

UNITED STATES PATENT AND TRADEMARK OFFICE

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BEFORE THE PATENT TRIAL AND APPEAL BOARD

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NEC CORPORATION, NOKIA CORPORATION, and  
ALCATEL SUBMARINE NETWORKS,  
Petitioners,

v.

NEPTUNE SUBSEA IP LIMITED,  
Patent Owner.

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IPR2018-01158  
Patent 8,380,068 B2

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Before BARBARA A. BENOIT, GREGG I. ANDERSON, and  
JASON W. MELVIN, *Administrative Patent Judges*.

ANDERSON, *Administrative Patent Judge*.

JUDGMENT  
Final Written Decision  
Determining All Challenged Claims Unpatentable  
35 U.S.C. § 318(a)

## I. INTRODUCTION

In this *inter partes* review, instituted pursuant to 35 U.S.C. § 314, NEC Corporation, Nokia Corporation, and Alcatel Submarine Networks (“Petitioner”)<sup>1</sup> filed a Petition (“Pet.,” Paper 4) pursuant to 35 U.S.C. §§ 311–19 that challenges claims 1–15 (“challenged claims”) of U.S. Patent No. 8,380,068, filed September 30, 2010 (Ex. 1001 (“’068 patent,” Ex. 1001, code(22))).<sup>2</sup> Neptune Subsea IP Limited (“Patent Owner”)<sup>3</sup> filed a Preliminary Response (“Prelim. Resp.,” Paper 8). We instituted an *inter partes* review of claims 1–15 (“Dec.,” Paper 10). After institution, Patent Owner filed a Patent Owner Response (“PO Resp.” Paper 15), Petitioner filed a Reply (“Reply,” Paper 20), and Patent Owner filed a Sur-Reply (“Sur-Reply,” Paper 28). An oral hearing was held on August 29, 2019, and a transcript made of record (“Tr.,” Paper 37).

The Petition is supported by the Declaration of Dr. Clifford R. Pollock (“Pollock Declaration,” Ex. 1003). The Response is supported by the Declaration of Dr. Mohammed N. Islam (“Islam Declaration,” Ex. 2003). The Reply is supported by the Second Declaration of Dr. Clifford R. Pollock (“Second Pollock Declaration,” Ex. 1023). The deposition of Dr. Pollock was taken by Patent Owner

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<sup>1</sup> NEC Networks & System Integration Corporation and NEC Corporation of America are additional real parties-in-interest. Pet. 88.

<sup>2</sup> The ’068 patent lists a prior filed provisional application no. 61/255,448, filed October 27, 2009. Ex. 1001, code(60). All the prior art relied on have issue or publication dates prior to the provisional’s filing date except Tanaka, which was filed on November 14, 2007. See Section II.D below. Patent Owner does not dispute that the asserted references are prior art to the ’068 patent.

<sup>3</sup> Neptune Subsea IP Ltd. is a wholly-owned subsidiary of Neptune Subsea Holdings, Ltd. Neptune Subsea Holdings, Ltd. is a UK corporation and is a wholly owned subsidiary of Xtera Topco Ltd. f.k.a. Neptune Subsea Acquisitions Ltd, also a UK corporation. Paper 7, 1. Also, Xtera, Inc. is a wholly-owned subsidiary of Neptune Subsea Holdings Ltd., and is a successor to Xtera Communications, Inc. *Id.*

after the Second Pollock Declaration (“Pollock Dep.,” Ex. 2005). The deposition of Dr. Islam was taken by Petitioner after the Islam Declaration (“Islam Dep.,” Ex. 1027).

We have jurisdiction under 35 U.S.C. § 6. This Final Written Decision is entered pursuant to 35 U.S.C. § 318(a) and 37 C.F.R. § 42.73 (2018). For the reasons discussed below, Petitioner has shown by a preponderance of the evidence that claims 1–15 of the ’068 patent are unpatentable.

## II. BACKGROUND

### A. *Related Proceedings*

The parties advise us that the ’068 patent is the subject of a number of civil actions including: *Certain Subsea Telecommunication Systems and Components Thereof*, ITC Inv. No. 337-TA-1098 (International Trade Commission); *Xtera, Inc. et al., v. NEC Corporation, et al.*, No. 17-cv-00175-O (N.D. Tex.); and *Xtera Inc. et al., v. Nokia Corporation et al.*, No. 17-cv-01876-GMS (D. Del.). Pet. 88–89; Paper 7, 2–3.

The parties also advise us that four other petitions for *inter partes* review have been filed by Petitioner in connection with related patents, including: IPR2018-01157 (U.S. Patent No. 8,351,798); IPR2018-01160 (U.S. Patent No. 8,406,637); IPR2018-01161 (U.S. Patent Nos. 8,971,171); and IPR2018-01190 (U.S. Patent No. 7,860,403). Pet. 89; Paper 7, 3.

### B. *Technology and the ’068 Patent*

The ’068 patent relates to transmission of optical signals over fiber optic communication networks. Ex. 1001, 1:14–54.

### *1. Technology*

Fiber-optic communication networks provide high-speed data between network nodes over “an aggregation of interconnected fiber-optic links.” Ex. 1001, 1:14–17. The fiber-optic link includes an optical signal source connected over optical fiber to an optical signal receiver. *Id.* at 1:17–24. “Long-haul and ultra-long-haul optics refers to the transmission of light signals overlong fiber-optic links on the order of hundreds or thousands of kilometers.” Ex. 1001, 1:34–36. Long-haul optics transmits light on separate channels in a single optical fiber, separating the channels into distinct wavelengths of “light using principles of Wave-length Division Multiplexing (WDM) or Dense WDM (DWDM).” *Id.* at 1:34–41.

### *2. '068 Patent (Ex. 1001)*

The '068 patent purports to advance long distance transmission of data over a fiber-optic communication network by “receiv[ing] and de-multiplex[ing] two groups of optical wavelength channels which are each treated separately as far as dispersion compensation and discrete amplification are concerned.” Ex. 1001, 1:59–62. “The optical assembly then multiplexes the two groups back into the same fiber for further transmission.” *Id.* at 1:62–64.

Figure 2B of the '068 patent illustrates the separate treatment of wavelength channels and is reproduced below.

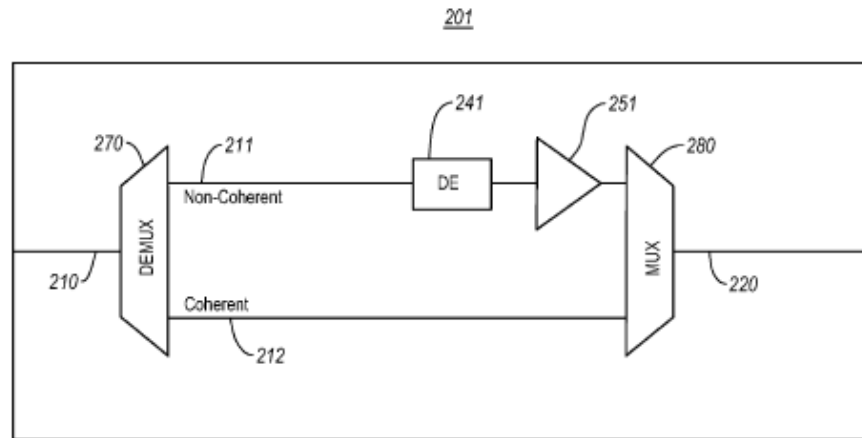


**Fig. 2B**

**Figure 2B is one embodiment of optical assembly 201.**

Ex. 1001, 2:30–31, 6:55. With reference to Figure 2B,

coherent optical channels are provided onto optical path 212 (also called herein a “coherent optical path” since it carries coherent optical wavelength channels), while the non-coherent optical channels are provided onto optical path 211 (also called herein a “non-coherent optical path” since it carries non-coherent optical wavelength channels).<sup>4</sup>

The non-coherent optical wavelength channels passes to a dispersive element (DE) 241 that introduces a different dispersion into the non-coherent optical channels as compared to the dispersion, if any, that is introduced into the coherent optical wavelength channels. In the illustrated case, for example, the coherent optical wavelength channels bypass the DE 241 completely such that DE 241 does not provide any dispersion for the coherent optical wavelength channels.

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<sup>4</sup> The '068 patent uses “non-coherent” but “noncoherent” is used in asserted reference Ip and the filings. See, e.g., Ex. 1005, 7; Pet. 14; PO Resp. 14. We use “non-coherent” unless quoting from argument or evidence using “noncoherent.”

*Id.* at 6:59–7:6. Optical assembly 201 provides “different dispersion to the coherent and non-coherent channels which may improve the performance for all channels.” *Id.* at 7:66–8:1. Because the coherent channels bypass DE 241,<sup>5</sup> avoiding “nonlinear interaction,” their performance may also be improved. *Id.* at 8:4–7.

### *C. Illustrative Claims*

Claims 1 and 12 of the challenged claims are independent claims relating respectively to an assembly and a system. Claims 2 through 11 depend directly or indirectly from claim 1. Claims 13 through 15 depend directly or indirectly from claim 12.

Claims 1 and 12 are reproduced below.

[1.P]<sup>6</sup> An optical assembly comprising:

[1.1.a] an input optical port for receiving a mixed optical signal

[1.1.b] containing a combination of coherent optical wave length channels and non-coherent optical wavelength channels;

[1.2] an optical demultiplexer configured to separate the combination of optical wavelength channels present on the input optical port such that a plurality of coherent optical wavelength channels and no non-coherent optical wave length channels are provided onto a coherent optical path, and such that a plurality of non-coherent optical wavelength channels and no coherent optical wave length channels are provided onto a non-coherent optical path;

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<sup>5</sup> The quoted portion of the '068 patent references “2451,” which is not mentioned anywhere else and appears to be an error. DE 241 is assumed to be the correct element. See Ex. 1001, Fig. 2B.

<sup>6</sup> Claim 1 is illustrative of the format used in the Petition, which we adopt, to identify separate limitations.

- [1.3] a dispersive element disposed in one or both of the coherent and non-coherent optical paths and that operates such that a different amount of dispersion is applied to the plurality of non-coherent optical wavelength channels traveling through the non-coherent optical path than the amount of dispersion, if any, that is applied to the coherent optical path; and
- [1.4] an optical multiplexer configured to receive and combine the optical wavelength channels from the coherent and non-coherent optical paths to form a mixed coherent and non-coherent optical output signal on an output of the optical multiplexer.

Ex. 1001, 9:30–55.

[12.P] An optical system comprising:

[12.1] a transmission terminal;

[12.2] a receiver terminal;

[12.3] a plurality of optical repeaters;

[12.4.a] a plurality of optical assemblies used to separate coherent optical channels from non-coherent optical channels,

[12.4.b] and apply different dispersion to the non-coherent optical channels as compared to dispersion, if any, that is applied to the coherent optical channels before recombining the coherent and non-coherent optical channels for further transmission towards the receiver terminal.

*Id.* at 10:34–44.

#### *D. Asserted Grounds of Unpatentability*

Petitioner alleges that claims 1–15 of the '068 patent would have been unpatentable on the following grounds. Pet. 1, 7–88.

| Claim(s) Challenged | 35 U.S.C. §      | References                                 |
|---------------------|------------------|--------------------------------------------|
| 1–9, 11–13, 15      | 103 <sup>7</sup> | Tanaka, <sup>8</sup> Ip <sup>9</sup>       |
| 2–5, 14             | 103              | Tanaka, Ip, Okuno <sup>10</sup>            |
| 4–5                 | 103              | Tanaka, Ip, Okuno, Tsukitani <sup>11</sup> |
| 10                  | 103              | Tanaka, Ip, Evans <sup>12</sup>            |
| 10                  | 103              | Tanaka, Ip, Tsukitani, Evans               |
| 14                  | 103              | Tanaka, Ip, Charlet <sup>13</sup>          |

### III. ANALYSIS

#### A. Claim Construction

This Petition was filed prior to November 13, 2018, and so we interpret claim terms of the challenged claims using the broadest reasonable interpretation (“BRI”) in light of the specification of the ’068 patent. 37 C.F.R. § 42.100(b) (2018); *see Cuozzo Speed Techs., LLC v. Lee*, 136 S. Ct. 2131, 2142 (2016) (upholding the use of broadest reasonable construction standard in *inter partes*

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<sup>7</sup> The Leahy-Smith America Invents Act (AIA), Pub. L. No. 112-29, 125 Stat. 284, 285–88 (2011), which revised 35 U.S.C. §§ 102 and 103, became effective March 16, 2013. The ’068 patent has an effective filing date of at least September 30, 2010 (*see* Section I, n.2 above), prior to the effective date of the AIA. Thus, the grounds asserted are under the pre-AIA version of § 103.

<sup>8</sup> Tanaka, US 8,625,996, issued January 7, 2014 (“Tanaka,” Ex. 1004).

<sup>9</sup> Ip, *Coherent Detection in Optical Fiber Systems*, Optics Express Vol. 16, No. 26 (January 21, 2008) (“Ip,” Ex. 1005).

<sup>10</sup> Okuno, US 6,611,637, issued August 26, 2003 (“Okuno,” Ex. 1006).

<sup>11</sup> Tsukitani, US 7,292,748, issued November 6, 2007 (“Tsukitani,” Ex. 1007).

<sup>12</sup> Evans, US 6,310,716, issued October 30, 2001 (“Evans,” Ex. 1008).

<sup>13</sup> Charlet, US 2007/0189775 A1, published August 16, 2007 (“Charlet,” Ex. 1009).

review); *see also* Changes to the Claim Construction Standard for Interpreting Claims in Trial Proceedings Before the Patent Trial and Appeal Board, 83 Fed. Reg. 51,340, 51,340 (Oct. 11, 2018) (final rule) (“This rule is effective on November 13, 2018 and applies to all IPR, PGR and CBM petitions filed on or after the effective date.”).

Petitioner proposes constructions for “coherent optical wavelength channels” and “dispersive element”/“optical element.” Pet. 5–7. In its Preliminary Response, Patent Owner contended we need not construe either “coherent optical wavelength channels” or the “element” terms. Prelim. Resp. 3; *see also Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co. Ltd.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017); *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (terms not in controversy need not be construed). In the Institution Decision, we agreed with Patent Owner and did not construe any term. Inst. Dec. 9–10. We also advised the parties to include constructions of any disputed term in the Response and Reply. *Id.* at 10.

In its Response, Patent Owner maintains its previous position, agreeing with the Institution Decision that this dispute does not require any express construction to resolve the dispute. PO Resp. 6–9. Petitioner’s Reply does not identify any dispute that is resolved by construction. Notwithstanding the preceding, whether the references, alone or in combination, teach “coherent optical wavelength channels” is a disputed issue. *See, e.g.*, Pet. 11–17; PO Resp. 17–37; Reply 3–4, 6–15; Sur-Reply 3–8.

The term “coherent” appears in the claim terms “coherent optical wavelength channels” and “coherent optical path,” and is fundamental to the arguments and evidence regarding “coherent detection.” Both parties’ arguments and the Ip reference refer to “coherent detection.” *See* Pet. 13 (citing Ip as

teaching “coherent detection”); PO Resp. 14 (Ip teaches “coherent detection”). The term “coherent detection”<sup>14</sup> appears in the Specification but not the claims. *See*, Ex. 1001, 7:52–65. The ’068 patent describes “coherent” as “refer[ing] to the ability to measure the electric field of the transmitted channel during detection (both amplitude and phase).” *Id.* at 2:55–62.

There is no dispute that “coherent optical wavelength channels” or “coherent detection” includes measurement of both phase and amplitude. Ex. 1001, 2:55–57 (“The term ‘coherent’ refers to the ability to measure the electric field of the transmitted channel during detection (both amplitude and phase).”); Pet. 5 (construction of “coherent optical wavelength channels”); Reply 10–11 (Petitioner arguing that in order to teach the limitations of claim 1, both amplitude and phase information must be measured); PO Resp. 24 (Patent Owner arguing coherent detection requires “detecting both amplitude and phase”); Sur-Reply 12 (“There is no dispute that ‘coherent’ refers to the ability to measure **both amplitude and phase** of the electric field of the transmitted channel during detection.”). This same understanding is found in Ip. Ex. 1005, 9 (“coherent detection . . . [is] based on the *recovery of the full electric field*, which contains both amplitude and phase information.”). We determine that “coherent optical wavelength channels” need not be expressly construed and, as stated in the Specification, the term “coherent” refers to “the ability to measure the electric field of the transmitted channel during detection (both amplitude and phase).” Ex. 1001, 2:55–57.

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<sup>14</sup> Hereafter we refer to “coherent optical wavelength channels” and “coherent optical path” as recited claim terms. In addressing the arguments and evidence we use “coherent detection” generally.

### *B. Obviousness*

All of the challenges to the '068 patent are based on obviousness under 35 U.S.C. § 103(a). Pet. 1.

#### *1. Legal Standard for Obviousness*

A patent claim is invalid as obvious if the differences between the claimed subject matter and the prior art are “such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.” 35 U.S.C. § 103(a).

The ultimate determination of obviousness is a question of law, but that determination is based on underlying factual findings. . . . The underlying factual findings include (1) “the scope and content of the prior art,” (2) “differences between the prior art and the claims at issue,” (3) “the level of ordinary skill in the pertinent art,” and (4) the presence of secondary considerations of nonobviousness such “as commercial success, long felt but unsolved needs, failure of others,” and unexpected results.

*In re NuVasive, Inc.*, 842 F.3d 1376, 1381 (Fed. Cir. 2016) (citing *inter alia* *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966)).

“To satisfy its burden of proving obviousness, a petitioner cannot employ mere conclusory statements. The petitioner must instead articulate specific reasoning, based on evidence of record, to support the legal conclusion of obviousness.” *In re Magnum Oil Tools Int’l, Ltd.*, 829 F.3d 1364, 1380 (Fed. Cir. 2016). Furthermore, in assessing the prior art, the Board must consider whether a person of ordinary skill would have been motivated to combine the prior art to achieve the claimed invention. *Nuvasive*, 842 F.3d at 1381.

As the Federal Circuit found, in quoting from the Supreme Court’s decision in *KSR Int’l Co. v. Teleflex Inc.*, 550 U.S. 398, 418–419 (2007),

“because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known,” “it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does.”

*Personal Web Technologies, LLC v. Apple, Inc.*, 848 F.3d 987, 991–992 (Fed. Cir. 2017).

## 2. *Person of Ordinary Skill in the Art*

Petitioner alleges a person of ordinary skill in the art would have “a Bachelor of Science in electrical engineering or a field related to fiber-optic communications and three to five years of experience in fiber-optic communications systems, or a related discipline.” Pet. 4–5 (citing Ex. 1003 ¶ 29). At the institution stage, Patent Owner did not comment on Petitioner’s proposed level of ordinary skill; nor does it propose an alternative. We therefore adopted Petitioner’s proposed level of ordinary skill. Inst. Dec. 12. Neither party proposes a different level of ordinary skill in any filings since institution. Because the proposed level of ordinary skill is consistent with the problems and solutions in the prior art of record (including Exhibits 1004 and 1005), we adopt this determination of the level of ordinary skill in the art for purposes of this Final Written Decision. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995) (In determining the level of ordinary skill, various factors may be considered, including the “types of problems encountered in the art; prior art solutions to those problems; rapidity with which innovation are made; the sophistication of the technology; and educational level of active workers in the field.” (internal quotation and citation omitted)).

*3. Obviousness of Claims 1–9, 11–13, and 15 Over Tanaka and Ip*

Petitioner alleges claims 1–9, 11–13, and 15 would have been obvious over Tanaka and Ip. Pet. 1, 7–49. Petitioner supports its arguments with the Pollock Declaration. Ex. 1003 ¶¶ 80–155.

*a. Tanaka (Ex. 1004)*

Tanaka explains that existing 2.5-Gbps (Gbit/sec) or 10-Gbps WDM were transmission techniques that would require being enhanced to 40-Gbps and that new data rates will require the same “transmission distance and frequency utilization factor as the 10-Gbps transmission systems.” Ex. 1004, 1:14–25. Signal degradation occurs as transmission technology transitions from 2.5-Gbps or 10-Gbps intensity modulation to 40-Gbps WDM where “the 40-Gbps WDM systems are required to have the same transmission distance and frequency utilization factor as the 10-Gbps transmission systems.” *Id.*

Tanaka describes the existing systems using “DPSK (Differential Phase-Shift Keying) [and] DQPSK (Differential Quadrature Phase-Shift Keying)” as phase shift keying modulation methods. See Ex. 1004, 1:26–36. Tanaka identifies “on-off keying” as a type of “intensity modulation” where “optical signals can be strengthened by increasing the number of wavelengths to be multiplexed.” *Id.* at 1:50–54; see also Ex. 1003 ¶¶ 82, 97 (“on-off keying” means bits encoded as presence or absence of light).

Tanaka “relates to optical transmitters and optical transmission methods suitable for use in optical WDM (Wavelength-Division Multiplexing) communication systems.” Ex. 1004, 1:8–12. Tanaka describes multiplexing and transmission of phase modulation and intensity modulation optical signals in order to upgrade transmission systems. *Id.* at 4:8–19.

Tanaka addresses the resulting problem of “variations in the intensity of an intensity modulation optical signal greatly affect[ing] the reception quality of phase modulation optical signals.” Ex. 1004, 4:20–22. More specifically, when the signals are multiplexed and transmitted “10-Gbps intensity modulation optical signals are arranged at wavelengths adjacent to the 43-Gbps phase modulation optical signal, the reception signal quality is degraded compared with the case where 43-Gbps phase modulation optical signals are arranged at all wavelength channels.” *Id.* at 4:50–58.

Tanaka suppresses “transmission quality degradation in network systems where intensity modulation and phase modulation optical signals are multiplexed.” Ex. 1004, 5:13–17. The problem is solved by adding a “bit time difference” “between the phase modulation optical signal and the intensity modulation optical signal.” *Id.* at 5:29–38. As described in connection with Figure 2 below, delay unit 12 provides the “bit time difference” described. *Id.* at 12:41–45.

In a first embodiment, Tanaka includes a delay block and splitting unit which “splits a wavelength multiplexed input signal into an intensity modulation optical signal and a phase modulation optical signal.” Ex. 1004, 11:41–43, Fig. 2. Figure 2 of Tanaka is reproduced below.

FIG. 2

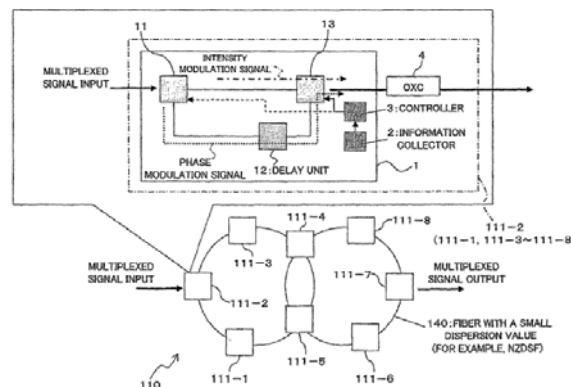


**Figure 2 is a block diagram illustrating optical transmitter 111 of data transmission network 110.**

Ex. 1004, 11:1–3. Figure 2 includes delay unit 12 which gives a delay time difference, i.e., the bit time difference, between the intensity modulation and phase modulation signals. *Id.* at 11:49–51. The time delay may be given to the intensity modulation signal, the phase modulation signal, or different time delays are assigned to each. *Id.* at 11:50–54. A combining unit 13 combines the intensity modulation and phase modulation signals and based on the time delay from the time delay unit. *Id.* at 11:46–49.

Figure 20 of Tanaka is reproduced below.

FIG. 20

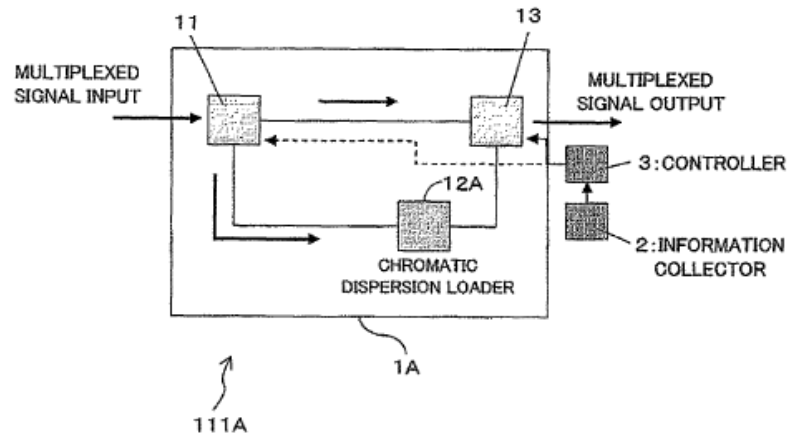


**Figure 20 is a block diagram of a second embodiment optical transmitter 111A of the invention.**

Ex. 1004, 9:40–42, 23:22–24. The second embodiment illustrated in Figure 20 differs from the first embodiment illustrated in Figure 2 in that the delay block of

optical transmitter 111A includes chromatic dispersion unit 12A in place of the delay unit 12. *Id.* at 23:24–28. Splitting unit 11 splits the “input signal (multiplexed signal) . . . into two signals. One of the two signals, as it is, is output to a wavelength-selective switch serving as the combining unit 13. The other signal is further given chromatic dispersion in the chromatic dispersion unit 12A.” *Id.* at 23:31–36. The optical coupler and chromatic dispersion loader create the bit time difference by loading the signals with different chromatic dispersion quantities. *Id.* at 23:43–48. The chromatic dispersion loader is inserted in either the phase modulation or the intensity modulation path. *Id.* at 24:46–49, 23:54–67.

*b. Ip (Ex. 1005)*

Ip is an article reviewing coherent, non-coherent, differentially coherent, and hybrid detection methods in high performance optical fiber systems. Ex. 1005, 1. Ip explains that “[a]n example of noncoherent detection is direct detection of on-off-keying (OOK) using a simple photodiode.” *Id.* at 7. Noncoherent detection measures the signal energy. *Id.*

A second detection method is differential phase-shift keying (DPSK),” which is an example of “differentially coherent detection.” *Id.* at 7. In differentially coherent detection, one bit is encoded per transmitted “symbol” and a phase measurement is made between the symbol of encoded data and one or more reference symbols. *Id.* at 5, 7. “A key motivation for employing differentially coherent detection is that binary DPSK has 2.8 dB higher sensitivity than noncoherent OOK.” *Id.* at 8.

Ip teaches “coherent detection” is “[t]he most advanced detection method” and constitutes “[t]he most promising detection technique for achieving high spectral efficiency while maximizing power (or SNR) efficiency.” Ex. 1005, 6, 9. With coherent detection, “the receiver computes decision variables based on the

*recovery of the full electric field, which contains both amplitude and phase information.” Id.*

Table 4 of Ip is reproduced below.

Table 4. Comparison between noncoherent, differentially coherent and coherent detection. For the first two detection methods, direct detection refers to the receiver implementations shown in Figs. 1–3, while homodyne/heterodyne refers to the equivalent implementations shown in Fig. 7.

|                                                                    | Noncoherent Detection  |           | Differentially Coherent Detection |           | Coherent Detection              |
|--------------------------------------------------------------------|------------------------|-----------|-----------------------------------|-----------|---------------------------------|
|                                                                    | Direct                 | Hom./Het. | Direct                            | Hom./Het. |                                 |
| Require LO?                                                        | No                     | Yes       | No                                | Yes       | Yes                             |
| Require Carrier Synchronization?                                   | No                     | No        | No                                | No        | Yes                             |
| Can compensate CD and PMD by a linear filter after photodetection? | No                     | Yes       | No                                | Yes       | Yes                             |
| Degrees of freedom per polarization per carrier                    | 1                      |           | 1                                 |           | 2                               |
| Modulation formats supported                                       | ASK, FSK, Binary PolSK |           | DPSK, CPFSK, Non-binary PolSK     |           | PSK, QAM, PolSK, ASK, FSK, etc. |

**Table 4 of Ip is a summary of detection methods.**

Ex. 1005, 14. “LO” in Table 4 refers to a local oscillator, which is a hardware component of the detection circuit required in some of the detection methods. *Id.* at 8.

*c. Claims 1 and 12*

First we discuss Petitioner’s arguments and supporting evidence, then Patent Owner’s arguments and supporting evidence, and then follow with an analysis of these arguments.

*i. Petitioner’s Arguments and Supporting Evidence*

In general, Petitioner relies on Tanaka’s separation of a mixed optical signal into intensity and phase modulation signals to teach the same “architecture” as recited in claim 1. Pet. 9–13, 17–25. Petitioner argues the separate signals of Tanaka are recombined after dispersion processing as one signal. *Id.* To the extent Tanaka does not use the words or expressly teach that the separated signals are “coherent” and “non-coherent” wavelength channels or paths, Petitioner argues a

person of ordinary skill would have had reason to combine Tanaka with the teachings of Ip relating to “coherent” and “non-coherent” detection. *Id.* at 13–16. Petitioner further argues that a person of ordinary skill would have been motivated to use “coherent” systems as taught by Ip because of Tanaka’s suggestion that when “upgrading transmission systems,” a person of ordinary skill would have found use of “coherent” wavelengths “is necessary. *Id.* at 16–17.

The preamble of claim 1, limitation [1.P], recites in pertinent part “[a]n optical assembly.” We agree with Petitioner that the preamble is not limiting. *See* Pet. 9; *see also DeGeorge v. Bernier*, 768 F.2d 1318, 1322 n.3 (Fed. Cir. 1985) (preamble generally does not limit the claims). Here, claim 1 does not depend on the phrase “optical assembly” for antecedent basis. Also, the body of claim 1 recites a structurally complete invention of an input optical port, two optical demultiplexers, and a dispersive element. The preamble of “optical assembly” does not recite essential structure or is not otherwise “necessary to give life, meaning, and vitality” to the claim. *Catalina Mktg. Int’l, Inc. v. Coolsavings.com, Inc.*, 289 F.3d 801, 808 (Fed. Cir. 2002) (citation and internal quotation marks omitted). In the alternative, Petitioner argues that the “optical transmitter 111A” of Tanaka is “an optical assembly.” Pet. 9–10 (citing Ex. 1004, 10:45–57, 23:22–30, Figs. 2, 20, 23).

Limitation [1.1.a] recites “an input optical port for receiving a mixed optical signal.” Petitioner argues Tanaka’s Figure 20, which illustrates a “multiplexed signal input,” meets the limitation. Pet. 10 (citing Ex. 1004, Fig. 20, 23:22–42, 8:54–60 (“an input port to which a wavelength multiplexed signal is input”); Ex. 1003 ¶ 92). According to Petitioner, Tanaka discloses that the input signal is “mixed” in disclosing the multiplexed signal includes “an intensity modulation optical signal and a phase modulation optical signal.” *Id.* at 10–11 (citing Ex.

1004, 5:25–29; 11:19–25; 24:56–59). Petitioner also provides a side by side comparison of Figure 2B of the '068 patent and Figure 40 of Tanaka illustrating respectively the '068 patent's "optical assembly" and Tanaka's "optical transmitter." *Id.* at 11.

Limitation [1.1.b] recites "containing a combination of coherent optical wavelength channels and non-coherent optical wavelength channels." Relating to "intensity modulation" and "phase modulation," Petitioner cites to the same disclosures of Tanaka as it did for limitation [1.1.a]. Pet. 11. In addition, Petitioner cites to Tanaka as "indicating that most disclosures relating to the first embodiment apply equally to the embodiment of FIG. 20." *Id.* (citing Ex. 1004, 23:24–30).

For the two required plural "channels" recitations of limitation [1.1.b], Petitioner argues "'WDM transmission systems' such as those discussed in Tanaka 'have the capacity of transmitting 40 channels' which can include both intensity/phase modulation channels." *Id.* at 11–12 (citing Ex. 1004, 1:57–61; 5:13–17; 4:11–19; 4:49–64). Relying in part on the Pollock Declaration, Petitioner contends "Tanaka discloses that in a preferred embodiment there are a plurality of intensity and phase modulation channels." *Id.* at 12 (citing Ex. 1004, 25:11–25; Ex. 1003 ¶ 94).

Specific to Tanaka's disclosure of "phase modulation," Petitioner argues Tanaka describes "DPSK (Differential Phase-Shift Keying) [and] DQPSK (Differential Quadrature Phase-Shift Keying)." Pet. 12 (citing Ex. 1004, 1:26–49). The Pollock Declaration includes testimony that DPSK and DQPSK are known to a person of ordinary skill as phase shift keying modulation methods for use in Tanaka's optical transmission system and are cited as part of Petitioner's showing. *Id.* (citing Ex. 1003 ¶¶ 95–96).

According to Petitioner, Tanaka describes “on-off keying” for “intensity modulation” channels. Pet. 12 (citing Ex. 1004, 1:14–25; Ex. 1003 ¶ 97). The Pollock Declaration and other prior art are cited for the contention that a person of ordinary skill “would have recognized that intensity modulation/on-off keying is an example of a non-coherent detection modulation method.” *Id.* (citing Ex. 1003 ¶ 97 (citing Ex. 1005, 7; Ex. 1013,<sup>15</sup> 284–285); Ex. 1010,<sup>16</sup> 874–886; Ex. 1014<sup>17</sup> ¶¶ 10–14 (citing Ex. 1016<sup>18</sup>; Ex. 1019<sup>19</sup>).

Petitioner also contends a person of ordinary skill “would have further recognized that DPSK and DQPSK (modulation in which both phase and quadrature components of a signal are detected) are examples of coherent detection modulation.” Pet. 12 (citing Ex. 1003 ¶ 96 (citing Ex. 1005, 7–9, 14; Ex. 1013, 284–287); Ex. 1014 ¶¶ 13–15; Ex. 1017<sup>20</sup>; Ex. 1019). Based on the preceding evidence, Petitioner concludes that “because Tanaka discloses that DPSK and DQPSK are modulation protocols suitable for use in the phase modulation optical channels, Tanaka also discloses that the mixed optical signal includes coherent

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<sup>15</sup> Leonid Kazovsky et al., *Optical Fiber Communications Systems* (1996) (Page numbers are to the pdf and not the exhibit.).

<sup>16</sup> John M. Senior, *Optical Fiber Communications: Principles and Practice*, 3rd Edition (December 26, 2008) (Page numbers are to the pdf and not the exhibit.).

<sup>17</sup> Declaration of Jacob Robert Munford, dated April 8, 2018 (evidence of public availability of Exhibits 1015, 1005, 1010, 1016, 1013, and 1017). Ex. 1014 ¶¶ 6–15.

<sup>18</sup> Machine Readable Catalog (MARC). Ex. 1014 ¶ 5 (Petitioner’s evidence of public availability for Ex. 1010).

<sup>19</sup> ISBN Registration for Ex. 1010.

<sup>20</sup> Western Michigan University library check out card (Petitioner’s evidence of public availability for Exhibit 1013 (Kazovsky)).

optical wavelength channels” and limitation [1.1.b] is disclosed by Tanaka.<sup>21</sup> *Id.* at 13 (citing Ex. 1004, 1:26–36, 5:25–29, 11:19–25, 24:56–59, 23:24–30, 25:11–25; Ex. 1003 ¶¶ 94–97).

Alternatively, Petitioner argues limitation [1.1.b] is disclosed by the combination of Tanaka and Ip. Pet. 13 (citing Ex. 1005, 7). Ip’s disclosure of “on-off-keying” is “intensity modulation” as taught by Tanaka. *Id.* (citing Ex. 1004, 1:14–54; Ex. 1005, 7; Ex. 1003 ¶¶ 98–99). Thus, Petitioner contends, the combination of Tanaka and Ip teaches that “noncoherent detection would be used for Tanaka’s intensity modulation channels.” *Id.*

As to the claimed “coherent optical wavelength channels,” Petitioner cites to Ip’s disclosure that “[t]he most advanced detection method is **coherent** detection, where the receiver computes decision variables based on the recovery of the **full electric field**, which contains **both amplitude and phase information**.” Pet. 13 (citing Ex. 1005, 9). Petitioner compares the preceding to the ’068 patent’s that “[t]he term ‘**coherent**’ refers to the ability to **measure the electric field ... (both amplitude and phase)**.” *Id.* at 14 (citing Ex. 1001, 2:55–57).

Petitioner concludes a person of ordinary skill “would have therefore recognized that it would be obvious and beneficial to use non-coherent detection for intensity modulation channels and coherent detection for phase modulation channels in Tanaka’s system (as suggested by Ip).” Pet. 14. Petitioner cites multiple reasons for combining Ip with Tanaka, including that coherent detection is “[t]he most advanced detection method” and allows for “**higher performance in**

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<sup>21</sup> Patent Owner argues that Petitioner’s Reply was the first time it argued Tanaka alone taught coherent detection. Sur-Reply 5 (citing Reply 11–15). As discussed above, this is not the case. Regardless, we do not base our findings of unpatentability on Tanaka alone but rather on the combination of Tanaka and Ip.

**optical fiber systems.’”** *Id.* at 13–16 (quoting Ex. 1005, 9, 1; Ex. 1003 ¶ 103; *see also* Ex. 1005, 6, 7, 9; Ex. 1003 ¶¶ 104–110 (additional reasons for the combination)). Petitioner also contends Tanaka expressly teaches a system combining phase modulation with intensity modulation channels, which, as discussed above, it contends are the recited coherent and non-coherent wavelength channels, “‘is necessary’ when ‘upgrading transmission systems.’” *Id.* at 16–17 (citing Ex. 1004, 4:11–19; Ex. 1003, ¶¶ 111, 101; *see also* Ex. 1004, 4:65–5:4; Ex. 1012,<sup>22</sup> 1; Ex. 1011<sup>23</sup> ¶ 5 (additional advantages of combining coherent (DPSK) and non-coherent (OOK) wavelength channels)).

Limitation [1.2] recites:

an optical demultiplexer configured to separate the combination of optical wavelength channels present on the input optical port such that a plurality of coherent optical wavelength channels and no non-coherent optical wavelength channels are provided onto a coherent optical path, and such that a plurality of non-coherent optical wavelength channels and no coherent optical wavelength channels are provided onto a non-coherent optical path.

Ex. 1001, 9:35–43.

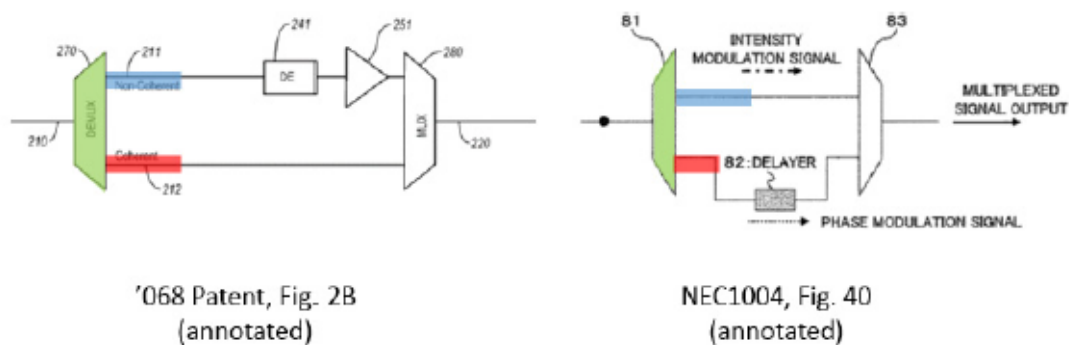
Tanaka’s Figure 20 illustrates a “splitting unit 11, which Petitioner contends is the recited “demultiplexer,” in which “the input signal (multiplexed signal) is split into two signals,” the intensity modulation optical signal and the phase modulation optical signal. Pet. 18–19 (citing Ex. 1004, 11:41–43, 23:31–32, 24:50–59, 40:15–19, Figs. 20, 23, *see also* Ex. 1004, 23:24–30 (Figure 2 applicable to the discussion of the embodiment of Figure 20); Ex. 1003 ¶¶ 112–116)).

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<sup>22</sup> B. Spinnler et al., *Nonlinear tolerance of differential phase shift keying modulated signals reduced by XPM*, Optical Fiber Communication Conference, 2004, OFC 2004, Los Angeles, CA, USA, 2004.

<sup>23</sup> EP 1 624 595 B1, Liu, Li et al., published April 18, 2007.

Petitioner relies on its arguments summarized above that the phase modulation channels are coherent channels and the intensity modulation channels are non-coherent channels. *Id.* at 19 (citing Ex. 1005, 6–9; Ex. 1004, 1:14–54, 23:20–25:7; Ex. 1003 ¶¶ 99–101). Petitioner also repeats its showing regarding multiple channels arguing Tanaka teaches “a combination of a plurality of phase modulation channels and intensity modulation channels.” *Id.* (citing Ex. 1004, 1:57–61, 25:11–25, 5:13–17, 4:11–19, 4:49–64; Ex. 1003 ¶¶ 94, 115). Petitioner continues by arguing “the separate intensity and phase modulation signals within the optical transmitter 111A” results in the phase modulation or coherent wavelength path having no non-coherent optical wavelength channels and the intensity modulation or incoherent wavelength path has no coherent optical wavelength channels. *Id.* at 20 (citing Ex. 1004, 23:31–32, 24:56–59, 11:41–43, Figs. 20, 23; Ex. 1003 ¶ 116). Further illustrating its argument that Tanaka teaches limitation [1.2], Petitioner provides an annotation of Figure 2B of the ’068 patent and Figure 40 of Tanaka, which is reproduced below.



**Figures 2B and 40, respectively of the ’068 patent and Tanaka, show optical transmission systems.**

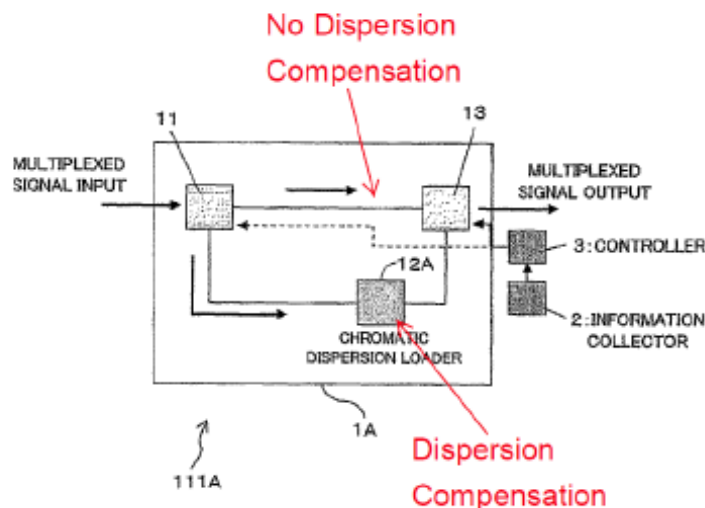
*Id.* (citing Ex. 1003 ¶ 113). Petitioner’s annotations of each figure show the non-coherent output of the ’068 patent demultiplexer on the left and Tanaka’s optical transmitter on the right in blue and the coherent output of each in red.

Limitation [1.3] recites:

a dispersive element disposed in one or both of the coherent and non-coherent optical paths and that operates such that a different amount of dispersion is applied to the plurality of non-coherent optical wavelength channels traveling through the non-coherent optical path than the amount of dispersion, if any, that is applied to the coherent optical path.

Petitioner points out that the '068 patent “describes the dispersive element as a component for applying dispersion compensation to an optical signal to correct for optical dispersion of an optical signal. Pet. 20 (citing Ex. 1001, 5:44–58, 6:43–54). Petitioner argues that “dispersive element” is described broadly in the '068 patent, including in one example a “dispersion compensating fiber.” *Id.* at 21 (citing Ex. 1001, 6:45–48, *see also* Ex. 1001, 5:49–58, 7:28–33, 8:1–7, 2:42–54 (describing other dispersive elements); Ex. 1003 ¶ 118). Petitioner argues Tanaka’s Figure 20 shows chromatic dispersion compensation is applied to only one set of channels. *Id.* at 21 (citing Ex. 1004, 23:22–67, 24:3–49, 5:44–49, Fig. 20). At page 21 of the Petition, annotated Figure 20 of Tanaka illustrates this point and is reproduced below.

FIG. 20

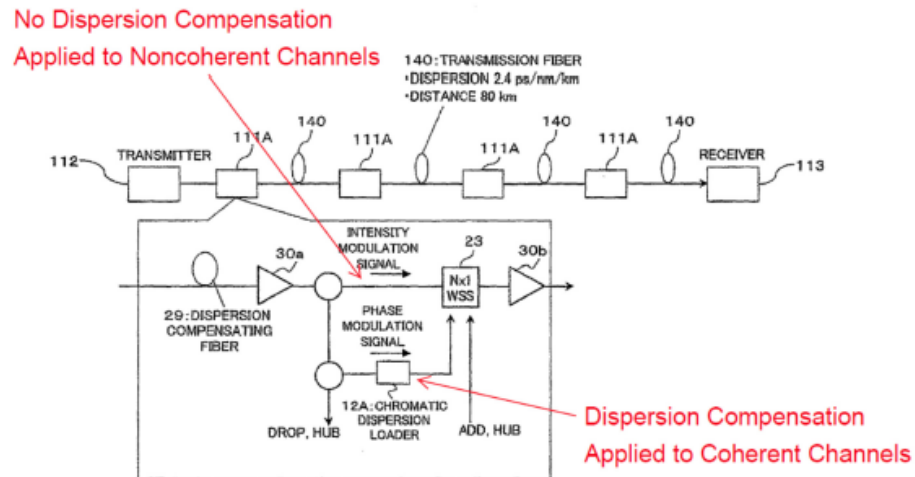


### Petitioner's Annotation of Figure 20 of Tanaka

*Id.* Annotated Figure 20 of Tanaka shows the chromatic dispersion loader 12A is inserted in the path of an optical signal, which can be either the phase modulation or the intensity modulation optical signal, such that “a chromatic ***dispersion difference*** is given between a phase modulation optical signal and an intensity modulation optical signal.”

*Id.* at 22 (citing Ex. 1004, 24:46–49, 24:27–29, 23:54–67). The Petition includes annotated Figure 23 of Tanaka, which is reproduced below.

FIG. 23



**Annotated Figure 23 shows the chromatic dispersion loader 12A applies dispersion compensation to the phase modulation or coherent channels but not to the intensity modulation or non-coherent channels.**

Pet. 22 (citing Ex. 1004, 24:50–25:7, Fig. 23). Petitioner argues “Tanaka also discloses that an example dispersion compensating unit is ‘dispersion compensating fiber,’ mirroring the ’068 patent’s example of using ‘dispersion compensating fiber’ as the dispersion compensating element.” *Id.* (compare Ex. 1004, 22:51–23:18 and Ex. 1001, 8:1–7). Petitioner argues the “use of dispersion compensating fiber in the chromatic dispersion loader 12A would have been obvious in light of Tanaka’s express disclosure of using dispersion compensating fiber to compensate for dispersion in an optical signal.”

*Id.* at 22–23 (citing Ex. 1003 ¶ 120; *see also Boston Scientific Scimed, Inc. v. Cordis*, 554 F.3d 982, 990 (Fed. Cir. 2009) (“Combining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness.”)).

Petitioner again compares Figure 2B of the ’068 patent to Figure 40 of Tanaka. Pet. 23 (*see above*). Petitioner argues optical element 82, labeled a “delayer” in the ’068 patent is related to Tanaka’s disclosure of a “time delay between channels” which is interrelated with chromatic dispersion.” *Id.* (citing Ex. 1004, 36:3–12, 23:3–13; Ex. 1003 ¶ 119).

Limitation [1.4] recites:

an optical multiplexer configured to receive and combine the optical wavelength channels from the coherent and non-coherent optical paths to form a mixed coherent and non-coherent optical output signal on an output of the optical multiplexer.

Ex. 1001, 9:51–55.

Pointing to Figure 20 of Tanaka and its “combining unit 13,” Petitioner argues the combining unit receives an input of two optical signals from the optical coupler 11 and chromatic dispersion loader 12A and “generates and outputs a wavelength multiplexed signal” labeled as the “Multiplexed Signal Output” in Figure 20. Pet. 24 (citing Ex. 1004, 23:31–24:18, 40:26–28, Figs. 20, 23; Ex. 1003 ¶¶ 121–122). Petitioner cites its showing made in connection with limitation [1.1.b] above that phase modulation channels are coherent channels and intensity modulation channels are non-coherent channels. *Id.* at 24. According to Petitioner, a person of ordinary skill would have recognized that the “wavelength multiplexed signal” is the recited mixed coherent and non-coherent optical output signal of limitation [1.4]. *Id.* at 25 (citing Ex. 1005, 6–9; Ex. 1004, 1:14–54; 23:20–25:7; Ex. 1003 ¶¶ 99–101).

Independent claim 12 includes elements corresponding to those of claim 1. Petitioner makes all but the same arguments for unpatentability of claim 12 as it did for

claim 1. Pet. 37–47. Patent Owner acknowledges that Petitioner’s claim 12 analysis mirrors the analysis for claim 1. PO Resp. 53. Patent Owner relies on the same arguments for both claims 1 and 12. *Id.* at 53–54.

*ii. Patent Owner’s Arguments and Supporting Evidence*

Patent Owner contends that Tanaka does not teach that the phase modulation signal of Tanaka’s Figure 20 means the signal is generated by DPSK or DQPSK. PO Resp. 19<sup>24</sup> (citing Ex. 2003 ¶¶ 40–66); *see also* Section III.B.3.a above (describing Tanaka Figures 2 and 20). More specifically, Patent Owner notes that Tanaka mentions DPSK and DQPSK only in the background section. PO Resp. 20 (citing Ex. 1004, 1:47–49). Patent Owner concludes that Petitioner cannot rely on DPSK/DQPSK to show “coherent optical wavelength channels.” *Id.* at 21 (citing Pet. 12 (citing Ex. 1003 ¶ 96 (citing Ex. 1005, 7–9, 14; Ex. 1013, 284–287))).

Patent Owner references Petitioner’s citation to Tanaka and argues the citation does not equate the phase modulation signal of Tanaka to DPSK or DQPSK modulation but rather that they are “being actively investigated.” *Id.* at 20

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<sup>24</sup> The Response notes as “an initial matter” that modulation, as taught by Tanaka, is not detection. PO Resp. 19–20 (citing Pet. 11–13; Dec. 37). Petitioner argues that modulation of the wavelength occurs during transmission whereas detection occurs at reception. *See* Tr. 17:5–18:2. Patent Owner agrees “a modulated signal that’s differentially coherent . . . [is] really no different than detecting a differentially coherent signal at the other end.” *Id.* at 33:9–12; *see also* Ex. 1023 ¶ 6 (“The modulation method selected for encoding information onto an optical carrier determines the necessary detection method.”) (citing Ex. 1005, Abstract, 6–10); *see also* Ex. 1005, 1, 6 (discussing both detection and modulation). As relevant to our findings and conclusions, once modulated for transmission, the same signal is received for detection.

(citing Ex. 1004, 1:47–49; Pet. 12).<sup>25</sup> According to Patent Owner, Tanaka’s “phase modulation signal,” separate from an intensity modulation signal, is not the recited “coherent optical wavelength channels.” *Id.* at 10–14 (describing Tanaka), 16–24. Patent Owner argues combining Ip with Tanaka does not remedy that Tanaka does not teach “coherent” signal transmission because Ip explains that differentially coherent signal detection, like DPSK, detects only phase and not both amplitude and phase, as one of ordinary skill would understand “coherent.” *Id.* at 14–16 (describing Ip), 24–31.

Patent Owner argues DPSK and DQPSK are phase modulation methods only and do not also involve “both amplitude and phase information,” as required by the undisputed understanding of the coherent terms. PO Resp. 22 (citing Ex. 1004, 1:47–48, 4:32–33; Ex. 2003 ¶ 48) (emphasis omitted); Sur-Reply 3–4; *see also* Section III.A above (regarding coherent terms). Patent Owner argues the Pollock Declaration, which supports Petitioner’s position, is a “conclusory **single paragraph** conclusion.” PO Resp. 23–24; *see also* Ex. 1003 ¶ 96 (a person of ordinary skill would have understood that DPSK and DQPSK disclose coherent detection modulation).

Relying on its own expert, Patent Owner asserts that “DPSK is an example of **differentially** coherent detection, but further review of *Ip* makes it clear that **differentially** coherent detection (detecting only phase) and coherent detection (detecting both amplitude and phase) are different techniques” and DPSK cannot be coherent detection. PO Resp. 24–25 (citing Ex. 1005, 1, 14 (Table 4 (*see*

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<sup>25</sup> Because we find the combination of Ip with Tanaka teaches the “coherent” wavelength channel, limitation [1.1.b], we need not reach whether or not “Tanaka alone” would meet Petitioner’s burden. *See* Sur-Reply, 5 (contending “Tanaka alone” is a new argument).

Section III.A.3.b above)); Ex. 2003 ¶¶ 51–55, 76–78). Patent Owner alleges Ip contradicts the Pollock Declaration testimony that “differentially coherent detection . . . constitutes a **form** of coherent detection, as that term is used in the ’068 patent.” *Id.* at 26 (citing Ex. 1003 ¶ 96; *see also* Ex. 2003 ¶¶ 56–57 (contradicting Pollock Declaration asserting “differentially coherent” is not “a form of ‘coherent detection’)). Patent Owner alleges Ip’s teaching that “‘coherent’ detection encodes information in all the available degrees of freedom (including both amplitude and phase).” PO Resp. 26–27 (citing Ex. 2003 ¶ 57; Ex. 1005, 14 (Table 4)). Patent Owner adds that Table 4 of Ip contrasts “differentially coherent detection,” which has “only has one degree of freedom per polarization per carrier,” with coherent detection, which has two degrees of freedom, amplitude and phase. *Id.* at 27 (citing Ex. 2003 ¶ 58).

Patent Owner cites Ip 2<sup>26</sup> and Kahn<sup>27</sup> as further support that “differentially coherent” is not “a form of ‘coherent detection.’” PO Resp. 27–29, *see also id.* (Ezra Ip and Joseph M. Kahn are both co-authors of Ip and Ip 2). Ip 2 is cited for its disclosure that “‘**[c]oherent detection**’ denotes synchronous detection by a phase-locked local oscillator, and **should be distinguished** from noncoherent detection (*e.g.*, of OOK) and **differentially coherent detection (*e.g.*, of DPSK).**” *Id.* at 28 (quoting Ex. 2004, 2029 n.1; Ex. 2003 ¶ 59). Kahn is cited as additional support that coherent detection is different from “noncoherent” detection and differentially coherent detection (DPSK). *Id.* at 28–29 (citing Ex. 2001, 1 (Table 1), 2 (Table 2); Ex. 2003 ¶ 60). Based on the preceding evidence, Patent Owner

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<sup>26</sup> Ezra Ip et al., *Linewidth Measurements of MEMS-Based Tunable Lasers for Phase-Locking Applications*, 17 IEEE Photonics, Technology Letters, 10 (2005), (“Ip 2,” Ex. 2004).

<sup>27</sup> J.M. Kahn, *Modulation and Detection Techniques for Optical Communication Systems*, OSA/COTA (2006), (“Kahn,” Ex. 2001).

argues “Dr. Pollock’s attempt to equate ‘differentially coherent’ with ‘coherent’ detection and thereby associate DPSK modulation with coherent detection is unsupported and incorrect.” *Id.* at 29 (citing Ex. 2003 ¶ 61).

Patent Owner next turns to the Pollock Declaration testimony in paragraph 96 that in DQPSK “both phase and quadrature components of a signal are detected.” PO Resp. 29. Based on evidence of record, including Ip, Patent Owner contends that “quaternary DPSK” is an example of “DPSK with **differentially coherent detection**” and is the same as DQPSK. *Id.* at 30 (citing Ex. 1005, 16; Ex. 2002,<sup>28</sup> 14:47–48 (“4-DPSK modulation (DQPSK, from Differential Quaternary PSK)”); Ex. 2001, 2 (Table 2); Ex. 2003 ¶ 64). Kahn’s Table 2 as highlighted in yellow by Patent Owner is reproduced below.

Table 2. Comparison of detection techniques. Shading denotes an advantage. Noncoherent and differentially coherent detection assume single-polarization filtering at the receiver. Receiver sensitivities are the values of  $n_b/n_{avg}$  required for  $P_b = 10^{-9}$ .

| Attribute                                                                             | Noncoherent             |                  | Differentially Coherent        |                  | Coherent                      |
|---------------------------------------------------------------------------------------|-------------------------|------------------|--------------------------------|------------------|-------------------------------|
| Maximum number of degrees of freedom (per polarization)                               | 1 (magnitude)           |                  | 1 (phase)                      |                  | 2 (two quadrature components) |
| Receiver sensitivity for binary                                                       | 38 photons/bit (2-PAM)  |                  | 20 photons/bit (2-DPSK)        |                  | 18 photons/bit (2-PSK)        |
| Receiver sensitivity for <b>quaternary</b>                                            | 134 photons/bit (4-PAM) |                  | 31 photons/bit <b>(4-DPSK)</b> |                  | 18 photons/bit (4-PSK)        |
|                                                                                       | Heterodyne / Homodyne   | Direct Detection | Heterodyne / Homodyne          | Direct Detection | Heterodyne / Homodyne         |
| Electrical filtering can be used to select channel (enables frequency-agile receiver) | Yes                     | No               | Yes                            | No               | Yes                           |
| Chromatic dispersion is linear distortion (enables effective electrical compensation) | Yes                     | No               | Yes                            | No               | Yes                           |
| Local oscillator laser required at receiver                                           | Yes                     | No               | Yes                            | No               | Yes                           |
| Polarization control or diversity required at receiver                                | Yes                     | No               | Yes                            | No               | Yes                           |

### Kahn Table 2 Comparing Detection Techniques

Ex. 2001, 2. Kahn’s Table 2’s comparison shows in grey shading advantages of each detection technique. *Id.* at Table 2.

Turning to the reasons for combining Tanaka and Ip, Patent Owner argues that none of the eight reasons cited by Petitioner (Pet. 14–16) show why a person of ordinary skill “would have only applied coherent detection to the phase

<sup>28</sup> Raheli, US 6,389,079, issued May 14, 2002 (“Raheli,” Ex. 2002).

modulation signal and non-coherent detection to *Tanaka*'s intensity modulation signal." PO Resp. 31–32. In addition, Patent Owner argues the reasons cited reflect improper hindsight. *Id.* at 32 n.4 (asserting that Petitioner assumes "that phase modulation signal and coherent channels refer to the same thing or that a phase modulation signal suggests coherent channels.").

As to the first six reasons listed by Petitioner (Pet. 14–15), Patent Owner argues they are generic and not specific as to why a person of ordinary skill would have "chosen the phase modulation signal in *Tanaka* for 'coherent' detection." PO Resp. 33 (citing Ex. 2003 ¶ 67). Thus, Patent Owner contends, only with hindsight would Ip be combined with *Tanaka*. *Id.* at 33–34.

Petitioner's seventh reason for a motivation to combine is that "intensity modulation in the form of on-off keying is a primary example of noncoherent detection" and *Tanaka* expressly identifies on-off keying as an intensity modulation method for use in *Tanaka*'s system. See Pet. 15 (citing Ex. 1005, 7; Ex. 1004, 1:14–54; Ex. 1003 ¶ 109). Patent Owner argues this reason does not relate to how or why a person of ordinary skill would have modified *Tanaka*'s phase modulated optical signal using coherent optical channels. PO Resp. 34 (citing Ex. 2003 ¶ 68).

Petitioner's eighth reason for the combination is that the combination is the application of a known technique, of non-coherent detection in intensity modulation channels to the *Tanaka*'s known optical system. Pet. 15–16. Patent Owner argues the reasoning presented is conclusory for two reasons. PO Resp. 34–35 (citing Ex. 2003 ¶ 69). First, Patent Owner argues that to find a motivation to combine existed requires us to find that *Tanaka*'s "phase modulation optical signal 'must have been generated by one of two modulation methods called DPSK and DQPSK.'" *Id.* at 35. According to Patent Owner, the eighth reason thus

requires us to find that “DPSK/DQPSK modulation necessarily provides ‘coherent’ optical wavelength channels.” *Id.* (citing Ex. 2003 ¶ 69).

Patent Owner also contests whether Petitioner has shown limitation [1.2], which recites, in pertinent part, “a plurality of coherent optical wave-length channels and no non-coherent optical wave length channels are provided onto a coherent optical path.” PO Resp. 36; *see also* Ex. 1001, 10:37–40. Patent Owner relies on its prior arguments that Petitioner has not shown “coherent optical wavelength channels” for support. *Id.* at 36–37. Patent Owner also argues that Tanaka’s teaching of “splitting signals” into amplitude and phase is not separating signals into “noncoherent” and “coherent” signals. *Id.* at 37–40, *see id.* at 38 (citing Ex. 1004 at 11:14–49, Fig. 2 (annotated); Ex. 2003 ¶¶ 73–75).<sup>29</sup> Patent Owner argues that Tanaka’s splitting of signals is solving the problem of cross-phase modulation between intensity and phase modulation and not the problem purportedly solved in the ’068 patent, separating non-coherent and coherent signals. PO Resp. 39–40 (citing Ex. 1004, 4:40–48, 11:41–49; Ex. 2003 ¶¶ 74–77).

Still considering limitation [1.2], Patent Owner argues a person of ordinary skill would not have been motivated to implement non-coherent and coherent optical paths into the system taught by Tanaka. PO Resp. 41–44. Patent Owner makes this argument on the assumption that we find that Tanaka discloses or suggests coherent optical wave-length channels. *Id.* at 41. Patent Owner still bases this argument on a finding that the amplitude and phase paths taught by Tanaka are separate and cannot be coherent because neither path combines amplitude and phase. *Id.* at 42–44 (citing Ex. 2003 ¶¶ 47, 71–78); *see* Section III.A above.

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<sup>29</sup> Patent Owner notes that Ip does not teach separating and combining signals. PO Resp. 40–41. Petitioner asserts the separating is taught by Tanaka. *See* Pet. 17–20.

Patent Owner also contends that the Tanaka and Ip combination does not disclose or suggest a “dispersive element” as claimed in limitation [1.3]. PO Resp. 44–45. Patent Owner argues Petitioner has not shown that “a different amount of dispersion is applied to the plurality of non-coherent optical wavelength channels traveling through the **non-coherent optical path** than the amount of dispersion, if any, that is applied to the **coherent optical path**” as required by limitation [1.3]. *Id.* at 45. Patent Owner alleges the showing made is “faulty” because it relies on the showing relating to limitation [1.2] regarding “coherent and non-coherent optical paths.” *Id.* (citing Ex. 2003 ¶ 79).

Patent Owner argues that “the Petition mixes different embodiments of *Tanaka* without explanation, and consequently is flawed.” PO Resp. 45 (citing Ex. 2003 ¶¶ 80–85); Sur-Reply 23–24. Patent Owner argues Petitioner relies on the second embodiment of Tanaka’s Figure 20 to identify the recited “mixed optical signal” limitation of claim 1, but uses the Tanaka’s background and third embodiment of Tanaka to show “coherent optical wavelength channels,” i.e., *plural* channels. *Id.* at 46–48 (citing Pet. 11–12 (citing Ex. 1004, 5:25–29, 11:19–25, 23:24–30, 24:56–59)).

Patent Owner notes that what the Petition cites from Tanaka’s second embodiment does not disclose “plural” channels but “includes a **single** intensity modulation signal and a **single** phase modulation signal.” PO Resp. 47–48 (quoting Ex. 1004, 5:25–29, 11:19–25, 23:24–30, 24:56–59). Patent Owner alleges plural channels are not taught in the second embodiment and turns to the third embodiment to fix the problem. *Id.* at 50 (citing Pet. 12 (citing Ex. 1004, 25:11–25)). Patent Owner also argues there is no showing of why or how a person of ordinary skill would have combined the second and third embodiments to reach plural channels. *Id.* at 48–50.

*iii. Discussion and Determination*

In its asserted combination of Tanaka and Ip, Petitioner relies on Tanaka for the limitations in the independent claims (claims 1 and 12) and additionally argues that “to the extent that that Tanaka does not expressly use the terms ‘coherent’ and ‘non-coherent,’ use of coherent detection for Tanaka’s phase modulation channels and non-coherent detection for Tanaka’s intensity modulation channels would have been obvious to a POSITA based on the suggestions of Ip.” Pet. 13.

A central issue is whether Petitioner has demonstrated that its combination of Tanaka and Ip teaches or suggests the requisite non-coherent and coherent detection required by the claims. We find that the Petitioner has met its burden to do so. There is no dispute that Ip discloses coherent detection as required by the claims. Both the challenged patent and Ip describe coherent detection as measuring the electric field of the transmitted channel (both amplitude and phase). Ex. 1001, 2:55–57 (“The term ‘coherent’ refers to the ability to measure the electric field of the transmitted channel during detection (both amplitude and phase.)”; Ex. 1005, 9 (“The most advanced detection method is coherent detection, where the receiver computes decision variables based on the recovery of the full electric field, which contain both amplitude and phase information.”); see Pet. 13 (citing Ex. 1001, 2:55–57, Ex. 1005, 9) (“This disclosure of Ip closely matches the description in the ’068 Patent.”); Ex. 1003 ¶ 96; Ex. 2003 ¶ 47. Thus, we find that Ip discloses coherent detection as required by the claims, as Petitioner contends (Pet. 13).

Similarly, we find that Ip’s non-coherent detection methods disclose the recited “non-coherent optical wavelength channels” because Ip’s description of non-coherent detection agrees with the description in the challenged patent—both discuss direct detection and not measuring the electric field. Ex. 1001, 5:22–25

(“Non-coherent optical wavelength channels are the optical wavelength channels that will be directly (or non-coherently) detected without measuring the electric field of the optical signal.”); Ex. 1005, 7 (“In noncoherent detection, a receiver computes decision variables based on a measurement of signal energy. An example of noncoherent detection is direct detection of on-off-keying (OOK) using a simple photodiode. . . . the achievable performance is suboptimal compared with optical or electrical equalization making use of the full electric field.”); see Pet. 13 (quoting Ex. 1005, 7) (Ip specifies that “[a]n example of noncoherent detection is direct detection of on-off-keying (OOK).”

Another central issue is whether Petitioner has demonstrated that “a skilled artisan would have had reason to combine the teaching of the prior art references to achieve the claimed invention, and that the skilled artisan would have had a reasonable expectation of success in doing so.” *PAR Pharm., Inc. v. TWI Pharm., Inc.*, 773 F.3d 1186, 1193 (Fed. Cir. 2014). Patent Owner contends that Petitioner’s combination is based on impermissible hindsight because Petitioner does not provide sufficient reasoning to explain why one of ordinary skill in the art would have used Ip’s coherent detection as a substitute for Tanaka’s phase modulation, rather than using Ip’s coherent detection for Tanaka’s intensity modulation. PO Resp. 31–35.

As explained in more detail below, we do not agree with Patent Owner. Rather, the record evidence supports Petitioner’s position that based on the many benefits of coherent detection identified by Ip, one of ordinary skill in the art would have been motivated to use Ip’s coherent detection for the phase modulation channel in Tanaka’s system. Pet. 14–15 (citing Ex. 1005, 6, 9). Specifically, Petitioner relies on Ip’s statements that (1) coherent detection is “[t]he most advanced detection method”), (2) is promising for achieving high spectral

efficiency while maximizing power (or SNR) efficiency, (3) “is highly advantageous because adaptive algorithms can be used to compensate time-varying transmission impairments,” (4) allows for “[a]dvanced forward error-correction code” that leads to decreased error rates in information transmission, (5) allows for “digitized signals [to] be delayed, split, and amplified without degradation in signal quality,” and (6) “allows the greatest flexibility in modulation formats.” Pet. 14–15 (quoting Ex. 1005, 6, 9).

We find persuasive Petitioner’s contentions that one of ordinary skill in the art would have used both non-coherent detection and coherent detection in Tanaka’s system “rather than replacing all of Tanaka’s channels with coherent detection phase modulation channels because, as expressly described by Tanaka, combination of phase modulation channels with intensity modulation channels in the same system ‘is necessary’ when ‘upgrading transmission systems.’” Pet. 16–17 (citing Ex. 1004, 4:11–19).

Similarly, we find persuasive Petitioner’s contention that one of ordinary skill in the art would have used non-coherent detection for Tanaka’s intensity modulation channel (rather than Tanaka’s phase modulation channel). Pet. 15. Tanaka identifies “on-off keying” as an intensity modulation method used in Tanaka’s system and Ip explains “[a]n example of noncoherent detection is direct detection of on-off-keying (OOK) using a simple photodiode.” Ex. 1004, 1:14–54; Ex. 1005, 7. Based on Tanaka’s teaching that “on-off keying” is used for intensity modulation, we also find that Tanaka teaches its intensity modulation is a non-coherent channel, as Petitioner contends. Pet. 12.

Because one of ordinary skill in the art would have used both non-coherent detection and coherent detection in Tanaka’s system when upgrading to Ip’s coherent detection (as suggested by Tanaka) and because Tanaka’s system uses

non-coherent channels in the form of intensity modulation, we also agree with Petitioner that one of skill in the art would have used Ip's coherent detection for Tanaka's phase modulation channels. Pet. 13, 15, 16–17.

We also note that Petitioner, in response to Patent Owner's argument, also provided evidence that non-coherent detection would not be compatible with phase modulation. Pet. Reply 6 (citing Ex. 1005, 7) (“Ip demonstrates that non-coherent detection is incompatible with modulation methods with a phase component due to the ‘loss of phase information during detection’ for non-coherent detection.”; Pet. Reply 7 (citing Ex. 1010, 766) (“It is possible, however, to use the optical phase change information if it is recovered by employing a coherent receiver (see Section 13.2) rather than a direct detection receiver.”).

We also find persuasive Petitioner's contention, which relies on testimony from Dr. Pollock, that Petitioner's proposed combination would lead to predictable results and, as such, one of ordinary skill in the art would have had a reasonable expectation of success in making the subject matter of the independent claims. Pet. 15–16 (citing Ex. 1003 ¶ 110). We also note the level of ordinary skill—a Bachelor of Science in electrical engineering or a field related to fiber-optic communications and three to five years of experience in fiber-optic communications systems, or a related discipline—further supports our finding. *Innovention Toys, LLC v. MGA Entm't, Inc.*, 637 F.3d 1314, 1323 (Fed. Cir. 2011) (“A less sophisticated level of skill generally favors a determination of nonobviousness . . . while a higher level of skill favors the reverse.”).

For these reasons and further reasons set forth below, we determine that Petitioner has demonstrated by a preponderance of the evidence that the subject matter of the independent claims would have been obvious in view of the combination of Tanaka and Ip set forth by Petitioner.

*a. Claims 1 and 12*

Regarding Limitation [1.1.a], based on a plain reading of Tanaka, we agree with Petitioner that Tanaka’s multiplex signal input of an intensity modulation optical signal and a phase modulation optical signal in Figure 20 teaches the recited “input optical port for receiving a mixed optical signal.” Ex. 1004, 5:25–29; 11:19–25; 24:56–59; Pet. 10–11 (citing Ex. 1004, 5:25–29; 11:19–25; 24:56–59). Tanaka’s multiplexed signal input of the two signals teaches a mixed optical signal.

The first dispute is over limitation [1.1.b]. We find that Tanaka teaches both a “phase modulation” signal and an “intensity modulation” signal where each are transmitted on a separate “wavelength channel.” Ex. 1004, 5:25–29, 35:36–41 (optical transmitter 111G relays “a wavelength multiplexed signal of an intensity modulation optical signal and a phase modulation optical signal through a transmission line”), Fig. 40.

We find that the Tanaka and Ip combination meets the “non-coherent optical wavelength channel” element of limitation [1.1.b]. Tanaka is relied on by Petitioner for its teaching of intensity modulation. See Pet. 11 (citing Ex. 1004, 5:25–29, 11:19–25, 24:56–59, 23:24–30, Fig. 20); Reply 4 (citing Ex. 2003 ¶ 77). The evidence of record supports a finding that detection of a wavelength based on intensity alone, as taught by Tanaka, is non-coherent. The Pollock declaration, the Islam Declaration, the Islam deposition, and Ip 2 all support our finding that intensity modulation is the recited “noncoherent optical wavelength channels.” Ex. 1005, 7 (noncoherent detection is measurement of signal energy as by direct detection of on-off-keying (OOK) by a photodiode); Ex. 1003 ¶ 64 (“in **non-coherent** systems, information is encoded in the intensity of the optical pulse”); Ex. 2003 ¶ 77; Ex. 1027, 102:10–16; 103:6–16; 101:19–21; 90:14–22; Ex. 2004, 1

(“noncoherent” detection is OOK). This assertion is made in Petitioner’s Reply at page 4. Patent Owner argues that “it is not true that an intensity modulated signal *has to be* non-coherently detected.” Sur-Reply 9 (citing Ex. 1005, 14 (Table 4) (regarding ASK); Ex. 2005, 110:17–111:5, 111:20–112:7) (emphasis added). As such, Patent Owner acknowledges that intensity modulation can be non-coherent detection and, on this record, that is supported by the evidence cited above.

We also find that Ip’s non-coherent detection channels disclose the recited “non-coherent optical wavelength channels” because, among other reasons, Ip’s description of “noncoherent” detection agrees with the description in the ’068 patent—both discuss direct detection and not measuring the electric field. The ’068 patent explains that “[n]on-coherent optical wavelength channels are the optical wavelength channels that will be directly (or non-coherently) detected without measuring the electric field of the optical signal.” Ex. 1001, 5:22–25. Ip has a similar disclosure:

In noncoherent detection, a receiver computes decision variables based on a measurement of signal energy. An example of noncoherent detection is direct detection of on-off-keying (OOK) using a simple photodiode. . . . the achievable performance is suboptimal compared with optical or electrical equalization *making use of the full electric field.*”

Ex. 1005, 7 (emphasis added).

We also find that Ip teaches non-coherent detection and that a person of ordinary skill would have replaced Tanaka’s intensity modulation channel with non-coherent detection rather than replacing all of Tanaka’s channels with coherent detection phase modulation channels. See Pet. 16. The motivation to do so would have been Tanaka’s teaching to multiplex and transmit intensity modulation and phase modulation optical signals for upgrading WDM transmission

systems. *See id.* at 17 (citing Ex. 1004, 4:11–19). We also agree with Petitioner that a person of ordinary skill would have had reasons to substitute Ip’s teaching of non-coherent detection for Tanaka’s intensity modulation channels because both are described as using on-off keying. *Id.* at 13 (citing Ex. 1005, 7 (“An example of noncoherent detection is direct detection of on-off-keying (OOK) using a simple photodiode.”); Ex. 1004, 1:50–54 (describing “intensity modulation (on-off keying) is used in WDM transmission systems)).

The other signal of limitation [1.1.b] is “coherent optical wavelength channels,” i.e., coherent detection. Ex. 1001, 9:32–33. As discussed in Section III.A above, a person of ordinary skill would have understood “coherent detection” to include measurement of the entire electric field, including amplitude and phase. *See* Ex. 1005, 9. Tanaka’s teaching of phase modulation is not “coherent” because it only includes phase detection not phase *and* amplitude. *See* Ex. 1004, 11:14–25, Fig. 2.

We find that Ip’s coherent channels disclose the second element of limitation [1.1.b], “coherent optical wavelength channels.” Our finding is based, in part, on the ’068 patent and Ip using nearly identical terminology to describe their respective coherent channels. The ’068 patent states that “[t]he term ‘coherent’ refers to the ability to measure the electric field of the transmitted channel during detection (both amplitude and phase).” Ex. 1001, 2:55–57. Ip explains that “[t]he most advanced detection method is coherent detection, where the receiver computes decision variables based on the *recovery of the full electric field*, which contain both amplitude and phase information.” Ex. 1005, 9. Petitioner argues “[t]his disclosure of Ip closely matches the description in the ’068 Patent.” *See* Pet. 13 (citing Ex. 1001, 2:55–57, Ex. 1005, 9); *see also* Ex. 1003 ¶¶ 98, 100 (Ip suggests use of coherent detection in combination with Tanaka’s intensity

detection); Ex. 2003 ¶¶ 47 (citing both the '068 patent and Ip disclosures of “coherent” require ability to measure “both amplitude and phase”).

Patent Owner argues Dr. Pollock is not qualified to provide opinions because his background is in lasers and not communications and therefore he does not have the level of ordinary skill associated with the '068 patent. Sur-Reply 28 (citing Pet. 4–5; Ex. 2005, 70:2–3, 73:13–19; *see also* Section III.B.2 above (determining level of ordinary skill)). We are not persuaded. An expert witness must be qualified as an expert by knowledge, skill, experience, training, or education to testify in the form of an opinion. Fed. R. Evid. 702. There is, however, no requirement of a perfect match between the expert’s experience and the relevant field. *SEB S.A. v. Montgomery Ward & Co.*, 594 F.3d 1360, 1373 (Fed. Cir. 2010). A person may not need to be a person of ordinary skill in the art in order to testify as an expert under Rule 702, but rather must be “qualified in the pertinent art.” *Sundance, Inc. v. DeMonte Fabricating Ltd.*, 550 F.3d 1356, 1363–64 (Fed. Cir. 2008). *See* Notice of Update to Office Patent Trial Practice Guide, 83 Fed. Reg. 156, (Aug. 13, 2018) (text of update available at [https://www.uspto.gov/sites/default/files/documents/2018\\_Revised\\_Trial\\_Practice\\_Guide.pdf](https://www.uspto.gov/sites/default/files/documents/2018_Revised_Trial_Practice_Guide.pdf)).

The record here supports our finding that coherent light is transmitted by a laser. *See, e.g.*, Ex. 1001, 3:52–54 (“lasers are an appropriate optical transmitter”); Ex. 1005, 9 (Fig. 4(a) (“TX laser” as an “implementation” of a “[c]oherent transmission system”)). “Coherent optical wavelength channels” for transmission and subsequent detection is the most significant question in this case and was all but the only issue argued at the oral hearing. *See generally* Tr.

Patent Owner argues Dr. Pollock’s deposition testimony directly contradicts Ip and his testimony should be given little or no weight. Sur-Reply 14–17 (chart

*comparing* Ex. 1005, 8, 9, 14 (Table 4) *and* Ex. 2005, 78:25–79:3,<sup>30</sup> 57:16–58:19, 58:11–12, 67:5–8, 67:21–23), *id.* at 29–31. The selected portions of testimony do not fairly reflect Dr. Pollock’s testimony because the testimony at page 78 [82] relates to Kahn, not Ip. *See* Ex. 2005, 73:20–21 (Ex. 2001 [Kahn] is marked). Although we find measuring *only phase* is not coherent detection, in the case of DQPSK, the record includes evidence that phase and quadrature, as in DQPSK, are “alternatives” to amplitude and phase information and Dr. Pollock cites to that evidence in support of his opinion regarding coherent detection. Ex. 1003 ¶ 96 (citing Ex. 1005, 9). Accordingly, although we are not persuaded in this case that Tanaka’s disclosure of DQPSK teaches coherent detection, there is evidence of record that provides a basis for Dr. Pollock’s testimony.

We are not persuaded that Petitioner must show that Tanaka’s teaching of phase modulation “*necessarily would* have been generated using DPSK or DQPSK.” *See* PO Resp. 20 (citing Ex. 1004, 1:47–49) (emphasis added). Obviousness is based on what would have been understood by a person of ordinary skill and, unlike inherent anticipation, is not predicated upon a showing of necessity. Tanaka expressly teaches a separate phase modulation channel and DPSK and DQPSK as known types of phase modulation. *See* Pet. 12 (citing Ex. 1003 ¶ 96 (citing Ex. 1005, 7–9; 14; Ex. 1013, 284–287)), *id.* at 13 (citing Ex. 1004, 1:26–36, 5:25–29, 11:19–25, 24:56–59, 23:24–30, 25:11–25; Ex. 1003 ¶¶ 94–97). We find a person of ordinary skill would have understood from Tanaka that DPSK and DQPSK are phase modulation.

One of ordinary skill in the art would have used non-coherent detection for Tanaka’s intensity modulation channel (rather than Tanaka’s phase modulation

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<sup>30</sup> The citation is incorrect and should be to page 82, lines 22 through 24. The remaining citations to the Pollock Deposition in the chart are correct.

channel). Pet. 15. Ip is relied on as a part of the combination as teaching what would have been understood about non-coherent and coherent as those terms are used in the claims. *Id.* at 13 (citing Ex. 1004, 1:14–54; Ex. 1005, 7; Ex. 1003 ¶¶ 98–99).

Ip describes coherent detection as the most advanced method and a person of ordinary skill would have looked to coherent detection in upgrading optical transmission systems from 2.5 or 10-Gbps to 40 Gbps, like Tanaka. Ex. 1004, 1:14–33. We find that a person of ordinary skill would have had reasons, as identified by Petitioner, to combine Ip with Tanaka and would have been motivated to do so because both references explain the need for increased performance in optical transmission systems. Pet. 15–16. A primary goal of Tanaka is to increase performance of optical transmission systems. *See* Ex. 1004, 5:15–24; *see also* Tr. 16:17–23 (Tanaka and '068 patent both directed toward achieving higher transmission rates). A person of ordinary skill would have recognized from Ip that “coherent detection is ‘[t]he most advanced detection method’ and allows for ‘**higher performance in optical fiber systems.**’” Pet. 14 (quoting Ex. 1005, 9, 1).

Increased performance is a strong motivation for a person of ordinary skill to have combined Ip’s teaching regarding coherent detection with the split signal optical system of Tanaka. Tanaka suggests that performance increases are coming, e.g., 40-Gbps and to “employ the existing equipment for WDM transmission of intensity modulation optical signals to upgrade transmission systems in steps and efficiently.” Ex. 1004, 1:19–25, 4:13–16. Such a suggestion would have led a person of ordinary skill to look to coherent transmission methods described in Ip as the “most advanced detection method.” Ex. 1005, 9.

We are not persuaded by Patent Owner’s argument that the preceding, and five additional reasons cited by Petitioner for the combination of Tanaka and Ip, are based on hindsight. PO Resp. 32–33. The only evidentiary support for this position is in the Islam Declaration, which states without any cited evidentiary support that Petitioners reasons are “generic advantages of ‘coherent’ detection.” *Id.* (citing Ex. 2003 ¶ 67). Known advantages of coherent detection are part of the reasons “coherent detection” would have been looked to for enhancement of an optical transmission system. Because the advantages of coherent detection would have been understood to a person of ordinary skill, such advantages are based on existing knowledge at the time and not hindsight.

We find that Tanaka and Ip both teach “intensity modulation in the form of on-off keying (OOK) is a primary example of noncoherent detection.” See Pet. 15 (citing Ex. 1005, 7; Ex. 1004, 1:14–54; Ex. 1003 ¶ 109). Patent Owner argues this, the seventh reason for the combination cited by Petitioner for the combination, does not relate to coherent optical channels. PO Resp. 34 (citing Ex. 2003 ¶ 68); see also Pet. 15 (“Seventh” reason). We find the fact that both Tanaka and Ip describe intensity modulation in the same field of endeavor, optical transmission systems, would be a reason why a person of ordinary skill would have looked at both references when trying to enhance performance of an optical system.

Petitioner’s eighth reason, the combination is an application of a known technique of non-coherent to intensity modulation channels to the Tanaka’s known optical system. Patent Owner’s two reasons for arguing this reason are flawed and are rejected for reasons discussed above.

The evidence shows the predictable use of familiar prior art elements associated with optical transmitters and optical signals according to their established functions. See Pet. 11–14 (citing Ex. 1004, 11:19–25 (optical

transmitters in a data transmission network); Ex. 1005, 7 (“Optical detection methods”); Ex. 1003 ¶¶ 93–111). The preceding evidence would have conveyed a reasonable expectation of success to a person of ordinary skill at the time of the invention. *See In re Kubin*, 561 F.3d 1351, 1360 (Fed. Cir. 2009) (“Obviousness does not require absolute predictability of success . . . all that is required is a reasonable expectation of success.”).

We are not persuaded by Patent Owner’s argument regarding limitation [1.2] that the Tanaka and Ip combination does not show both non-coherent and coherent “optical paths.” First, as discussed above, Tanaka’s intensity modulation channels are non-coherent channels, a finding that is not disputed. *See* Ex. 2003 ¶ 77; Ex. 1027, 90:19–91:2, 139:4–8, 156:9–157:9, 90:1–7); Reply 4–5. Ip teaches coherent detection and there existed at the time of the invention both reasons and motivation for a skilled artisan to have combined Ip’s teaching of coherent detection with Tanaka’s optical transmission system. Petitioner has shown the Tanaka and Ip combination teaches non-coherent and coherent wavelength channels. We find Tanaka teaches a non-coherent path for the intensity modulation signal and Ip teaches a coherent path for Tanaka’s phase modulation signal, whether or not it is DQPSK.

We are not persuaded that the “splitting” between two channels as taught by Tanaka is limited to intensity and phase. *See* PO Resp. 37. As already discussed, the intensity channel is non-coherent. As also previously discussed, a person of ordinary skill would have been motivated by the desire for increased performance to look to coherent wave-lengths (both amplitude and phase), which would be a simple substitution for the phase channel of Tanaka. Given the teachings of Ip, a person of ordinary skill would have had reason to expect such a combination to be successful. Because we find that the combination of Tanaka and Ip teach non-

coherent and coherent “optical wavelength channels” and the corresponding “optical paths,” we need not reach Patent Owner’s argument that Tanaka alone would not have motivated a person of ordinary skill to implement the two recited optical paths. See PO Resp. 41–43; Pet. Reply 15–17; Sur-Reply 5.

Patent Owner argues that the “dispersive element” of limitation [1.3] is not disclosed or suggested by the combination of Tanaka and Ip. PO Resp. 44–45. This argument relies on Patent Owner’s argument above that limitation [1.2], reciting a non-coherent and a separate coherent “optical path,” has not been shown. *Id.* at 45. This argument is not persuasive for reasons stated above regarding the two “optical paths.” More specifically, Tanaka teaches “chromatic dispersion loader 12A” can be “inserted in the route of the phase modulation optical signal” or “the intensity modulation optical signal.” Pet. 21–23; Ex. 1004, 24:46–49; 24:27–29; 23:54–67; Ex. 1027, 136:9–137:21.

We find plural embodiments from Tanaka may be relied upon to show “optical wavelength channels,” i.e., more than one channel. When all of the limitations are found in two separate embodiments, “[i]f a person of ordinary skill can implement a predictable variation, § 103 likely bars its patentability.” *Boston Scientific Scimed, Inc. v. Cordis*, 554 F.3d 982, 991 (quoting *KSR*, 127 S. Ct. at 1740); see also Inst. Dec. 34–35 (citing *Boston Scientific*). Where the two embodiments disclosed in the prior art reference are described in close proximity to each other, as they are here, *Boston Scientific* court found a motive to combine exists and a leap of inventiveness is not required. *Id.*

Further, Petitioner is not relying solely on a combination of embodiments to teach plural channels. Petitioner cites to Tanaka’s description of a “WDM system having multiple intensity modulation channels and multiple phase modulation channels” for the plural “channels” recitation. Pet. Reply 19 (citing Pet. 11–12;

Ex. 1003 ¶ 94). Stated differently, Petitioner argues a person of ordinary skill “would have understood that Tanaka’s system not only includes multiple phase modulation and intensity modulation channels, but is *designed* to solve problems caused by the multiplexing of multiple phase modulation and intensity modulation channels into one signal.” *Id.* at 20 (citing Ex. 1003 ¶ 94; Ex. 1023 ¶¶ 36–40; Ex. 1027, 101:19–21 (“The splitting in Tanaka separates the non-coherent channels from the DPSK/DQPSK channels.”). Patent Owner does not respond to these positions in its Sur-Reply, instead restating its previous arguments. Sur-Reply 23–24. Further, we find that a person of ordinary skill would have understood that WDM may include multiple intensity and phase modulation channels. Pet. 11–12; Ex. 1003 ¶ 94.

Regarding limitation [1.4], based on a plain reading of Tanaka, we agree with Petitioner that Tanaka’s combining unit 13 of Figure 20 receives an input of two optical signals from the optical coupler 11 and chromatic dispersion loader 12A and “generates and outputs a wavelength multiplexed signal” labeled as the “Multiplexed Signal Output” in Figure 20. Pet. 24 (citing Ex. 1004, 23:31–24:18, 40:26–28, Figs. 20, 23; Ex. 1003 ¶¶ 121–122). For the reasons discussed previously with respect to limitation [1.2], we agree with Petitioner that “to the extent that that Tanaka does not expressly use the terms ‘coherent’ and ‘non-coherent,’ use of coherent detection for Tanaka’s phase modulation channels and non-coherent detection for Tanaka’s intensity modulation channels would have been obvious to a POSITA based on the suggestions of Ip.” Pet. 13. What naturally follows is that one of ordinary skill in the art would have understood Tanaka’s “wavelength multiplexed signal” in Petitioner’s combination of Tanaka and Ip would be a mixed coherent and non-coherent optical output signal, as Petitioner contends. Pet. 25 (citing Ex. 1005, 6–9; Ex. 1004, 1:14–54; 23:20–

25:7). As such, we find that Petitioner’s combination of Tanaka and Ip teaches or suggests “an optical multiplexer configured to receive and combine the optical wavelength channels from the coherent and non-coherent optical paths to form a mixed coherent and non-coherent optical output signal on an output of the optical multiplexer,” as recited in limitation [1.4].

As stated above, independent claim 12 includes corresponding elements to those of claim 1. Petitioner makes all but the same arguments for unpatentability of claim 12 as it did for claim 1. Pet. 37–47. Patent Owner does not separately argue claim 12. PO Resp. 53–54. Petitioner has shown by a preponderance of the evidence that claims 1 and 12 would have been obvious over Tanaka and Ip.

*b. Claims 2–9, 11, 13, and 15*

Claims 2–9 and 11 depend from claim 1 and claims 13 and 15 depend from claim 12. Petitioner’s showing on these claims is at pages 25 through 37 of the Petition. Petitioner also relies on the Pollock Declaration. See Ex. 1003 ¶¶ 123–155. Petitioner’s argument and supporting evidence is summarized below.

Claim 2 recites, in pertinent part, “one or more optical elements that are configured to approximately equalize the optical gain or loss of a first path and a second path from the input optical port to the output of the optical multiplexer.” Petitioner cites to paragraphs 123 through 130 of the Pollock Declaration for support.

The ’068 patent states “‘optional elements 221, 251, 222, 232, and 252,’ which can be optical attenuators, optical amplifiers, and the like, can equalize gain/loss.” Pet. 25–27. Relying on an annotation of Figure 20 of Tanaka, Petitioner identifies two paths, a first path in purple and a second in green. *Id.* at 27. Tanaka teaches a “separating unit [] separates a wavelength multiplexed signal into intensity modulation and phase modulation optical signals” and multiple

“variable optical attenuator[s] 93 . . . give an intensity variation.” Ex. 1004, 36:44–37:3. Petitioner concludes a person of ordinary skill “would have recognized that these different amounts of optical attenuation provided in the phase and intensity modulation paths ‘suppress cross-phase modulation’ by equalizing the optical gain or loss of the first path and the second path.” Pet. 28 (citing Ex. 1003 ¶ 127; Ex. 1004, 37:23–38).

Patent Owner argues the showing for claim 2 does not establish that Tanaka addresses “equalizing optical gain or loss.” PO Resp. 53 (citing Ex. 2003 ¶¶ 88–89); Sur-Reply 24–25. Petitioner responds that a person of ordinary skill “would have recognized that Tanaka’s suppression of cross-phase modulation is achieved by equalizing the optical gain/loss of the signal paths.” Pet. Reply 23 (citing Pet. 27–30; Ex. 1003 ¶¶ 126–128). Petitioner also argues a person of ordinary skill “would have known that optical amplifiers include ‘an equalizing section’ for providing ‘a gain equalizing effect’ to optical signals.” *Id.* at 23–24 (citing Ex. 1006, 1:20–37; Ex. 1003 ¶ 133).

Patent Owner’s Sur-Reply responds to the Okuno combination, a different ground asserted regarding claim 2 (see Section III.4 below), but not to Petitioner’s arguments in the Reply. Sur-Reply 25. Dr. Islam’s testimony repeats that Tanaka is silent on equalization and does not add any additional reasons supporting Patent Owner’s position. Ex. 2003 ¶¶ 88–89. Conversely, Dr. Pollock’s testimony is supported by cites to Tanaka, including that variable optical attenuators shown in the embodiment of Figure 41 “suppress cross-phase modulation (nonlinear effect) that occurs in a transmission fiber.” Ex. 1003 ¶ 126 (quoting Ex. 1004, 37:23–38) (emphasis omitted). The preceding finding supports Dr. Pollock’s testimony that a person of ordinary skill would have recognized that “these different amounts of optical attenuation provided in the phase and intensity modulation paths were for

the purpose of equalizing the optical gain or loss of the first path and the second path thereby suppressing cross-phase modulation (nonlinear effect) that occurs in the transmission fiber.” *Id.* ¶ 127. We credit Dr. Pollock’s testimony because it relies on detailed citations to Tanaka, which supports his testimony, and find that Petitioner has shown claim 2 would have been obvious based on Tanaka. *Id.* ¶ 126 (quoting Ex. 1004, 37:23–38; citing Ex. 1004, 36:44–37:3, Fig. 41).

Claim 3 depends from claim 2 and recites that “at least one of the one or more optical elements is an optical attenuator.” Ex. 1001, 10:2–3. Petitioner relies on its showing regarding claim 2 above regarding “variable optical attenuators.” Pet. 30–31 (citing Ex. 1004, 36:44–37:43; Ex. 1003 ¶¶ 126–128).

Claim 4 depends from claim 2 and recites “at least one of the one or more optical elements is an optical amplifier.” Ex. 1001, 10:5–6. Petitioner cites to Figure 23 elements 30a and 30b as the recited optical amplifiers. Pet. 31–32 (citing Ex. 1004, 24:50–25:7, Fig. 23; Ex. 1003 ¶ 132).

Claim 5 depends from claim 4 and recites “the optical amplifier comprises at least one of a rare-Earth doped optical amplifier or a discrete Raman amplifier or a hybrid optical amplifier which comprises both rare-Earth doped fiber amplification and fiber Raman amplification.” Ex. 1001, 10:8–12. Petitioner relies on the disclosure of Tanaka to show a Raman amplifiers in conjunction with amplifiers of the optical transmitters and Figure 23 shows the amplifiers as elements 111 and 111A. Pet. 32–33 (citing Ex. 1004, 23:20–25:7; 13:44–51; Fig. 23; Ex. 1003 ¶ 136). Petitioner contends that Raman amplifiers were well-known in the art, as was use of rare-earth amplifiers. *Id.* at 33 (citing Ex. 1003 ¶¶ 136–137, 41–43; Ex. 1007, 4:28–29, 12:38–43, 24:44–49; Ex. 1008, 1:59–67, 2:20–3:40; Ex. 1010, 618–622, 34, 269, 338, 602; Ex. 1013, 481–482, 504–505).

Claim 6 depends from claim 1 and recites “an optical amplifier configured to amplify the mixed coherent and non-coherent optical signal.” Ex. 1001, 10:15–16. Petitioner cites to Tanaka’s Figure 23, which shows an intensity modulation signal and a phase modulation signal both passing through switch 23. Pet. 34. Petitioner argues both signals are output together, “which is equivalent to the multiplexed signal output by the ‘combining unit 13’ of FIG. 20, discussed with respect to element [1.4].” *Id.* at 34–35 (citing Ex. 1004, 24:50–54, 23:31–24:7, Figs. 20, 23; Ex 1003 ¶ 138).

Claim 7 depends from claim 1 and recites “the dispersive element is included in the non-coherent optical path.” Ex. 1001, 10:19–20. Petitioner explains that Tanaka teaches that “[i]n FIG. 20, while the **chromatic dispersion loader 12A** is inserted in the route of the phase modulation optical signal, it **may be inserted in the route of the intensity modulation optical signal.**” Pet. 35 (citing Ex. 1004, 24:41–49). Petitioner references its showing in connection with limitation [1.1.b] that the “intensity modulation path is the noncoherent path.” *Id.* (citing Ex. 1005, 6–9; Ex. 1004, 1:14–54, 23:20–25:7, Ex. 1003 ¶¶ 99–101).

Claim 8 depends from claim 7 and recites “coherent optical path does not include dispersive elements.” Tanaka discloses that the “chromatic dispersion loader 12A [can be] inserted in the route of the phase modulation optical signal” or “it may be inserted in the route of the intensity modulation optical signal.” Ex. 1004, 24:41–49. Relying on the preceding and the Pollock Declaration, Petitioner asserts that a person of ordinary skill “would have understood that moving the chromatic dispersion loader 12A from the phase modulation path to the intensity modulation path would mean that there would no longer be a chromatic dispersion loader 12A in the phase modulation (i.e., coherent) path.” Pet. 35 (citing Ex. 1003

¶¶ 140–141); *see also* Section III.B.3.c.iii above (finding the coherent path is the phase modulation path of Tanaka).

Claim 9 depends from claim 8 and recites “coherent optical path does not include an amplifier.” Ex. 1001, 10:24–25. Petitioner refers to its showings regarding claims 7 and 8 which “address alternative configurations for FIG. 20 and neither discloses inserting an amplifier into either the coherent or noncoherent path.” Pet. 36 (citing Ex. 1004, 24:41–49; Ex. 1003 ¶¶ 142).

Claim 11 depends from claim 1 and recites “dispersive element is included in the coherent optical path.” Ex. 1001, 10:32–33. Petitioner annotates Figure 20 of Tanaka in red, circling the phase modulation signal and pointing to the “Chromatic Dispersion Loader 12A.” Pet. 37 (citing Ex. 1004, 24:41–49, 23:59–63, 24:50–53, Figs. 23, 20). Annotated Figure 23 is argued as illustrating “the chromatic dispersion loader 12A is inserted in the route of the phase modulation optical signal.” *Id.*; *see also* Section III.B.3.c.iii above (finding the coherent path is the phase modulation path of Tanaka); Ex. 1003 ¶¶ 99–101.

Claim 13 depends from claim 12 and recites three limitations, [13.1], [13.2], and [13.3]. The limitations are set out below followed by Petitioner’s showing as to each.

[13.1] The optical system in accordance with claim 12, wherein at least one of the plurality of optical assemblies comprises: an optical demultiplexer configured to receive a mixed coherent and non-coherent optical signal at its input, and output a plurality of coherent optical wavelength channels onto a coherent optical path, and a plurality of non-coherent optical wavelength channels onto a non-coherent optical path.

Ex. 1001, 10:45–53. Petitioner argues that limitation [13.1] is substantially similar to limitations [1.1.a]–[1.2] addressed above. Pet. 47 (citing prior showing at Pet.

10–20 and evidence relied on). We agree that the limitations are substantially similar and adopt our prior analysis here.

[13.2] “a dispersive element disposed in one or both of the coherent and non-coherent optical paths and that operates such that a different dispersion is applied to the non-coherent optical path as compared to the dispersion, if any, applied to the coherent optical path; and . . .

Ex. 1001, 10:54–58. Petitioner argues that limitation [13.2] is substantially similar to limitation [1.3] addressed above. Pet. 48 (citing prior showing at Pet. 20–23 and evidence relied on). We agree that the limitations are substantially similar and adopt our prior analysis here.

[13.3] an optical multiplexer configured to receive and combine the plurality of coherent optical wavelength channels from the coherent optical path, and the plurality of non-coherent optical wavelength channels from the non-coherent optical path to form a mixed coherent and non-coherent optical output signal.

Ex. 1001, 10:59–64. Petitioner argues that limitation [13.3] is substantially similar to limitations [1.4] addressed above. Pet. 48 (citing prior showing at Pet. 23–25 and evidence relied on). We agree that the limitations are substantially similar and adopt our prior analysis here.

Claim 15 depends from claim 12 and recites “each of the plurality of optical repeaters has at least one of the plurality of optical assemblies.” Petitioner annotates Tanaka’s Figure 23, circling the “optical relay transmitters 111A in red. Pet. 48–49 (citing Ex.1004, 23:22–42, 24:50–25:7, Figs. 23, 20; Ex. 1003 ¶ 155). Petitioner refers to its showing regarding claims 12 and 13, summarized above, for its argument that Tanaka teaches the “optical assemblies.” *Id.* at 49 (citing Ex. 1003 ¶¶ 144–154, 92–122).

*c. Summary*

As summarized by the argument and supporting evidence above, Petitioner has shown by a preponderance of the evidence that claims 1 through 9, 11 through 13, and 15 would have been obvious over Tanaka and Ip.

*4. Obviousness of Claims 2–5 and 14 Over Tanaka, Ip, and Okuno*

Petitioner alleges claims 2–5 and 14 would have been obvious over Tanaka, Ip, and Okuno. Pet. 1, 49–62. Petitioner also relies on the Pollock Declaration. Ex. 1003 ¶¶ 156–181. Tanaka and Ip are described in Sections III.B.3.a and b above.

*a. Okuno (Ex. 1006)*

Okuno “relates to a dispersion-compensating module functioning to compensate for the chromatic deviation occurring in an optical transmission line” for use in “an optical transmission system.” Ex. 1006, Abs. Figure 7 is reproduced below.

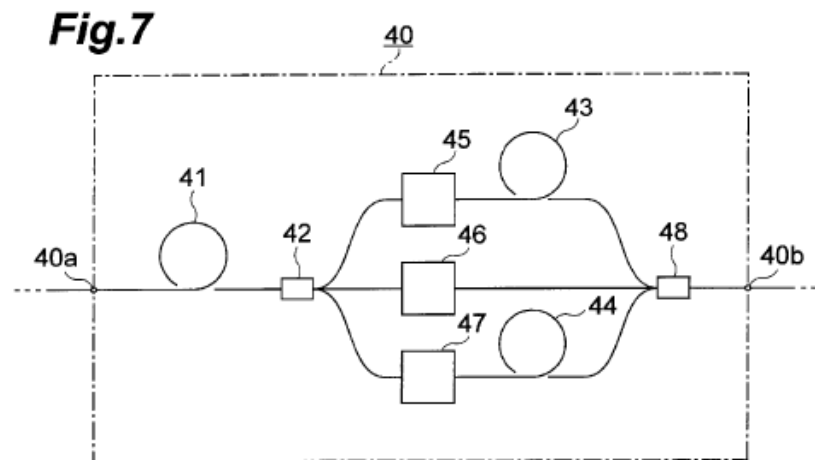


**Figure 7 is a schematic view of a fourth embodiment of the dispersion-compensating module.**

*Id.* at 5:62–64, 9:54–58. Dispersion-compensating module 40 includes “a demultiplexer 42 for demultiplexing the WDM signals into the respective light

signals, and a multiplexer 48 for multiplexing the respective light signals demultiplexed by the demultiplexer 42 and outputting a multiplexed signal.” *Id.* at 10:3–7. The optical signals reach multiplexer 48 after being demultiplexed based on wave length, i.e.,  $\lambda_1$  propagates through optical attenuator 45,  $\lambda_2$  propagates through optical attenuator 46, and  $\lambda_3$  propagates through optical attenuator 47. *Id.* at 10:33–45. Okuno explains “dispersion-compensating optical fiber” is used to “compensate[] for the residual chromatic dispersion of the signal light component” of each optical path. *Id.* at 10:46–64. Okuno’s “optical attenuators 45 to 47” are located in each respective optical path to equalize the loss across each path. *Id.* at 10:7–11, 10:59–11:12.

*b. Claims 2–5 and 14*

Petitioner has already made a sufficient showing that claim 2 is unpatentable. See Section III.B.3.d above. For this ground, Petitioner alleges “to the extent that Tanaka does not expressly show both optical elements for equalizing gain/loss and dispersion compensating elements in the same embodiment, claim 2 is provided by the Tanaka-Ip-Okuno combination.” Pet. 51 (citing Ex. 1003 ¶¶ 158–166). Petitioner references its showing in Section III.B.3.d above for Tanaka’s teaching of the recited “first” and “second paths.” *Id.* at 51–52 (citing Ex. 1004, 23:20–25:7, Fig. 20 (annotated at Pet. 52 showing first path in violet and second path in green); Ex. 1003 ¶ 160).

According to Petitioner, Okuno “discloses placing ‘**optical attenuators** 45 to 47 as the **loss-equalizing means**’ along each of the demultiplexed signal paths to equalize the gain/loss of the optical signal, along with dispersion compensating elements in some of the paths, as shown in FIG. 7.” Pet. 52. Petitioner annotates Figure 7 of Okuno at page 53 of the Petition, which is reproduced below.

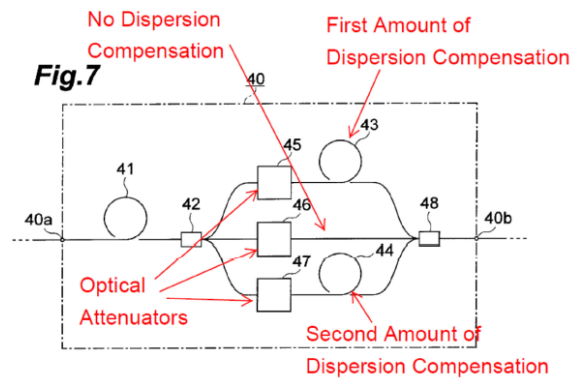


**Figure 7 is an annotated schematic configuration of the fourth embodiment of the dispersion-compensating module 40.**

Ex. 1006, 9:55–10:2. Petitioner annotates Figure 7 of Okuno in red pointing out two of the dispersion compensating optical fibers units 43 and 44 and optical attenuators 45, 46, and 47. Pet. 53 (citing Ex. 1006, 9:64–10:11; 10:59–64, Fig. 7).

Patent Owner disputes that Petitioner has sufficiently shown claim 2 is obvious over the Tanaka, Ip, and Okuno combination. PO Resp. 54–58. The arguments regarding claim 2 are argued as applicable to claims 3–5, which depend from claim 2. *Id.* at 57.

For claim 2, Patent Owner argues that Okuno’s Figure 7, reproduced above, illustrates that “optical attenuators 45 to 47 can adjust the respective optical powers of the light signals having the three wavelengths  $\lambda_1$  to  $\lambda_3$  thereby flattening the gain deviations and/or loss deviations among the respective light signals in total.” PO Resp. 56 (citing Ex. 1006 at 11:8–12, Fig. 7 (annotated above); Ex. 2003 ¶ 91). Patent Owner argues the disclosed flattening of gain between light signals is “different from approximately equalizing the optical gain or loss of **a first path [e.g., non-coherent optical path] and a second path [e.g., coherent optical path]**, as required by claim 2.” *Id.* at 56–57 (citing Ex. 2003 ¶ 92).

We are not persuaded by Patent Owner’s argument because Okuno’s “optical attenuators 45 to 47” are disclosed as “the loss-equalizing means” by “adjust[ing] the optical power of respective demultiplexed light signals” and that each “loss-equalizing means is disposed in an optical path.” Ex. 1006, 9:64–10:11; 3:18–25; *see also* Reply 24–25 (citing Pet. 51–55; Ex. 1003 ¶¶ 158–166; Ex. 1006, 2:55–57). The cited testimony of Dr. Islam does not add any additional substance to Patent Owner’s argument.

Claim 3 depends from claim 2 and recites “one of the one or more optical elements is an optical attenuator.” Ex. 1001, 10:2–3. Petitioner cites to the “loss-equalizing means” of Okuno’s Figure 7 “optical attenuators 45 to 47.” Pet. 55 (citing Ex. 1006, 9:64–10:11; 10:59–64; Fig. 7).

Claim 4 depends from claim 3 and recites “at least one of the one or more optical elements is an optical amplifier.” Ex. 1001, 10:5–6. Petitioner relies on the Pollock Declaration, in part, to teach the claimed subject matter. Pet. 55–58 (citing Ex. 1003 ¶¶ 168–172). Petitioner cites Okuno’s Figure 6, which it annotates, to show, dispersion compensation (element 31), optical attenuator (32), and optical amplifier (33). *Id.* at 57 (citing Ex. 1006, 9:9–44, Fig. 6; Ex. 1003 ¶¶ 171–172).

Claim 5 depends from claim 4 and recites “the optical amplifier comprises at least one of a rare-Earth doped optical amplifier or a discrete Raman amplifier or a hybrid optical amplifier which comprises both rare-Earth doped fiber amplification and fiber Raman amplification.” Ex. 1001, 10:8–12. As discussed above, Petitioner relies on the Tanaka, Ip, and Okuno combination for its challenge to claims 2 and 4. Petitioner references its showing regarding claim 5 from Section III.B.3.d above. Pet. 58.

Claim 14 depends from claim 12 and recites “some of the plurality of optical repeaters do not have one of the plurality of optical assemblies.” Ex. 1001, 10:66–

67. Claim 12 requires separate coherent and non-coherent optical channels and different dispersion applied to each. *See* Pet. 41–45 (limitations [12.4.a] and [12.4.b]). For claim 14, Petitioner relies in part on its showing for claim 12. Pet. 59 (citing to showing for limitations [12.4.a–12.4.c] on the Tanaka and Ip ground (Pet. 41–47)).

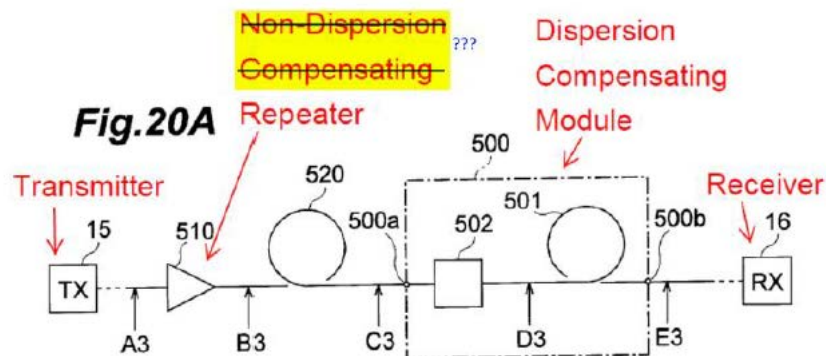
Petitioner contends the recited “optical repeaters” are shown as “optical relay transmitters 111A” in Petitioner’s annotation of Figure 23 of Tanaka. Pet. 59 (citing Ex. 1004, 24:50–25:7, Fig. 23 (annotated)). Petitioner argues “each optical relay transmitter 111A of Tanaka includes one of the claimed ‘optical assemblies’ for applying different dispersion compensation to coherent and noncoherent optical paths.” *Id.* (citing Ex. 1004, 23:22–67, 24:30–49, 5:44–49, 24:50–25:7, Figs. 20, 23; Ex. 1003 ¶¶ 148–151, 178).

Petitioner relies on Okuno for its disclosure of “an optical transmission path between a transmitter and receiver that includes both a dispersion compensating repeater and a non-dispersion compensating repeater.” Pet. 59–60 (citing Ex. 1006, 18:25–55, Fig. 20A). Petitioner argues Okuno teaches that “the dispersion compensating module according to the present invention can function as a repeater” similar to the optical relay transmitter 111A of Tanaka. *Id.* at 60 (citing Ex. 1006, 2:66–67). Petitioner concludes:

Therefore, in the resulting Tanaka-Ip-Okuno combination, the transmission line between the transmitter and receiver would include both a repeater having the claimed optical assembly (Tanaka’s optical relay transmitter 111A positioned in place of Okuno’s dispersion-compensating module 500) and a repeater without the claimed optical assembly (Okuno’s optical amplifier/repeater 510).

*Id.* (citing Ex. 1003 ¶178).

Patent Owner argues Okuno does not teach a “non-dispersion compensating” repeater.<sup>31</sup> PO Resp. 57–58 (citing Ex. 2003 ¶ 93). Referencing Figure 20A of Okuno, Patent Owner contends the element 510 is an “optical amplifier,” not a “non-dispersion” optical repeaters. *Id.* at 58 (citing Ex. 1006, 18:30; Ex. 2003 ¶ 93). Patent Owner’s argument is illustrated by its annotation of Petitioner’s annotation of Okuno’s Figure 20A, from page 60 of the Petition. PO Resp. 58. Okuno’s Figure 20A annotated by both parties is reproduced below.



**Okuno Figure 20A is a view showing a schematic configuration of the optical transmission system (annotated by both parties).**

Ex. 1006, 6:47–48, Fig. 20A (annotated). Patent Owner’s annotation strikes out “Non-Dispersion Compensating” and adds “???” for element 510 of Okuno’s Figure 20A.

Petitioner responds that Okuno discloses:

the express functionality of an optical amplifier (which does not include dispersion compensation) by disclosing that “optical amplifiers [that] are disposed at appropriate repeating intervals” will “usually comprise[] an amplifying section for amplifying the optical power of respective light signals and an equalizing section for lowering the gain differences occurring among the respective light signals, thus yielding not only an optical amplifying effect but also a gain-equalizing effect.”

<sup>31</sup> This argument is directed to limitation [12.4.b], i.e., claim 12 from which claim 14 depends. See Section II.C above (limitation [12.4.b]).

Reply 28 (quoting Ex. 1006, 1:19–33). The Pollock Second Declaration states that Figure 20A includes no dispersion at the amplifier/repeater 510 and dispersion at the dispersion compensating module 50. *Id.* (citing Ex. 1023 ¶¶ 46–49); *see also* Ex. 1006, Fig. 20A (annotated above). Significantly, as Dr. Pollock points out, Okuno explains that “[t]he optical link of Fig. 20 further includes a dispersion-compensating module 500, and Okuno makes clear that ‘the dispersion-compensating module according to the present invention can **function as a repeater.**’” Ex. 1023 ¶ 46 (citing Ex. 1006, 18:25–55; 2:66–67). Dr. Islam’s testimony acknowledges that the amplifier is a repeater but also states that there is no specific teaching of a “non-dispersion compensating” repeater. Ex. 2003 ¶ 93 (citing Ex. 1006, 18:30). Similarly, Patent Owner’s Sur-Reply responds that “nowhere do *Okuno* or *Charlet*<sup>32</sup> state dispersion compensation functionality of the optical amplifiers.” Sur-Reply 26 (citing Reply, 28–29; Ex 1006, Fig. 20A).

We are not persuaded by Patent Owner’s argument, which denies, without sufficient support, that Okuno teaches nondispersion at the repeater 510. We credit the Second Pollock Declaration that, although Okuno discloses a dispersion module, it does not suggest that the amplifier/repeater 510 “includes dispersion compensating functionality” because Dr. Pollock’s testimony is well reasoned and relies on detailed citations to Okuno, which support his testimony. Reply 28 (citing Ex. 1023 ¶¶ 46–49); Ex. 1023 ¶¶ 46–49 (citing Ex. 1006, 18:25–55, 2:66–67; Fig. 20A; 1:19–33).

Petitioner identifies five separate reasons a person of ordinary skill would “implement the system of Tanaka-Ip to include ‘loss equalizing’ optical attenuators

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<sup>32</sup> Charlet as a basis for the unpatentability of claim 14 is discussed in Section III.B.8 below.

in each demultiplexed optical path of a dispersion compensation unit (as suggested by Okuno).” Pet. 53–55. For example, the first reason is “a POSITA would have recognized that inserting optical attenuators into the coherent and noncoherent paths of the optical relay transmitters 111A of the Tanaka-Ip combination would provide loss equalization across the different signal paths, thereby providing uniform signal quality.” *Id.* at 53 (citing Ex. 1006, 9:64–10:11; Ex. 1003 ¶ 162). Petitioner also argues the result of the combination would achieve the predictable result of applying “a known technique to a known system (e.g., the Tanaka-Ip optical communication system) ready for improvement to yield predictable results.” *Id.* at 55 (citing Ex. 1003 ¶ 166; *KSR*, 550 U.S. at 417 (2007)).

Petitioner also identifies several reasons for why a person of ordinary skill would have combined Okuno with Tanaka and Ip. Pet. 60–62. The first reason is that a person of ordinary skill “would have recognized that, in at least some scenarios, a multi-channel optical signal would require signal repeating to correct for signal loss more often than the signal requires optical dispersion compensation.” *Id.* at 61 (citing Ex. 1003 ¶ 179).

Patent Owner generally denies that the reasons cited by Petitioner “come close to providing a reason as to why a POSITA would have additionally relied on *Okuno* in the manner proposed by Petitioners.”<sup>33</sup> PO Resp. 55. Patent Owner does not cite any evidence for its general denial. We are not persuaded by Patent Owner’s general denial. We find Petitioner’s reasons for the combination sufficient. See Pet. 60–62.

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<sup>33</sup> As summarized below, Patent Owner repeats variations of this language throughout its Response.

As summarized by the argument and supporting evidence above, Petitioner has shown by a preponderance of the evidence that claims 2 through 5 and 14 would have been obvious over Tanaka, Ip, and Okuno.

*5. Obviousness of Claims 4–5 Over Tanaka, Ip, Okuno, and Tsukitani*

Petitioner alleges claims 4–5 would have been obvious over Tanaka, Ip, Okuno, and Tsukitani. Pet. 1, 62–68. Petitioner also relies on the Pollock Declaration. Ex. 1003 ¶¶ 182–191. Tanaka, Ip, and Okuno are described in Sections III.B.3.a, III.B.3.b, and III.B.4.a above.

*a. Tsukitani (Ex. 1007)*

Figure 2 of Tsukitani is reproduced below.

**Fig.2**

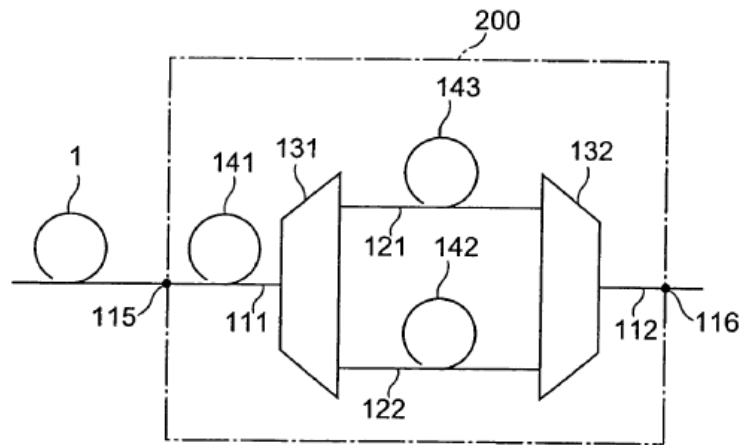


**Figure 2 is a schematic block diagram of a second embodiment of Tsukitani's dispersion compensating system.**

Ex. 1007, 6:42–44, 10:24–28. The “dispersion-compensating system” includes demultiplexer 131, which receives optical signals on first common transmission line. *Id.* at 9:26–28. Multiplexer 132 outputs multiplexed optical signals” onto a second common transmission line 112. *Id.* at Abs., 9:26–48, 10:24–54.

In a fourth embodiment shown in Figure 4, Tsukitani further discloses optical amplifiers in addition to the second embodiment's dispersion compensation system. Ex. 1007, 12:22–29. The optical amplifiers amplify the optical signals to compensate for dispersion. *Id.* at 12:30–59, Fig. 4.

*b. Claims 4 and 5*

Claim 4 depends from claim 2 and recites “at least one of the one or more optical elements is an optical amplifier.” We summarized the showing in the Petition regarding other grounds challenging claim 2 in Sections III.B.3.b and III.B.4.b above.

Petitioner argues “to the extent that claim 4 is interpreted narrowly to require placement of the optical amplifier along one of the split signal paths between the demultiplexer and the multiplexer, Tsukitani discloses a dispersion compensation unit in which optical amplifiers are placed along each of two wavelength demultiplexed optical signal paths suitable for use with the system of Tanaka-Ip-Okuno.” Pet. 64–65 (citing Ex. 1007, 12:22–59, Fig. 4). Petitioner concludes that a person of ordinary skill would have implemented “the system of Tanaka-Ip-Okuno to include optical amplifiers in each demultiplexed optical path of a dispersion compensation unit (as suggested by Tsukitani).” *Id.* at 66.

Claim 5 depends from claim 4 and recites “the optical amplifier comprises at least one of a rare-Earth doped optical amplifier or a discrete Raman amplifier or a hybrid optical amplifier which comprises both rare-Earth doped fiber amplification and fiber Raman amplification.” Ex. 1001, 10:8–12. Petitioner cites to its showing in Section III.B.3.d above regarding claim 5. Pet. 67–68. In addition, Petitioner argues “Tsukitani specifies that ‘a Raman amplifier’ should be used as the optical amplifiers shown in FIG. 4.” *Id.* at 67 (citing Ex. 1007, 12:38–43, 4:28–29, 24:44–49).

Patent Owner argues Tsukitani fails to teach equalizing gain or loss.<sup>34</sup> PO Resp. 58–59 (citing Ex. 2003 ¶ 94). Petitioner relies on Okuno, not Tsukitani, for equalizing. See Reply 26 (citing Pet. 65–66 (citing Ex. 1006, 1:20–37; Ex. 1010, 830–831; Ex. 1008, 4:56–5:12; Ex. 1003 ¶¶ 185–186)). Patent Owner does not respond to this assertion beyond arguing that Petitioner does not respond to its arguments on Tsukitani. Sur-Reply 25. We need not discuss Patent Owner’s Tsukitani arguments because Petitioner relies on Okuno for what Patent Owner argues is missing from Tsukitani.

Petitioner cites four reasons for inserting the optical amplifiers “in each demultiplexed optical path of a dispersion compensation unit (as suggested by Tsukitani).” Pet. 66–67 (citing Ex. 1003 ¶¶ 187–190). The first reason for inserting the dispersion compensation units taught by Tsukitani into the claimed coherent and non-coherent paths is to fully reduce the dispersal of the optical transmission line while fully amplifying the optical signal to compensate for signal loss due to the optical dispersion correction. *Id.* (citing Ex. 1007, 12:44–59; Ex. 1003 ¶ 187).

Patent Owner generally denies that the reasons cited by Petitioner “come close to providing a reason as to why a POSITA would have additionally relied on *Tsukitani* in the manner proposed by Petitioners.” PO Resp. 59. Patent Owner argues that Tsukitani “fails to disclose or suggest phase/intensity modulation signals, coherent/noncoherent channels, and equalizing gain or loss.” *Id.* (citing Ex. 2003 ¶ 94). This argument is not persuasive because Petitioner does not rely

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<sup>34</sup> The argument is directed to claim 2, which recites in part that the claimed optical assembly is configured to “approximately equalize the optical gain or loss.” See Sections III.B.3.b and III.B.4.b above analyzing claim 2.

on Tsukitani for this element. Petitioner has shown sufficient reasons for the combination because Dr. Pollock’s testimony is well reasoned and relies on detailed citations to Tanaka, Ip, Okuno, and Tsukitani which support his testimony. Pet. 66–67 (citing Ex. 1003 ¶¶ 187–191).

As summarized by the argument and supporting evidence above, Petitioner has shown by a preponderance of the evidence that claims 4 and 5 would have been obvious over Tanaka, Ip, Okuno, and Tsukitani.

*6. Obviousness of Claim 10 Over Tanaka, Ip, and Evans*

Petitioner alleges claim 10 would have been obvious over Tanaka, Ip, and Evans. Pet. 1, 68–77. Petitioner also relies on the Pollock Declaration. Ex. 1003 ¶¶ 192–204. Tanaka and Ip are described in Sections III.B.3.a and III.B.3.b above.

*a. Evans (Ex. 1008)*

Evans “relates to optical amplifier systems” including “Raman amplifiers.” Ex. 1008, 1:5–8. Evans describes an “amplifier system 10” that splits optical signals based on wave length, and includes “a discrete Raman fiber amplifier module 14 operatively connected to the distributed Raman fiber multiplexer 12 by this coupler/beamsplitter 13.” *Id.* at 3:19–28. The Raman amplifier module applies different amounts of amplification to the split optical signal paths, “first and second amplification stages 17A and 17B.” *Id.* at 3:41–4:3. Figure 1 is reproduced below.

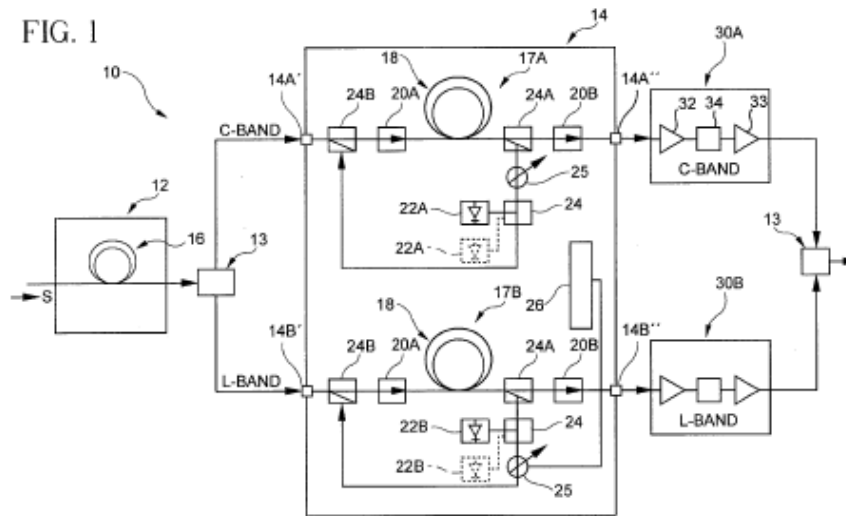


**Figure 1 is a schematic view of an amplifier system including a distributed Raman amplifier**

*Id.* at 2:61–65. The optical signal in each amplification stage is additionally amplified by being pumped with light provided from “pump[s] 22A, 22B” which are coupled to the propagated signals in each amplification stage by, for example, “wavelength selective coupler 24A.” *Id.* at 4:43–5:12.

Evans further discloses that use of “dispersion compensating fiber” can introduce loss into an amplifier stage. Ex. 1008, 2:14–18. Evans’ solution to compensate for this loss is that “the dispersion compensating fiber 18 can be pumped just enough to provide no net gain or loss” to make each amplification stage lossless. *Id.* at 4:18–28.

#### *b. Claim 10*

Claim 10 depends from claim 7, which depends from claim 1 and recites “the non-coherent optical path includes an optical amplifier with sufficient gain to compensate for from 50 percent to 150 percent of the loss contributed by a remainder of the optical elements in the non-coherent path.” Ex. 1001, 10:27–30.

We analyzed claim 1 in Section III.B.3.c above and claim 7 in Section III.B.3.d above.

Petitioner asserts that Evans further teaches that “‘dispersion compensating fiber’ can introduce loss into an amplifier stage.” Pet. 69 (citing Ex. 1008, 2:14–18). Evans is argued solving compensation losses by pumping the compensating fiber “just enough to provide no net gain or loss” to make each amplification stage lossless. *Id.* at 69–70 (citing Ex. 1008, 4:18–28).

Based on the preceding teaching of Evans, Petitioner argues that “use of optical amplifiers to compensate for the loss caused by dispersion compensating elements along an optical signal path was known in the prior art.” Pet. 71 (citing Ex. 1003 ¶¶ 197–200). Relying on the Pollack Declaration and Evans teaching regarding lossless amplification, Petitioner concludes a person of ordinary skill in the art would have recognized the amplifier provides an amount of gain such that there is “no net gain or loss” means the amplifier “compensates for 100% of the loss contributed by the dispersion compensating element, and therefore this amplifier along the noncoherent path in the Tanaka-Ip-Evans combination provides compensation that falls squarely within the claimed ‘50 percent to 150 percent’ range.” *Id.* at 74 (citing Ex. 1008, 4:17–28, 5:65–6:1; Ex. 1003 ¶ 200).

Patent Owner argues Evans “fails to disclose or suggest phase/intensity modulation signals and noncoherent channels.” PO Resp. 60. This argument is based on claim 1, which we have already analyzed, finding Petitioner’s showing is sufficient in Section III.B.3.c. Patent Owner then argues the “Petitioners fail to explain how ‘no net gain loss’ discloses or suggests the claimed ‘sufficient gain to compensate for from 50 percent to 150 percent of the loss contributed by a remainder of the optical elements within the non-coherent optical path.’” *Id.* at 60–61 (citing Ex. 2003 ¶ 96). Patent Owner argues that the “no net gain loss”

teaching of Evans is insufficient because claim 10 “includes a lengthy limitation with a numerical range.” *Id.* at 61.

Petitioner responds that a person of ordinary skill in the art “would have recognized that Evans’ disclosure of pumping light into a path ‘just enough to make a loss-less broad band’ such that ‘no net gain or loss’ is achieved indicates that all ‘gain or loss’ is compensated for by Evans’ light pumping technique.” Reply 27 (citing Ex. 1003 ¶ 200). We are not persuaded that “a lengthy limitation with a numerical range” rebuts Petitioner’s showing that “no net gain or loss” means the amplifier compensates for 100% of the loss contributed by the dispersion compensating element. *See* Pet. 74. One hundred percent compensation is within the claimed “‘50 percent to 150 percent range,” meeting the limitation of claim 10.

Petitioner identifies several reasons for combining Evans with Tanaka and Ip. Pet. 74–76. The first reason is that a person of ordinary skill in the art “would have recognized that insertion of a dispersion compensating element in a signal transmission path introduces loss and that insertion of an optical amplifier in the signal transmission path can compensate for this loss, thereby leading to greater signal integrity.” Pet. 74–75 (citing Ex. 1008, 2:14–18; Ex. 1003 ¶ 201).

Patent Owner generally denies that the reasons cited by Petitioner “come close to providing a reason as to why a POSITA would have additionally relied on *Evans* in the manner proposed by Petitioners.” PO Resp. 60. Patent Owner argues that Evans “fails to disclose or suggest phase/intensity modulation signals, coherent/noncoherent channels.” *Id.* This argument is not persuasive because Petitioner does not rely on Evans for this element. Petitioner has shown sufficient reasons for the combination because Dr. Pollock’s testimony is well reasoned and

relies on detailed citations to Tanaka, Ip, and Evans, which support his testimony. Pet. 74–76 (citing Ex. 1003 ¶¶ 201–204).

As summarized by the argument and supporting evidence above, Petitioner has shown by a preponderance of the evidence that claim 10 would have been obvious over Tanaka, Ip, and Evans.

### *7. Obviousness of Claim 10 Over Tanaka, Ip, Tsukitani, and Evans*

Petitioner alleges claim 10 would have been obvious over Tanaka, Ip, Tsukitani, and Evans. Pet. 1, 77–82. Petitioner also relies on the Pollock Declaration. Ex. 1003 ¶¶ 205–221. Tanaka, Ip, Tsukitani, and Evans are described in Sections III.B.3.a, III.B.3.b.2, III.B.5.a and III.B.6.a above.

#### *a. Claim 10*

Above we analyzed claim 10 on different grounds and found it unpatentable. See Section III.B.6 above. Largely repeating what it alleged in Section III.B.6 above, Petitioner alleges that “[w]hile Tsukitani does not expressly disclose the amount of gain provided by the optical amplifiers,” Evans does so. Pet. 80 (citing Ex. 1008, 4:17–28). Petitioner asserts a person of ordinary skill would have known to “implement the system of Tanaka-Ip-Tsukitani to set the amplification level of Tsukitani’s amplifier to compensate for 100% of the loss contributed by Tanaka’s dispersion compensating element 12A (as suggested by Evans).” *Id.* at 82 (citing Pet. 68–77 (showing made for Section III.B.6); Ex. 1003 ¶¶ 218–221).

Petitioner argues four reasons to implement the system of Tanaka-Ip to include an optical amplifier in the non-coherent path to compensate for loss due to the dispersion compensating element 12A of Tanaka, as suggested by Tsukitani. Pet. 81–82 (citing Ex. 1003 ¶¶ 210–213). The first reason is to reduce dispersion while allowing amplification to correct for signal loss due to optical dispersion correction. *Id.* at 81; see also *id.* at 82 (citing Ex. 1003 ¶¶ 218–220).

Patent Owner generally denies that the reasons cited by Petitioner “come close to providing a reason as to why a POSITA would have additionally relied on *Tsukitani* and *Evans* in the manner proposed by Petitioners.” PO Resp. 62. Patent Owner argues that neither *Tsukitani* nor *Evans* disclose or suggest coherent or noncoherent channels.” *Id.* Patent Owner’s arguments regarding the 50 percent to 100 range of claim 10 are based on the alleged lack of sufficient reason for combining *Tsukitani* with *Evans*. *Id.* at 62–63. Specifically, Patent Owner again argues the range of claim 10 is not shown and would be a reason not to make the combination. *Id.* at 63 (citing Ex. 2003 ¶ 98). This argument is not persuasive because we find above that *Evans* discloses the range claimed. See Section III.B.6.b above. Petitioner has shown sufficient reasons for the combination because Dr. Pollock’s testimony is well reasoned and relies on detailed citations to Tanaka, Ip, and *Tsukitani*, which support his testimony. Pet. 81–82 (citing Ex. 1003 ¶¶ 210–213, 218–220).

As summarized by the argument and supporting evidence above, Petitioner has shown by a preponderance of the evidence that claim 10 would have been obvious over Tanaka, Ip, *Tsukitani*, and *Evans*.

#### *8. Obviousness of Claim 14 Over Tanaka, Ip, and Charlet*

Petitioner alleges claim 14 would have been obvious over Tanaka, Ip, and Charlet. Pet. 1, 82–88. Petitioner also relies on the Pollock Declaration. Ex. 1003 ¶¶ 222–231. Tanaka and Ip are described in Sections III.B.3.a and III.B.3.b above.

##### *a. Charlet (Ex. 1009)*

Charlet describes a “network element for use in a wavelength division multiplex optical transmission system” for “compensating dispersion related propagation effects of optical WDM signals.” Ex. 1009 ¶¶ 4–8. Figure 2 shows a

“network element 5” that suppresses all Amplified Spontaneous Emission (ASE) noise of the amplifying means when one of two paths is cut. *Id.* ¶ 36.

*b. Claim 14*

We previously found claim 14 unpatentable on different grounds. See Section III.B.4.b above.

For this ground, Petitioner relies in part on its showing for claim 12. Pet. 84 (citing to showing for limitations [12.4.a–12.4.c] on the Tanaka and Ip ground (Pet. 41–47)); see n. 31 above. According to Petitioner, “Charlet discloses interspersing optical repeaters that provide different amounts of dispersion compensation to different optical signal paths with optical repeaters that do not provide dispersion compensation, with the repeaters separated by optical fiber spans between a transmitter and a receiver.” *Id.* at 84–85 (citing Ex. 1009 ¶¶ 33–35, Fig. 1 (annotated at Pet. 85)).

We agree with Petitioner that a person of ordinary skill would have recognized, for example in Okuno, that optical amplifiers are commonly used as repeaters. Pet. 85–86 (citing Ex. 1006, 18:29–30; Ex. 1011 ¶ 2; Ex. 1010, 57–60, 611, 619, 751–752); Reply 29. We also find Charlet distinguishes the optical amplifiers 4.1a, 4.2a, etc. illustrated in Figure 1 from dispersion compensating elements 5. Reply 29 (citing Ex. 1009 ¶¶ 33–35, Fig. 1 (annotated at Pet. 85)).

Patent Owner argues that Charlet does not teach the “non-dispersion compensating repeaters.” PO Resp. 63; see also Sur-Reply 25–26. Petitioner responds that there is no evidence that “optical amplifier designs” would include “dispersion compensating elements 5.” Reply 29 (citing Ex. 1023 ¶¶ 50–52; PO Resp. 64–65). Thus, Petitioner argues Charlet’s optical amplifier is a repeater that does not include dispersion compensating functionality. *Id.* (citing Ex. 1009 ¶¶ 33–35, Fig. 1 (annotated at Pet. 85)).

Petitioner argues three reasons “to implement the system of Tanaka-Ip to intersperse optical repeaters that include dispersion compensation assemblies (such as the optical relay transmitters 111A of Tanaka) interspersed with non-dispersion compensating repeaters along an optical transmission line (as suggested by Charlet).” Pet. 86–87 (citing Ex. 1003 ¶¶ 229–231). The first reason is a “multi-channel optical signal would require signal repeating to correct for signal loss more often than the signal requires optical dispersion compensation.” *Id.* at 86 (citing Ex. 1003 ¶ 229); *see also* PO Resp. 63–64 (generally denying reasons are sufficient). Petitioner has shown sufficient reasons for the combination because Dr. Pollock’s testimony is well reasoned and relies on detailed citations to Tanaka, Ip, and Charlet, which support his testimony. *See* Pet. 86–87 (citing Ex. 1003 ¶¶ 229–231).

As summarized by the argument and supporting evidence above, Petitioner has shown by a preponderance of the evidence that claim 14 would have been obvious over Tanaka, Ip, and Charlet.

#### IV. CONCLUSION<sup>35</sup>

Tanaka and Ip teach “non-coherent” and “coherent optical wavelength channels” recited in independent claims 1 and 12. This is the primary issue in this

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<sup>35</sup> Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).

proceeding. We also conclude that the combination of references relied on by Petitioner teaches the dependent claims.

In summary:

| <b>Claims</b>          | <b>35 U.S.C. §</b> | <b>References</b>            | <b>Claims Shown Unpatentable</b> | <b>Claims Shown Unpatentable</b> |
|------------------------|--------------------|------------------------------|----------------------------------|----------------------------------|
| 1–9, 11–13, 15         | 103                | Tanaka, Ip                   | 1–9, 11–13, 15                   |                                  |
| 2–5, 14                | 103                | Tanaka, Ip, Okuno            | 2–5, 14                          |                                  |
| 4–5                    | 103                | Tanaka, Ip, Okuno, Tsukitani | 4–5                              |                                  |
| 10                     | 103                | Tanaka, Ip, Evans            | 10                               |                                  |
| 10                     | 103                | Tanaka, Ip, Tsukitani, Evans | 10                               |                                  |
| 14                     | 103                | Tanaka, Ip, Charlet          | 14                               |                                  |
| <b>Overall Outcome</b> |                    |                              | 1–15                             |                                  |

#### V. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that, claims 1–15 of the '068 patent are held unpatentable;

FURTHER ORDERED that, because this is a Final Written Decision, parties to this proceeding seeking judicial review of our Decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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