to have greater parallel decoding capacity. (*E.g.*, Petition at 16-18). Instead, the Petition argued that Barsoum described that “not all” constellations would be optimized and therefore, did not describe that “each” of the plurality of nonuniform multidimensional (QAM) constellations were optimized to have a greater parallel decoding capacity at a specific SNR. (Petition at 16-17) (emphasis in Petition).

But now Petitioner argues for the first time in its Reply that Barsoum somehow did not teach optimizing *any* nonuniform multidimensional (QAM) constellations. (*E.g.*, Reply at 3, 4-5, 5-11, 11-14, 14-19). Therefore, while initially arguing that Barsoum did not provide support for claims 5, 15, and 25 because not all of the multidimensional constellations are optimized, Petitioner now asserts the entirely different argument that Barsoum fails to disclose how *any* are optimized. This is a meaningfully distinct contention and a “marked departure from the grounds identified with particularity in the petition” and considering the new arguments and evidence “would impose ‘unfair surprise’ on the patent owner and, consequently, violate both the APA and the IPR statute.” *Corephotonics*, 84 F.4th. at 1002; *see also Ariosa*, 805 F.3d at 1367-68. Petitioner should have, and could have, identified this ground of invalidity in the Petition but failed to do so. *Ariosa*, 805 F.3d at 1364 (Petitioner must identify ground of invalidity with specificity in the Petition).

2. That Petitioner’s Reply Improperly Presents A New And Untimely Theory Is Confirmed By The Reply’s Exclusive Reliance On a New Declaration and Evidence

A comparison of the evidence and arguments presented in the Petition and in the Reply confirm that Petitioner’s Reply improperly raises a new and untimely theory.

Where the Petition devoted only six pages to the issue of priority for claims 5, 15, and 25, the Reply devotes 21 pages to the issue. And there is no overlap between the two—Petitioner’s Reply does not mention its Petition theories, does not cite to the original Hochwald declaration for support, and does not address or rely on the Barsoum passages previously addressed and relied on in the Petition. *See Corephotonics*, 84 F.4th at 1008 (“Determining whether a reply has improperly raised a new theory or argument requires a comparison between the petitioner’s petition and the petitioner’s reply.”).

Regarding the declarations, where the Petition relied on 13 paragraphs from Dr. Hochwald’s original declaration (EX1003), the Reply does not cite to that declaration at all. Instead, because the Reply’s theory is new and untimely, Petitioner submitted a “***Second***” declaration from Dr. Hochwald (31 pages and 41 paragraphs long) and relies solely on this new evidence. (EX1029).

Regarding Barsoum, the Reply fails to cite *any* disclosure in Barsoum that Petitioner cited in support of its priority argument in the Petition. (*Compare* Petition

at 13-19 (citing portions of EX1015, 6:13-23), *with* Petitioner Reply (citing portions of EX1015,² 1:33-49, 2:37-41, 2:56-3:19, 6:6, 6:45-49, 7:30-34, 7:58-60, 8:2-7, 12:11-48)). Indeed, in the Petition, Petitioner cited just 11 lines in Barsoum. Now, Petitioner cites over 60 lines in Barsoum, none of which are the 11 lines from the Petition. Worse, Petitioner was fully aware of the disclosures in Barsoum on which it now relies—it cited many of these disclosures in other sections of the petition—but failed to raise the present priority challenge. (*See, e.g.*, Petition at 45).

Also, in an attempt to support Petitioner's new theory, Petitioner submits and relies on two new exhibits, EX1030 and EX1031. Again, if this new theory were presented in its Petition (as it could and should have been), there would be no need to resort to such new evidence (and a new declaration and new Barsoum passages) to support it.

For all of the foregoing reasons, Patent Owner Constellation respectfully requests that the Board decline to consider this new theory and evidence.

² In the Petition, Petitioner cited almost exclusively to Barsoum, EX1015, in addressing priority for claims 5, 15, and 25. (*See* Petition at 13-19). In the Petitioner Reply, Petitioner cited almost exclusively to the '700 Patent, EX1001, which shares a specification. (*See generally* Petitioner Reply). For ease of comparison, Patent Owner has converted citations to EX1001 in the Petitioner Reply to equivalent citations in EX1015.

III. Petitioner's New Theory Is Baseless

Petitioner's new theory and arguments are not only untimely and improper, they are also baseless. As discussed, claims 5, 15, and 25 do not require optimization, they merely require a plurality of non-uniform multidimensional symbol (QAM) constellations, where each QAM constellation is capable of providing greater parallel decoding capacity at a specific signal-to-noise ratio (SNR) than the other QAM constellations in the plurality. (Ex. 1001, at claims 5, 15, and 25). And as also previously discussed, Constellation has already established, and the Board has already twice found, that Barsoum includes adequate written description of such constellations.

Accordingly, Petitioner now argues that (contrary to their explicit language) these claims do not merely require that each QAM constellation provide greater parallel decoding capacity at a specific SNR, they further require that each constellation be optimized for a specific SNR. And under its new theory, Barsoum does not provide priority for the claims because Barsoum supposedly does not describe this (unstated) optimization limitation.

Accordingly, to substantively prevail on its new theory, Petitioner must establish three (and *all three*) things:

- (1) Claims 5, 15, and 25 should be construed to require that each of the plurality of constellations be optimized for parallel decoding capacity at a specific SNR;
- (2) Such optimization is not adequately disclosed by Barsoum's disclosure of a first approach, i.e., "optimizing a multidimensional QAM constellation [by] directly optimiz[ing] over each degree of freedom;" and
- (3) Such optimization is not adequately disclosed by Barsoum's disclosure of a second approach, which "is to first optimize a PAM constellation, then apply that PAM constellation to both of the in-phase and quadrature components."

(E.g., Reply at 2-5).

To prevail, Petitioner must meet its burden on *all three* of these issues. As discussed below, Petitioner fails to meet its burden on *any*.

A. Petitioner's Required "Optimized" Construction Is Baseless

To prevail on its argument that Barsoum does not include an adequate written description of optimized QAM constellations, it must first establish that claims 5, 15, and 25 actually include such an "optimized" limitation. Petitioner has not.

By their explicit ordinary language, the challenged claims require only that each of the claimed plurality of constellations is capable of providing *greater*

parallel decoding capacity at a specific signal-to-noise ratio (SNR) than the other constellations in the plurality:

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 other symbol constellations in the plurality of*** multidimensional symbol constellations at the same SNR.

(Ex. 1001, '700 Patent, at claims 5, 15, and 25). The claims do not mention “optimized” or otherwise include a requirement that each constellation be capable of providing an optimized parallel decoding capacity.

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 Services, Inc. v. Stryker Corporation*, 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).

Although, Petitioner advocates deviating from the plain and ordinary meaning of the claims to read in an “optimized” requirement, Petitioner does not even assert (much less identify and prove) any such special definition or disavowal. To the

contrary, in the Petition, Petitioner argued that no claim construction was necessary, and its Reply includes no claim construction analysis or arguments whatsoever.

(Petition at 28).

Petitioner’s “optimized” construction is thus incorrect. And because the entirety of its latest theory hinges on its incorrect claim construction, for this reason alone Petitioner has failed to show the challenged claims are unpatentable.

B. Even Under Petitioner’s Untimely New Theory and Incorrect Claim Construction, Barsoum’s First Approach Indisputably Provides Sufficient Written Description for Claims 5, 15, and 25

Barsoum describes two approaches to achieve optimized multidimensional constellations. (EX2025 ¶5). The first approach Barsoum discloses to achieve optimized multi-dimensional constellations is to directly optimize a QAM over each degree of freedom. (EX1015 12:38-48; EX2025 ¶5). Petitioner does not contend that this disclosed approach fails to provide an adequate written description for claims 5, 15, and 25 if they are construed to merely require “*greater* parallel decoding capacity” (as actually claimed) rather than *optimized* parallel decoding capacity (as Petitioner argues). (Reply at 3). Thus, under the correct claim construction, Petitioner fails.

Indeed, there is no real dispute that this approach provides sufficient written description for claims 5, 15, and 25, even under Petitioner’s incorrect claim construction—Petitioner does not dispute that this first approach is described and

discloses optimizing QAMs; rather, Petitioner merely irrelevantly and wrongly complains that there is not enough detail about this first approach. (Reply at 3).

1. Petitioner Does Not Dispute Barsoum Indisputably Discloses A First Approach For Optimizing QAMs

After inexplicably ignoring it in the Petition, the Reply devotes less than a page to Barsoum's first disclosed approach for optimizing QAMs. In that single page, Petitioner does not dispute (1) that Barsoum in fact discloses the first approach; or (2) that this approach is for optimizing QAMs.

Nor could Petitioner reasonably do so because Barsoum explicitly describes this first approach as optimizing the QAMs over each degree of freedom (N-degrees of freedom):

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.

(EX1015 12:38-48).

For this reason alone, Petitioner and its new theory fail.

2. Petitioner's Complaint Concerning "Details" Is Irrelevant and Baseless

Unable to dispute that Barsoum's first approach is disclosed and describes optimizing QAMs, Petitioner is reduced to complaining that Barsoum does not provide additional "details" about this first approach. (Reply at 3). Petitioner's complaint is both irrelevant and baseless.

First, Petitioner's complaint is irrelevant because Petitioner identifies no precedent or reasons requiring such purportedly missing "details." (Reply at 3). And such details are *not* required because "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." *CenTrak, Inc. v. Sonitor Techs., Inc.*, 915 F.3d 1360, 1365-69 (Fed. Cir. 2019) (citation and internal quotation marks omitted).

And here it is undisputed that a POSITA would understand that Barsoum's first approach discloses the optimization that Petitioner wrongly argues is required by the challenged claims.

Second, even though no more details are required, Barsoum does in fact provide additional details. For example, Barsoum describes how to optimize constellations including the use of unconstrained or constrained non-linear

optimization. (EX1015 8:34-37; EX2001 ¶53-55; EX2025 ¶9). Barsoum provides possible objective functions for the optimization. (EX1015 8:37-40, 49-56; EX2001 ¶53-55; EX2025 ¶9). Barsoum discloses that point locations are varied. (EX1015 8:41-42, 49-56; EX2001 ¶53-55; EX2025 ¶9). Barsoum describes running the optimization process iteratively. (EX1015 8:49-56; EX2001 ¶53-55; EX2025 ¶9). Barsoum identifies various optimization constraints. (EX1015 2:37-41, 2:55-66, 8:23-24, 8:57-9:2; EX2025 ¶9). Barsoum even includes a detailed flow diagram (FIG. 5) of an example optimization process. (EX1015 7:10-8:23; EX2025 ¶9).

Indeed, the only identified specific “missing” detail identified by Petitioner is whether this first approach concerns optimizing uniform or non-uniform QAMs. (Reply at 3). But this complaint makes no sense. Barsoum improves upon *uniform* constellations (that have equally spaced locations) by instead optimizing constellations by changing the distances between locations. (EX1015 2:37-48, 2:56-3:9, 4:47-47-59, 7:15-17). Thus, as described in Barsoum, the *optimized constellations are non-uniform constellations*, and Petitioner has identified no basis for arguing that the first approach for producing optimized constellations may somehow instead concern uniform (i.e., non-optimized) constellations. (EX1015 2:37-48, 2:56-3:9, 4:47-47-59, 7:15-17).

Removing all doubt, Petitioner Reply’s argument is directly contradicted by its admissions in the Petition, where it asserted that “[Barsoum] 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” (Petition at 52) and that “[a] POSITA would have understood [Barsoum] as explaining that operations can be performed on a non-uniform constellation so that *the non-uniform constellation can be optimized* for [capacity] in order to have greater capacity.”). (Petition at 16, emphasis in original).

C. Barsoum’s Second Approach Also Provides Sufficient Written Description for Claims 5, 15, and 25

Barsoum’s disclosed second approach for achieving optimized multidimensional constellations is to optimize a constellation in a first dimension (in other words, optimize a PAM constellation), and then orthogonalize that optimized constellation to additional dimensions (in other words, turn the optimized PAM into an optimized QAM constellation). (EX1015, 12:11-37; EX2001 ¶56-59; EX2025 ¶5).

Even if optimization were a claim requirement, Petitioner’s argument here fails because the second approach indisputably “optimizes” under the only “optimize” definition before the Board. And Petitioner’s arguments to the contrary are based on a misstatement of the teaching of *Fuentes*, one of the new and improper exhibits provided with Petitioner’s Reply.

1. Petitioner Does Not Dispute That QAMs of Second Approach are Optimized Under The Only Definition Before The Board

The only definition of “optimized” before the Board is that “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.” (POPR at 22; POR at 24; EX2001 ¶53, EX2025 ¶12).

Further, the challenged Patent identifies numerous different ways for defining the “optimized” solution. For example, in one optimization embodiment, achieving the optimized solution requires varying constellation points until a maximized capacity is achieved. (*E.g.*, EX1001 3:4-12; *see also, e.g.*, EX1015 2:56-63; EX2001 ¶55; EX2025 ¶13). In another embodiment, the optimized solution is reached when constellation points provide “a given capacity at a reduced signal-to-noise ratio compared to” an equally spaced constellation. (*E.g.*, EX1001 2:51-55; *see also, e.g.*, EX1015 2:37-41; EX2001 ¶55; EX2025 ¶13). In other examples, the optimized solution is achieved when the constellation results in a “predetermined improvement” over an equally spaced constellation. (*E.g.*, EX1001 2:6-12; *see also, e.g.*, EX1015 1:59-65; EX2001 ¶55; EX2025 ¶13). In another example, an optimized solution is reached when a performance of each iteration of an optimization process have converged; in other words, when additional iterations of the process does not

result in a meaningful performance improvement. (*E.g.*, EX1001 8:23-24; EX2001 ¶55; EX2025 ¶13).

Petitioner does not dispute any of the foregoing or offer an alternate definition of “optimization.” Nor does Petitioner even argue, much less prove, that Barsoum’s second approach does not optimize QAMs under this undisputed definition.

a. Petitioner Does Not Argue that the Disclosed QAMs Created from Disclosed PAMs Do Not Provide Improved Capacity Characteristics

Petitioner does not even assert, much less prove, that a QAM made according to Barsoum’s second approach (*i.e.*, creating the QAM from a PAM optimized for a particular SNR) is somehow not “optimized” under the undisputed meaning of that term.

Under that undisputed meaning, optimization includes choosing an objective function (such as a system’s capacity) and then repeatedly (iteratively) changing variables (such as constellation locations and labels in one or more dimensions) until an optimized solution is found. (POPR at 22; POR at 24; EX2001 ¶53; EX2025 ¶12).

Petitioner does not dispute that, in the second approach described by Barsoum, this is precisely what happens. In this second approach, an objective function is chosen (capacity), parameters are varied (locations in a first dimension), and an optimized solution (*e.g.*, QAM created by orthogonalizing the locations in the first

dimension) is found when the resulting nonuniform (QAM) constellation provides an improvement. (EX1015 8:30-9:2, 12:11-37; EX2001 ¶¶53-57; EX2025 ¶17).

b. Disclosed QAMs of the Second Approach Do Provide Improved Capacity Characteristics and are Optimized

The disclosed QAM constellations of the second approach are optimized because they do provide improved capacity characteristics. (EX2001 ¶¶53-57; EX2025 ¶18). As explained by Barsoum, this is at least “[d]ue to the orthogonality of the in-phase and quadrature components the capacity characteristics of the resulting QAM-64 constellation are identical that of the PAM-8 constellation on a per-dimension basis.” EX1001 12:64-67, EX1015 12:33-37).

As explained by expert declarant Dr. Caire:

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.

(EX2025 ¶19).

c. Petitioner Fundamentally Misunderstands Fuentes Because Fuentes’ “1D-NUCs” Are 2-Dimensional Optimized QAMs

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*.

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; EX2025 ¶21). *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. (EX1030 19-20, 62-63; EX2025 ¶21). Importantly, the “1D NUCs” of *Fuentes* ***are not 1 dimensional PAM constellations*** as Petitioner incorrectly argues. (EX2025 ¶21).

This is clearly shown within *Fuentes* in figure 1.2, reproduced below and annotated, which illustrates an equally spaced QAM (left), a “1D-64NUC” (middle)(created by optimizing in 1-dimension then orthogonalizing to the second

dimension), and a “2D-64NUC” (right)(created by optimizing in both in-phase and quadrature dimensions). (EX1030 20; EX2025 ¶22).

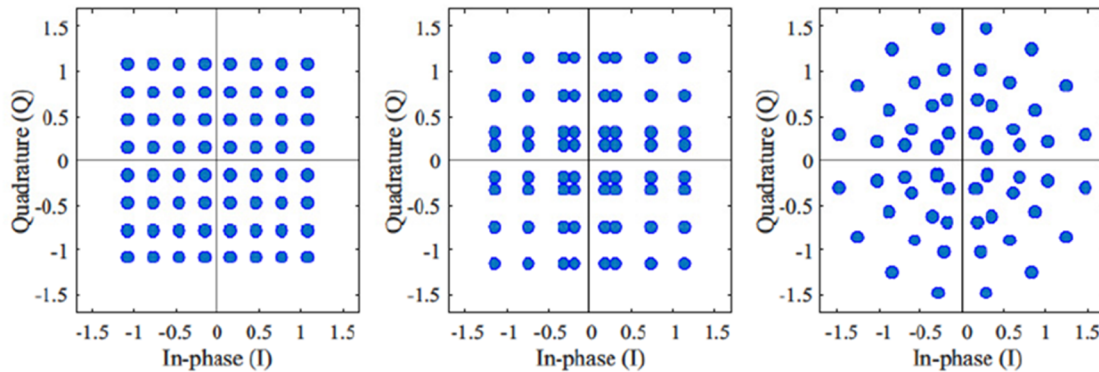


Figure 1.2: Different constellations considered. Uniform 64QAM (left), 1D-64NUC (center) and 2D-64NUC (right) **optimized** for a SNR of 10 dB and AWGN channel.

But Petitioner ignores this disclosure of *Fuentes*, instead arguing that the “1D-NUCs” of *Fuentes* are 1-dimensional constellations. (Petitioner Reply 7-8).

Because *Fuentes*’ “1D-NUCs” are not 1-dimensional constellations, figure 3.16, relied upon by Petitioner (Petitioner Reply at 9), is thus ***not*** comparing capacity of 1-dimensional constellations and 2-dimensional constellations as Petitioner incorrectly argues. (EX2025 ¶24). Rather, Figure 3.16 is comparing two types of 2-dimensional constellations. (EX2025 ¶24). Both types are QAM constellations, ***and both types are optimized.*** (EX2025 ¶24).

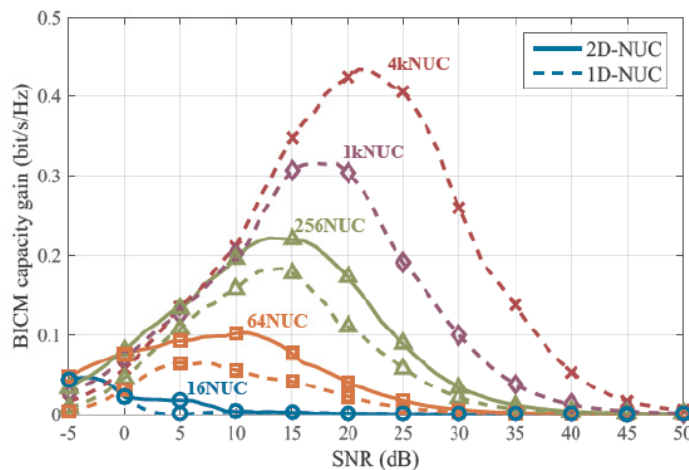


Figure 3.16: Gain of 1D/2D-NUC over QAM, for the i.i.d. Rayleigh channel model, and a range of SNR values between -5 and 50 dB.

And *Fuentes* confirms that the so called “1D-NUCs”, which are QAMs, are optimized:

- “The use of one-dimensional NUCs has different advantages when optimizing.”
- “it is possible to optimize a 1D-16NUC...”
- “It can be observed that 16NUCs optimized for very low SNRs provide higher gains than the rest.”
- “Figure 3.4: Different one-dimensional 16NUCs, optimized for SNRs of 0, 3, and 6 dB...”
- “Optimizing in one dimension maximizes the BICM capacity...”
- “With NUCs, the constellation symbols are optimized by means of signal shaping techniques to provide an improved performance...”

(EX1030, 19-20, 62-63, 66, 70-71; EX2025 ¶25).

This incorrect understanding by Petitioner not only undermines the Petitioner's arguments but confirms that the second approach described in Barsoum to creating optimized QAMs does indeed result in optimized QAMs, and that the inventors had possession of the challenged claims as of the filing date of Barsoum.

d. Fuentes, the Evidence the Petitioner Newly Introduced, Confirms that the Disclosed QAMs of the Second Approach Are Optimized Multidimensional Constellations That Provide Improved Capacity Characteristics

Figure 3.16 of *Fuentes* shows the capacity gain of respective 2-dimensional constellations created by orthogonalizing respective 1-dimensional constellations that have been optimized at a respective given SNR (denoted as “1D-NUC” in the figure). (EX2025 ¶26). The y-axis shows the capacity gain as compared to an equally spaced QAM. (EX2025 ¶26). Thus, since the “1D-NUC” lines (dotted lines) have a range of SNR where the lines are above zero, these 2-dimensional constellations created by orthogonalizing respective 1-dimensional constellations do in fact provide an increase in capacity as compared to an equally spaced QAM. (EX2025 ¶26). And *Fuentes* confirms that, for a given SNR, there is one nonuniform multidimensional constellation (“1D-NUC”) that provides for a greater capacity at a given SNR than the other nonuniform multidimensional constellations (“1D-

NUCs”). (EX1030 75 “at any SNR, there is always a particular NUC that maximizes the greatest BICM capacity”; EX2025 ¶26).

Thus, figure 3.16 of *Fuentes*, when properly interpreted, supports the exact fact upon which the Petitioner is trying to cast doubt – that each 2-dimensional constellation created by orthogonalizing respective 1-dimensional constellations, which each have been optimized at a given SNR, will provide a greater capacity at that SNR than other 2-dimensional constellations created by orthogonalizing 1-dimensional constellations optimized at different SNRs. (EX2025 ¶27).

2. Further Optimizing A QAM Created from Optimized PAM Not Required Because It Is Undisputed That QAMs of Second Approach Provide Improved Capacity Characteristics

Petitioner argues that description of further optimizing a QAM that is created from a 1-dimensional PAM is required. (Petitioner Reply at 5-11). But even when importing the unwarranted optimization limitation into the challenged claims, no further optimization of a QAM is required in order for a QAM created from an optimized PAM to be considered optimized. This is because, as noted above, the QAMs created with the second approach do provide an improvement in capacity at their respective SNRs and are already optimized. Thus a QAM created by the second approach is an optimized QAM.

As noted above, this too is confirmed by *Fuentes*, who refers to a QAM created by optimizing in 1-dimension as an optimized constellation (so called “1D-NUCs”). (EX1030 19-20, 62-63, 66, 70-71; EX2025 ¶24-25).

3. Petitioner Argument Regarding Different Spacing Between 1-Dimensional and 2-Dimensional Constellations is Beside the Point and Draws a Flawed Conclusion

Petitioner relies upon Barsoum’s discussion that increasing dimensionality of a constellation allows for larger minimum distance to conclude that Barsoum discloses that a 1-dimensional constellation optimization would not apply to a 2-dimensional constellation. (Petitioner Reply at 12). The Petitioner’s rationale is that Barsoum has described that the $d_{\min}$ for a 1-dimensional constellation is different than the $d_{\min}$ for a 2-dimensional constellation. However, this rationale cannot be applied to orthogonalization because orthogonalization increases the number of constellation points. (EX2025 ¶30).

In more detail, the ‘700 Patent’s description of “[i]ncreasing the dimensionality of a constellation allows larger minimum distance for constant constellation energy per dimension” is describing an increase in dimensionality for a fixed number of constellation points. (EX2025 ¶31). For example, the $d_{\min}$ of a PAM-4 will be smaller than the $d_{\min}$ of a QAM-4. (EX2025 ¶31). This logic does not apply when comparing, as the Petitioner does, the capacity characteristics of a PAM to a QAM created by orthogonalizing the PAM because the QAM will have a

number of constellation points equal to the square of the PAM constellation points (e.g., QAM-64 results from orthogonalizing PAM-8). (EX2025 ¶31).

4. Barsoum Discloses Differences in Parallel Decoding Capacity Between Different Non-Uniform Multidimensional Symbol Constellations And Fuentes Confirms Barsoum's Disclosure

Petitioner argues that Barsoum fails to describe comparisons of parallel decoding capacity between different non-uniform multidimensional constellations. (Petitioner Reply 19-21). But Petitioner does not address Barsoum's clear disclosure on this point that was relied upon by the Board in its institution decision. Barsoum describes that optimizing a constellation for capacity at a first SNR also teaches that other constellations optimized for a different SNR will not provide the same benefits at the first SNR. (Institution Decision, 15; POPR at 55-56; EX. 1015, 4:62-5:11, 7:26-29, 8:47-56; EX2001 ¶60; EX2025 ¶32). Such disclosure is *not* limited to single dimension constellations nor has Petitioner argued that it is. (EX2001 ¶60; EX2025 ¶32). Moreover, *Fuentes* confirms that optimizing a 2-dimensional constellation for capacity at a first SNR also teaches that other constellations optimized for a different SNR will not provide the same benefits at the first SNR. (EX2025 ¶32). *Fuentes* states "[e]ach NUC performs better at its design SNR than its uniform variant... [m]oreover, at any SNR, there is always a particular NUC that maximizes the greatest BICM capacity." (EX1030 75).

IV. CONCLUSION

For any of the foregoing reasons, the Board should find that the Petitioner has failed to prove that the challenged claims are unpatentable.

Dated: February 7, 2024

Respectfully submitted,

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CERTIFICATE OF WORD COUNT

Pursuant to 37 C.F.R. §42.24(d), Patent Owner hereby certifies, in reliance on the word count of the word-processing system (Microsoft Office Word 2010) used to prepare this Sur-Reply to Petitioner Reply, that the number of words in this paper is 5,518. This word count excludes the tables of contents, tables of authorities, certificate of word count, certificate of service, and table of exhibits.

Dated: February 7, 2024

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CERTIFICATE OF SERVICE

I certify that copies of Patent Owner's Sur-Reply to Petitioner's Reply and accompanying Constellation Exhibit 2025 are being served by electronic mail on the following counsel of record:

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