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# D E C I S I O N
## of 11 January 2005

**Case Number:** T 0105/03 - 3.4.2

**Application Number:** 94303538.6

**Publication Number:** 0627639

**IPC:** G02B 6/22

**Language of the proceedings:** EN

**Title of invention:**
Optical fiber for wavelength division multiplexing

**Patentee:**
AT&T Corp.

**Opponent:**
-

**Headword:**
-

**Relevant legal provisions:**
EPC Art. 54, 56, 84

**Keyword:**
"Main request: clarity, novelty and inventive step - yes"

**Decisions cited:**
-

**Catchword:**
-

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**Case Number:** T 0105/03 - 3.4.2

# D E C I S I O N
**of the Technical Board of Appeal 3.4.2**
**of 11 January 2005**

**Appellant:** AT&T Corp.
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**Decision under appeal:** **Decision of the Examining Division of the European Patent Office posted 15 July 2002 refusing European application No. 94303538.6 pursuant to Article 97(1) EPC.**

**Composition of the Board:**

**Chairman:** A. G. Klein
**Members:** M. P. Stock
G. E. Weiss

## Summary of Facts and Submissions

I. The applicant and appellant has appealed against the decision of the examining division refusing European patent application number 99 113 716.7 on the ground that it did not meet the requirements of Articles 56 and 84 EPC. The examining division reasoned that the subject-matter of claim 1 according to a main and an auxiliary request then on file was not clear and did not involve an inventive step. *Inter alia* the following documents were cited:

D1: OHASHI ET AL. TRANSACTIONS OF THE INSTITUTE OF ELECTRONICS AND COMMUNICATION ENGINEERS OF JAPAN, SECTION E, vol. E73, No. 4, April 1990, TOKYO JP, pages 571 to 575; and

D3: MARCUSE ET AL. JOURNAL OF LIGHTWAVE TECHNOLOGY. vol. 9, No. 1, January 1991, NEW YORK US, pages 121 to 128.

In particular, the examining division was of the opinion that the claims defined the fibre in terms of results to be achieved and also lacked essential features related to a fibre optic wavelength division multiplex (WDM) system. However, the essence of the present application, i.e. avoiding WDM operation at the zero dispersion wavelength, was completely anticipated by document D3. Moreover, the skilled person would derive a value of "2ps/nm-km" from D3 and obviously consider the use of such a fibre for data communication systems.

II. In its grounds of appeal the appellant requested the issue of a communication under Rule 51(4) EPC based on the pending claims of either the main request or the auxiliary request. As a further auxiliary measure oral proceedings were requested. Appellant's arguments can be summarised as follows:

The definition of the claimed subject-matter in terms of parameters was justified since such a fibre could not be defined in other terms without unduly restricting the scope of the claim. The claims were related to an article comprising an optical fibre having specific characteristics one of which was a given range of the average chromatic dispersion. Since this feature and other characteristics permitted reduction of an optical fibre to practice in the form of an article having such a fibre, claim 1 included all essential features.

A dispersion shifted fibre (DSF) had been introduced and had become the only fibre used in state-of-the-art long-distance systems. In a DSF the waveguide dispersion compensated for chromatic dispersion at the wavelength of operation, 1550 nm. The inventors had recognised that this universal practice had to be abandoned in multi-channel systems based on WDM, since the use of DSF resulted in unwanted crosstalk between the channels. The (known) non-linear effect of four-wave mixing (4WM or FWM) resulting in generation of spurious signals - sum and difference frequencies of adjoining channels - had been overlooked. The solution according to the present invention was a new fibre which instead of zero dispersion, exhibited a small value of dispersion "in the range of 2-4ps/nm-km". This

non zero dispersion fibre (NZDF) afforded not only the periodic phase cancellation, which limited the growth of spurious signal to tolerable amplitude, but also assured sufficiently small pulse spreading to meet bit-rate objectives expected of DSF. Upon disclosure, NZDF completely replaced DSF for long distance communications.

The appellant has filed copies of documents (a) to (g) related to journal articles, press announcements, awards and a news release, reflecting the universal acceptance of the NZDF under the trade name "Truewave".

Claim 1 according to the main request reads as follows:

"1. Article comprising at least one optical fiber suitable for use in wavelength division multiplex systems, the fiber including a core and a clad, having an attenuation at 1550nm ≤ than 0.25dB/km, having a cut off wavelength of less than 1.40μm and a dispersion slope less than 0.15ps/ ($nm^2$-km) characterized in that the absolute magnitude of the average chromatic dispersion at 1550nm for a fiber length of at least 2.2km is in the range of 2-4ps/nm-km."

## Reasons for the Decision

1. *Amendments*

1.1 Claim 1 (main request)

The amended lower limit 2ps/nm-km of the chromatic dispersion is disclosed in the table "WDM" at page 6 of the original description.

1.2 Description, page 8

The unit used in the description as originally filed to describe the channel spacing has been changed from "μm" to "nm". It is general knowledge among persons skilled in the art, that in WDM systems as considered in the context of the present application, the channel spacing is measured in nanometres (nm) rather than in micrometers (μm). This is consistent with the definition of a channel spacing of "1.5 nm or greater" provided for WDM in the context of the invention, as indicated at page 3, lines 13 to 14, with the definition of channel separations "from 1nm-2nm" at page 5, lines 11 to 14, and with a channel-to-channel separation of "≈2nm" reported from a four-channel system employing a non-shifted fibre, see page 2, lines 21 to 24. The corresponding frequencies, as indicated at the original page 8 in parenthesis, although lying in the GHz-regime as expected, were not consistent with the figures in nm, in that they have an inverse order. However, they have been deleted according to the amendment. The order of the values in nm is correct, since according to Figure 1, increasing channel spacing results in increased capacity, see page 8, lines 29 to 31.

Therefore the Board concludes that the values of channel spacing according to the amendments are directly and unambiguously derivable from the application as originally filed, see Article 123(2) EPC.

1.3 The remaining amendments are of self-explanatory nature and therefore need not be discussed.

2. *Clarity (main request)*

2.1 The attenuation at a given wavelength, cut-off wavelength, dispersion slope and average chromatic dispersion at the given wavelength are all parameters commonly used for specification of an optical fibre. The Board agrees with the appellant that it is clear to a skilled person how a fibre having the parameters defined in claim 1 can be realised by modifying core diameter and core and clad doping levels of the fibre, as indicated in the present application, see page 7, lines 11 to 13 and 27 to 31 and page 8, lines 1 to 9.

2.2 The average chromatic dispersion is independent of the length of the fibre. However, the definition of a length in this context is not obscure, contrary to what was stated by the examining division. The Board agrees with the appellant that this definition means that the given range 2-4ps/nm-km has to be fulfilled for fibres having a length of at least 2.2 km. This is also in agreement with the explanation at page 6, last three lines.

2.3 The present invention is related to an article comprising at least one optical fibre having specific characteristics, in particular, a given range for the

absolute magnitude of the average chromatic dispersion at a given wavelength. The problem solved by these characteristics is related to avoiding crosstalk between the channels in a multi-channel system. Even though the problem is related to an application of the optical fibre, it is the optical fibre which has the specific characteristics. In such a case it would be unfair and contrary to common practice to limit the claim to the particular device in which the fibre is used, namely to a wavelength division multiplex (WDM) system, as seems to have been suggested by the examining division. Rather, a corresponding statement of use would be acceptable, namely that the optical fibre is "suitable for use in wavelength division multiplex systems", as is in fact indicated in claim 1. Moreover, the appellant has provided convincing arguments as to why it needs protection for a (general) article comprising an optical fibre. New systems, while using the new fibre, were likely to operate on a single channel as installed. Substitution of the claimed fibre for the traditional dispersion shifted fibre (DSF) would often be made in contemplation of future multi-channel operation.

2.4 Therefore the Board arrives at the conclusion that claim 1 according to the main request is clear and supported by the description as required by Article 84 EPC.

3. *Novelty (main request)*

3.1 A comparison of specifications for state-of-the-art DSF at page 1 of the present description with specifications for the claimed fibre for WDM systems at

page 6 yields the result that the ranges given for the dispersion are different. The range <3.5ps/nm-km over 1525-1575nm given for DSF must be interpreted according to page 3, lines 7 to 12, and means that at the chromatic dispersion null point $\lambda_0$=1550nm a chromatic dispersion of <1ps/nm-km is required. The chromatic dispersion of the fibre defined in claim 1 at 1550nm is in the range 2-4ps/nm-km and is thus different from the chromatic dispersion value of the DSF.

3.2 Document D3 - the bibliographic references of which are apparently misquoted in the decision under appeal - is related to a theoretical study based on a computer simulation of the "effect of fiber nonlinearity on long-distance transmission." A value for the chromatic dispersion of -2ps/nm-km is indicated in the first paragraph of section IV at page 124, which has the same order of magnitude as values falling within the claimed range in contrast to ranges -0.21±0.5ps/nm-km and 0.21±0.5ps/nm-km indicated in section V at pages 125 and 126, respectively. However, the value -2ps/nm-km has a negative sign and thus does not fall within the claimed range. The present application explicitly concentrates on positive values of dispersion, see page 7, lines 13 to 15.

3.3 Document D1 discloses an optical fibre which is of the DSF type, designated as "dispersion-modified" fibre having a zero dispersion wavelength, see title and summary. The chromatic dispersion is "specified to be below 2ps/nm/km in the range 1.5-1.6μm", page 571, right-hand column, third paragraph, and Figure 13 with the description, page 575, left-hand column, second paragraph.

3.4 Thus, since none of the values of the chromatic dispersion disclosed in the relevant prior art falls within the range given in claim 1 of the present application, the board concludes that the subject-matter of claim 1 is new within the meaning of Article 54(1) EPC.

4. *Inventive step (main request)*

4.1 As is apparent from section 3 above, the subject-matter of claim 1 differs from that disclosed in D3, in that the absolute magnitude of the average chromatic dispersion at 1550nm for a fibre length of at least 2.2 km is in the range 2-4ps/nm-km. The objective problem solved by this feature addresses the suitability for use in wavelength division multiplex (WDM) systems. The invention is based on the recognition that the low chromatic dispersion of a dispersion-shifted fibre (DSF) at the operation wavelength causes difficulties in WDM operation due to the effect of four-wave mixing (FWM) or four-photon mixing (FPM). The effect of FWM or FPM has been considered in D3, see point 3.2 above. The main teaching of D3 is that in multi-channel WDM systems no channel should be located exactly at the zero-dispersion wavelength since this would cause catastrophic build-up of spurious waves, see page 128, left-hand column, second paragraph. According to the last paragraph on this page it follows that, in a two-channel system, neither channel should be placed closer than 0.5nm to the zero-dispersion wavelength. Therefore, it is evident to the skilled person that, according to D3, two-channel operation was still feasible using a

DSF as long as none of the channels coincided with the zero dispersion wavelength. In contrast to that, the present invention teaches the use of a fibre having larger chromatic dispersion falling within the claimed range 2-4ps/nm-km, which is suitable for a multi-channel WDM system.

4.2 The examining division has expressed the opinion that the essence of the present invention, i.e. avoiding WDM operation at the zero-dispersion wavelength, was completely anticipated by D3. Even though D3 did not directly suggest a certain range for an appropriate dispersion, a value of -2ps/nm-km was assumed in the calculation presented in D3, which would be considered by the skilled reader for a practical WDM system in view of the statement, see page 125, right-hand column, third paragraph, that "in practical communication systems with optical amplifiers, the persistence of the spurious pulse energy after each amplifier may not be all that troublesome since its level is usually quite low and since it can always be removed by filters placed behind each amplifier". It was evident from section V of D3 or the dispersion curves depicted in Figure 8 of D1 that the value of 2ps/nm-km is slightly different for each of the wavelengths used in a WDM system. Accordingly, the disclosure of D3 had to be interpreted in the sense that a dispersion of about 2ps/nm-km was suitable for a practical communication system in keeping with the lower limit of the range defined in claim 1 of the current application.

4.3 The Board, however, is of the opinion that D3 is primarily a theoretical investigation whose assumptions and results, as far as they are related to absolute

numbers, would be regarded by skilled persons with caution. This is reflected by the concluding statement of the authors of D3 themselves, see last paragraph of section IV "Conclusions" on the last page, "Finally, we speculate that a two-channel ASK system at 2.5Gb/s modulation rate should be feasible with normal (nonsoliton) pulses spaced 2 to 3nm apart, provided both channels are located in the region of normal group velocity with neither channel placed closer than 0.5nm to the zero-dispersion wavelength". This teaching implies that a dispersion-shifted fibre (DSF) should be employed having a rather low chromatic dispersion around the zero-dispersion wavelength (see present application, page 3, lines 7 to 12) of less than 1ps/nm-km in a region around 1.55µm which is 0.01µm=10nm wide, where according to D3 the channels are to be placed. This dispersion value is considerably lower than according to the present claim 1. Moreover, from the various figures for the chromatic dispersion, which differ by an order of magnitude, suggested in D3, see point 3.2 above, there is no conclusive teaching to employ values of the chromatic dispersion falling within the claimed range of 2-4ps/nm-km for a wavelength of 1550nm. The value of -2ps/nm-km given in D3, as relied upon by the examining division in support of its reasoning, not only is negative, which is of relevance in the context of pulse propagation, but is given in the document only as a dispersion parameter specifically selected in a computer simulation of colliding pulses so as to simulate occurrence of pulse coincidence at an arbitrarily chosen distance of 12.5 km.

4.4 Nor does D1, which also relates to DSF, teach the use of values of the chromatic dispersion falling within the claimed range of 2-4ps/nm-km for a wavelength of 1550nm, see point 3.3 above. It was therefore not obvious to the skilled person to provide an article comprising an optical fibre having the claimed chromatic dispersion.

4.5 The Board also noted that the fibre made available by the invention was widely accepted under the trade name "Truewave" in the field of fibre optic communication, as is apparent from the documents (a) to (g) provided by the appellant. This consistent and convincing evidence confirms the Board's opinion that the subject-matter of claim 1 according to the main request involves an inventive step within the meaning of Article 56 EPC.

5. Since the subject-matter of claim 1 according to the main request meets the requirements of the EPC, the auxiliary request need not be considered. Neither was it necessary to conduct oral proceedings.

## Order

**For these reasons it is decided that:**

1. The decision under appeal is set aside.

2. The case is remitted to the first instance with the order to grant a patent in the following version:

**Description**:

Pages: 1 to 5 and 9 as originally filed
6 to 8 filed with letter of 25 November 2002

**Claims**:

Nos.: 1 to 10 filed with letter of 25 November 2002 (Main request)

**Drawings**:

Sheets: 1/2 to 2/2 as originally filed

The Registrar: The Chairman:

P. Martorana A. G. Klein