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Datasheet for the decision
of 3 April 2019

Case Number: T 0269/14 - 3.5.07

Application Number: 08773555.1

Publication Number: 2201691

IPC: H03M13/03, H04L1/00

Language of the proceedings: EN

Title of invention:
Scalable information signal, apparatus and method for encoding a scalable information content, and apparatus and method for error correcting a scalable information signal

Applicant:
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.

Headword:
Multidimensional layered FEC/FRAUNHOFER-GESELLSCHAFT

Relevant legal provisions:
EPC Art. 54, 56, 83, 123(2)

Keyword:
Amendments - added subject-matter (no)
Inventive step - (yes)
Sufficiency of disclosure - (yes)

Beschwerdekammern

Boards of Appeal

Chambres de recours

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Case Number: T 0269/14 - 3.5.07

D E C I S I O N
of Technical Board of Appeal 3.5.07
of 3 April 2019

Appellant: (Applicant)
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Decision under appeal:
Decision of the Examining Division of the European Patent Office posted on 22 July 2013 refusing European patent application No. 08773555.1 pursuant to Article 97(2) EPC

Composition of the Board:

Chairman R. Moufang
Members: C. Barel-Faucheux
M. Jaedicke

Summary of Facts and Submissions

I. The applicant (appellant) appealed against the decision of the Examining Division refusing European patent application No. 08773555.1.

II. The contested decision cited the following documents:

D1: Stankovic et al., "Real-Time Error Protection of Embedded Codes for Packet Erasure and Fading Channels", IEEE transactions on circuits and systems for video technology, vol. 14, no. 8, 1 August 2004, pages 1064-1072;

D2: Dumitrescu et al., "Globally Optimal Uneven Error-Protected Packetization of Scalable Code Streams", IEEE transactions on multimedia, vol. 6, no. 2, 1 April 2004, pages 230-239;

D3: Schwarz et al., "Overview of the Scalable Video Coding Extension of the H.264/AVC Standard", IEEE transactions on circuits and systems for video technology, vol. 17, no. 9, 1 September 2007, pages 1103-1120.

The Examining Division decided that:

- The main request and the second and third auxiliary requests were not allowable as they did not meet the requirements of Article 56 EPC.
- The first auxiliary request was not admitted into the proceedings.

III. With the statement of grounds of appeal, the appellant maintained the requests considered in the contested decision.

IV. In a communication pursuant to Article 15(1) RPBA accompanying a summons to oral proceedings, the Board drew the appellant's attention to the following documents which have been published by the inventors of the present application after the priority date of the present application:

D4: Hellge et al., "Mobile TV Using Scalable Video Coding and Layer-aware Forward Error Correction", IEEE International Conference on Multimedia and Expo, 23 June 2008, pages 1177-1180;

D5: Hellge et al., "Multidimensional Layered Forward Error Correction Using Rateless Codes", IEEE International Conference on Communications, Beijing, China, 19 May 2008, pages 480-484.

V. In a reply to said communication, the appellant filed a new main request and fifty-five auxiliary requests.

VI. In a further communication, the Board informed the appellant that some clarity issues under Article 84 EPC still arose for all the submitted requests, and that it was prepared to discuss inventive step, in particular having regard to the following document "A2" cited in the description on page 1:

A2: A. Bouabdallah et al., "Dependency-aware Unequal Erasure Protection Codes", Journal of Zhejiang University SCIENCE A, 2006 7 (Suppl. I), pages 27-33.

VII. Oral proceedings were held as scheduled, during which the appellant submitted claim 1 of a new main request. The chairman indicated that the Board considered the submitted claim 1 to comply with the requirements of the EPC and that it expected the appellant to file a completed new main request and an adapted description and figures within the next two weeks. The chairman announced that the proceedings would be continued in writing.

VIII. With its letter of 1 February 2019, the appellant submitted a new set of claims 1 to 11 as "a new main request", and a new description (pages 1 to 37) as well as a corrected Figure 6 on new drawing sheet 6/18. It maintained all the other pending requests as "auxiliary requests relative to the new main request".

IX. The rapporteur informed the appellant by phone, on 19 and 26 February 2019, that some clarity objections under Article 84 EPC remained in claims 8 and 9 of the main request. In reply, the appellant submitted correspondingly amended sets of claims 1 to 10 with its letters of 20 and 26 February 2019.

X. The Board understands that the appellant requests that the decision under appeal be set aside and that a patent be granted on the basis of:
- the set of claims of the new main request filed by letter of 26 February 2019 or, in the alternative, on the basis of the set of claims of one of the requests, including the previous main request, filed by letter of 18 December 2018, in the order that they were presented when they were filed;
- the description, pages 1 to 37, filed on 1 February 2019;
- the drawings, sheets 1/18 to 5/18, and 7/18 to 18/18, filed on 22 July 2008, and sheet 6/18, filed on 1 February 2019.

XI. Main Request

Independent claim 1 of the main request reads as follows:

"Layered information signal which comprises lowest layer portion data, first higher layer portion data and second higher layer portion data, which are disjoint to each other, wherein the layered information signal is scalable in a plurality of dimensions (12, 14) and wherein portions (10, 10a, 10b, 10c) of the layered information signal represent information content at different constellations (x_{10}, x_{11}, x_{00}, x_{01}) of levels of the plurality of dimensions,

wherein a first portion (10a) of the layered information signal which encompasses the lowest layer portion data and the first higher layer portion data has coded therein the information content at a level of a first one of the plurality of dimensions higher than a level in the first dimension at which the lowest layer portion data has coded therein the information content,

wherein a second portion (10b) of the layered information signal which encompasses the lowest layer portion data and the second higher layer portion data has coded therein the information content at a level of the second dimension higher than a level in the second dimension at which the lowest layer portion data has coded therein the information content,

wherein the layered information signal is forward error correction protected by each of the lowest layer portion data, the first higher layer portion data and the second higher layer portion data having redundancy information associated therewith such that

> each redundancy information is dependent on the respective portion data with which it is associated,

the redundancy information associated with the first higher layer portion data is dependent on the first higher layer portion data and the lowest layer portion data, and

the redundancy information associated with the second higher layer portion data is dependent on the second higher layer portion data and the lowest layer portion data,

wherein the layered information signal is a media signal."

Claims 2 to 5 are directly dependent on claim 1.

Independent claim 6 reads as follows:

"Apparatus for encoding an information content into a layered information signal which comprises lowest layer portion data, first higher layer portion data and second higher layer portion data, which are disjoint to each other, wherein the layered information signal is scalable in a plurality of dimensions and wherein portions of the layered information signal represent information content at different constellations of levels of the plurality of dimensions, comprising

[sic] generator for generating the plurality of portions so that a first portion of the layered information signal which encompasses the lowest layer portion data and the first higher layer portion data has coded therein the information content at a level of a first one of the plurality of dimensions higher than a level in the first dimension at which the lowest layer portion data has coded therein the information content, and that a second portion of the layered

information signal which encompasses the lowest layer portion data and the second higher layer portion data has coded therein the information content at a level of the second dimension higher than a level in the second dimension at which the lowest layer portion data has coded therein the information content,

[sic] protector for forward error correction protecting the layered information signal by associating redundancy information to each of the lowest layer portion data, the first higher layer portion data and the second higher layer portion data such that

each redundancy information, is dependent on the respective portion data with which it is associated,

the redundancy information associated with the first higher layer portion data is dependent on the first higher layer portion data and the lowest layer portion data, and

the redundancy information associated with the second higher layer portion data is dependent on the second higher layer portion data and the lowest layer portion data."

Independent claim 7 reads as follows:

"Method for encoding an information content into a layered information signal which comprises lowest layer portion data, first higher layer portion data and second higher layer portion data, which are disjoint to each other, wherein the layered information signal is scalable in a plurality of dimensions and wherein portions of the layered information signal represent information content at different constellations of levels of the plurality of dimensions, comprising

generating the plurality of portions so that a first portion of the layered information signal which encompasses the lowest layer portion data and the first higher layer portion data has coded therein the information content at a level of a first one of the plurality of dimensions higher than a level in the first dimension at which the lowest layer portion data has coded therein the information content, and that a second portion of the layered information signal which encompasses the lowest layer portion data and the second higher layer portion data has coded therein the information content at a level of the second dimension higher than a level in the second dimension at which the lowest layer portion data has coded therein the information content; and

forward error correction protecting the layered information signal by associating redundancy information to each of the lowest layer portion data, the first higher layer portion data and the second higher layer portion data such that

each redundancy information is dependent on the respective portion data with which it is associated,

the redundancy information associated with the first higher layer portion data is dependent on the first higher layer portion data and the lowest layer portion data, and

the redundancy information associated with the second higher layer portion data is dependent on the second higher layer portion data and the lowest layer portion data."

Independent claim 8 reads as follows:

"Apparatus for error correcting a layered information signal which comprises lowest layer portion data, first higher layer portion data and second higher layer portion data, which are disjoint to each other, wherein the layered information signal is scalable in a plurality of dimensions (12, 14) and wherein portions (10, 10a, 10b, 10c) of the layered information signal represent information content at different constellations (x_{10}, x_{11}, x_{00}, x_{01}) of levels of the plurality of dimensions, wherein a first portion of the layered information signal which encompasses the lowest layer portion data and the first higher layer portion data has coded therein the information content at a level of a first one of the plurality of dimensions higher than a level in the first dimension at which the lowest layer portion data has coded therein the information content, wherein a second portion of the layered information signal which encompasses the lowest layer portion data and the second higher layer portion data has coded therein the information content at a level of the second dimension higher than a level in the second dimensions [sic] at which the lowest layer portion data has coded therein the information content, wherein the layered information signal is forward error correction protected by each of the lowest layer portion data, the first higher layer portion data and the second higher layer portion data having redundancy information associated therewith such that each redundancy information is dependent on the respective portion data with which it is associated, the redundancy information associated with the first higher layer portion data is dependent on the first higher layer portion data and the lowest layer portion data, and the redundancy information associated with the second higher layer portion data is dependent on the second higher layer portion data and the lowest layer portion data, the apparatus comprising:

a corrector for performing forward error correction on the layered information signal within the lowest layer portion data to obtain an error corrected lowest layer portion data either

i) by use of the redundancy information associated with the lowest layer portion data, and

at least one of

the first higher layer portion data and the redundancy information associated with the first higher layer portion data, and

the second higher layer portion data and the redundancy information associated with the second higher layer portion data, or

ii) by firstly attempting to error correct the layered information signal within the lowest layer portion data by use of the redundancy information associated with the lowest layer portion data, without use of the redundancy information associated with the first and second higher layer portion data and without the first and second higher layer portion data, and

if the first attempt is not successful, re-attempting to error correct the layered information signal within the lowest layer portion data by use of the redundancy information associated with the lowest layer portion data, and the at least one of the first higher layer portion data and the redundancy information associated with the first higher layer portion data and the second higher layer portion data and the redundancy information associated with the second higher layer portion data; and

a deriver for deriving, by decoding, the information content at the constellation at which the lowest layer portion data has coded therein the layered information signal from the error corrected lowest layer portion data."

Independent claim 9 reads as follows:

"Method for error correcting a layered information signal which comprises lowest layer portion data, first higher layer portion data and second higher layer portion data, which are disjoint to each other, wherein the layered information signal is scalable in a plurality of dimensions (12, 14) and wherein portions (10, 10a, 10b, 10c) of the layered information signal represent information content at different constellations (x_{10}, x_{11}, x_{00}, x_{01}) of levels of the plurality of dimensions, wherein a first portion of the layered information signal which encompasses the lowest layer portion data and the first higher layer portion data has coded therein the information content at a level of a first one of the plurality of dimensions higher than a level in the first dimension at which the lowest layer portion data has coded therein the information content, wherein a second portion of the layered information signal which encompasses the lowest layer portion data and the second higher layer portion data has coded therein the information content at a level of the second dimension higher than a level in the second dimensions [sic] at which the lowest layer portion data has coded therein the information content, wherein the layered information signal is forward error correction protected by each of the lowest layer portion data, the first higher layer portion data, and the second higher layer portion data having redundancy information associated therewith such that each redundancy information is dependent on the respective portion data with which it is associated, the redundancy information associated with the first higher layer portion data is dependent on the first higher layer portion data and the lowest layer portion data, and the redundancy information associated with the second higher layer portion data is dependent on the second higher layer portion data and the lowest layer portion data, the method comprising:

performing forward error correction on the layered information signal within the lowest layer portion data to obtain an error corrected lowest layer portion data either

i) by use of the redundancy information associated with the lowest layer portion data, and

at least one of

> the first higher layer portion data and the redundancy information associated with the first higher layer portion data, and

the second higher layer portion data and the redundancy information associated with the second higher layer portion data, or

ii) by firstly attempting to error correct the layered information signal within the lowest layer portion data by use of the redundancy information associated with the lowest layer portion data, without use of the redundancy information associated with the first and second higher layer portion data and without the first and second higher layer portion data, and

if the first attempt is not successful, re-attempting to error correct the layered information signal within the lowest layer portion data by use of the redundancy information associated with the lowest layer portion data, and the at least one of the first higher layer portion data and the redundancy information associated with the first higher layer portion data and the second higher layer portion data and the redundancy information associated with the second higher layer portion data; and

deriving, by decoding, the information content at the constellation at which the lowest layer portion data has coded therein the layered information signal from the error corrected lowest layer portion data."

Independent claim 10 defines "A computer program having a program code for performing, when executed on a computer, a method as claimed in any of claims 7 and 9."

XII. In view of the outcome of the appeal, the text of the auxiliary requests is not relevant for the present decision.

Reasons for the Decision

1. Admissibility of appeal

1.1 The appeal complies with the provisions referred to in Rule 101 EPC and is therefore admissible.

2. The application

2.1 The application relates to information signals, such as media signals encoding information content, and to the error correction of such information signals.

2.2 Media transmission is affected by information losses due to transmission errors in many transmission channels. In the case of a video bit stream encoded by scalable (i.e. progressively refinable) video coding (SVC), for example, the effect of losses on the decoded video quality mainly depends on which parts of the bit stream are affected.

2.3 In unidirectional channels, forward error correction (FEC) technologies can be used to combat these losses. Many protection schemes addressing this issue have been proposed, such as unequal error protection (UEP) or priority encoding transmission (PET). Both approaches give more protection to lower and more important layers. In SVC, the loss of any layer x leads to unusable decoding results for all layers *l* > x referencing layer x.

2.4 Even when using stronger FEC protection (more redundancy symbols) for the more important lower layers as in a UEP scheme, there is no guarantee that, in any error condition, the reconstruction of relatively strongly protected layers is possible with a higher probability than for less strongly protected layers.

2.5 As depicted in Figure 19, if a lower layer is lost, higher enhancement layers cannot be decoded due to missing references. In this example, layer *l* at time t is lost due to transmission errors, so that layers m with m > *l* cannot be decoded. Successfully received FEC protection of enhancement layers is useless (see background section of the description).

2.6 The present application thus proposes that higher level or higher layer portions, i.e. portions representing the information content at a higher level in at least one scalability dimension, are associated with respective redundancy information which is not only dependent on the part of the respective portion being disjoint to overlapping lower level portions, but also on the part overlapping with the latter portions (page 16, lines 10 to 17, of the description as originally filed). In this way, the chances of success of forward error correcting an error within the lower level portion at the reception side are increased (see summary section of the description).

2.7 According to the illustrative embodiment of Figure 1a, the whole information signal allows for a reconstruction of the information content at the higher level of 1 in both scalability dimensions 12 and 14, while sub-portion 10c merely allows for a reconstruction of the information content at the lower level 0 in both scalability dimensions 12 and 14. The other sub-portions 10a and 10b are in between, in that they allow for a reconstruction of the information content at the higher level of 1 in one of the scalability dimensions 12 and 14, and at the lower level in the other of both scalability dimensions 12 and 14, as illustrated on the right-hand side of Figure 1a. If the data within portion 10c is somehow corrupted, the information content is not correctly reconstructable, even at the lowest constellation of levels in the two dimensions 12 and 14. This is also true for the higher levels, due to their dependency on the data within portion 10c. Data loss outside portion 10c, however, does not hinder a reconstruction of the information content at, at least, the lowest constellation 00 (page 13, line 27, to page 14, line 20, of the description as originally filed).

2.8 Figure 1b shows an example of an information signal where the number of levels in the scalability dimension 12 is different from the number of levels in the other scalability dimension 14.

2.9 As illustrated in Figure 2, a portion generator 26 is configured to encode the information content 22 into scalable data, such as the information signal data shown in Figures 1a to 1c, but in an unprotected format (page 16, lines 30 to 33, of the description as originally filed). Differing from the representation of Figures 1a to 1c, the portion data output by portion generator 26 is understood to be non-overlapping (page 17, lines 10 to 13, of the description). The portion generator 26 is configured to accompany the lowest layer portion data 32a by disjoint higher level portion data 32b which enables, in combination with the lowest level portion data 32a, an increase of the reconstructable quality in certain levels and in one or several scalability dimensions (page 17, lines 2 to 7, of the description).

2.10 An FEC protector 28 illustrated in Figure 2 comprises a plurality of modules 28a-d, each module 28a to 28d being uniquely associated to a different one of the portions output by portion generator 26, or to a different one of the quality levels/layers to which the portions correspond. Each module 28a to 28d performs an FEC protection on its respective portion data. However, as stated above, in addition to the respective disjoint portion data, each module 28a to 28d receives data of lower level portions contributing or being necessary for the respective quality level (page 17, lines 28 to 38, of the description). Modules 28a to 28d may use either a systematic code or a non-systematic code, for example a Luby transform (LT) code (page 18, lines 22 to 35, of the description).

2.11 Each of these protected higher level disjoint portions has redundancy information that protects also protected disjoint portions of lower levels. Still, the various overlapping portions of the protected information signal at output 24 which enable reconstruction at different levels are individually decodable in order to enable the reconstruction of the information content at the respective level without necessitating any information from the remainder of the protected information signal (page 19, lines 3 to 12, of the description).

2.12 This FEC scheme is called "*layered FEC*" in the present application.

2.13 The protected information signal thus generated by apparatus 20 may be error corrected at reception side by use of the method shown in Figure 3. In essence, a first attempt is performed in order to error correct a lower level portion by use of its associated redundancy information only. Merely in case of a miss, redundancy information of higher level portions is used additionally (page 20, line 36, to page 21, line 2, of the description).

2.14 According to a simpler approach, shown in Figure 4, the redundancy information of higher level portions may be used instantaneously in order to participate in the error detection and error correction of lower level portions.

2.15 Figure 5 shows an example of a dependency structure of a media stream wherein redundancy symbols for an enhancement layer are calculated over the source symbols of all subjacent referenced layers, as proposed in the present application.

2.16 Figure 6 depicts encoding of two dependency layers with this *layered FEC*. The bits in the redundancy vector P_1 of dependency layer 1 are calculated over source symbols of dependency layer 1 and subjacent layer 0, i.e. in combination with source symbols of layer 0 on which layer 1 depends. Therefore, P1 is an XOR combination of the information bits of the vector of the layer 0, I_0, and the information bits of the vector of the layer 1, I_1. The systematic code word C_1 is a concatenation of source bits vector I_1 and the redundancy vector P1 (page 24, lines 23 to 30, of the description). A decoding referring to this encoding example of Figure 6 is depicted by Figure 8.

2.17 It is taught in the description (page 27, lines 1 to 4) that the layered FEC thus described adds additional dependencies in upper layers parity bits, and that therefore, due to the layer dependencies, correctly received higher enhancement layers are worthless without correct lower layers.

2.18 When the above-described layered FEC is extended by allowing different layered FEC encoding at the same time over different dimensions of a scalable media signal, this is called *multidimensional layered FEC (MDL FEC)* in the present application. In other words, layered FEC can be used for multidimensional dependency structures.

3. Main Request

3.1 Claim 1 of the main request relates to a layered information signal which comprises the following features itemised by the Board:

(a) [Layered information signal which comprises] lowest layer portion data, first higher layer portion data and second higher layer portion data, which are disjoint to each other,

(b) wherein the layered information signal is scalable in a plurality of dimensions and

(c) wherein portions of the layered information signal represent information content at different constellations (x_{10}, x_{11}, x_{00}, x_{01}) of levels of the plurality of dimensions,

(d) wherein a first portion of the layered information signal which encompasses the lowest layer portion data and the first higher layer portion data has coded therein the information content at a level of a first one of the plurality of dimensions higher than a level in the first dimension at which the lowest layer portion data has coded therein the information content,

(e) wherein a second portion of the layered information signal which encompasses the lowest layer portion data and the second higher layer portion data has coded therein the information content at a level of the second dimension higher than a level in the second dimension at which the lowest layer portion data has coded therein the information content,

(f) wherein the layered information signal is forward error correction protected by each of the lowest layer portion data, the first higher layer portion data and the second higher layer portion data having redundancy information associated therewith such that

(g) each redundancy information is dependent on the respective portion data with which it is associated,

(h) the redundancy information associated with the first higher layer portion data is dependent on the first higher layer portion data and the lowest layer portion data, and

(i) the redundancy information associated with the second higher layer portion data is dependent on the second higher layer portion data and the lowest layer portion data,

(j) wherein the layered information signal is a media signal.

3.2 Independent claim 6 defines an apparatus for encoding an information content into a layered information signal as defined in claim 1; independent claim 7 defines a corresponding method.

3.3 Independent claim 8 defines an apparatus for error correcting a layered information signal as defined in claim 1; independent claim 9 defines a corresponding method.

3.4 Independent claim 10 defines a computer program having a program code for performing, when executed on a computer, a method as claimed in any of claims 7 and 9.

4. Compliance with Article 123(2) EPC

4.1 Claim 1 is partially based on claim 1 as originally filed.

4.1.1 Features (a) to (e) are based on originally filed claim 1 and on the description as originally filed, from page 16, line 30, to page 17, line 25, in conjunction with Figure 1a and the corresponding description from page 12, line 22, to page 14, line 2.

4.1.2 Features (f) to (i) are based on the description as originally filed, from page 17, line 27, to page 18, line 18, in conjunction with Figure 1a and the corresponding description from page 12, line 22, to page 14, line 2.

4.1.3 Feature (j) is based on the description as originally filed, on page 1, lines 7 to 9.

4.2 Independent claim 6 defines an apparatus for encoding an information content into a layered information signal as defined in claim 1 and is based on claim 14 as originally filed and on the passages of the description cited above for claim 1 and Figure 2.

4.3 Independent claim 7 defines a corresponding method for encoding an information content into a layered information signal as defined in claim 1 and is based on claim 27 as originally filed and on the passages of the description cited above for claim 1 and Figure 2.

4.4 Independent claim 8 defines an apparatus for error correcting a layered information signal as defined in claim 1 either by the method illustrated in Figure 3 and described on page 19, line 23, to page 21, line 2, for the alternative ii), or by the simpler approach illustrated in Figure 4 and described on page 21, lines 2 to 22, for the alternative i). It is also based on claims 31 and 32 as originally filed (the reference in claim 32 to claim 29 instead of claim 31 is an obvious mistake that the reader would have immediately recognised and corrected).

4.5 Independent claim 9 defines a corresponding method for error correcting a layered information signal as defined in claim 1. It is also based on claim 33 as originally filed.

4.6 Independent claim 10 defines a computer program having a program code for performing, when executed on a computer, a method as claimed in any of claims 7 and 9. It is based on claim 37 as originally filed.

4.7 Dependent claims 2 and 3 are respectively based on dependent claims 4 and 10 as originally filed, with some amendments in accordance with present claim 1.

Dependent claims 4 and 5 are respectively based on dependent claims 11 and 13 as originally filed.

4.8 The Board is therefore satisfied that claims 1 to 10 fulfil the requirements of Article 123(2) EPC.

5. Novelty - Article 54 EPC

5.1 The Examining Division did not contest the novelty of the claims, considering the closest prior art as being the unequal error protection scheme.

5.2 Document D1 discloses a transmission system wherein an embedded source bit stream is transformed into N packets of L symbols, each such that information layers of decreasing importance are protected with increasingly weaker maximum distance separable (MDS) erasure codes (e.g. Reed-Solomon (RS) codes). Unequal loss protection (or UEP) solutions for this system were also devised by several researchers (section I, "Introduction").

Document D1 teaches that a "popular" forward error correction system builds L segments $S_1,\dots,S_L$, each of which consists of m_i source symbols, and protects each segment S_i with an (N, m_i) systematic RS code. For each i, $f_i=N-m_i$ denotes the number of RS redundant symbols that protect segment S_i. If n packets of N are erased, then the RS codes ensure that all segments that contain at most N-n source symbols can be recovered. Thus, by adding the constraint $f_1>= f_2>= \dots >= f_L$, if at most f_i packets are erased, then the receiver can recover at least the first i segments (section II, "Packet loss protection", sub-section A).

A so-called "product" code is constructed (section III, "Product code", sub-section A) by first protecting the embedded source code with RS codes, then cyclic redundancy check (CRC) symbols are added to each row. Finally, each row is encoded with the same rate convolutional punctured code (RCPC).

5.3 Document D2 is quite similar to document D1 but with a focus on scalable source sequences in the uneven error protection (or UEP) framework. It underlines that "since the scalable source sequence is only sequentially refinable, decoding of the i^{th} source segment depends on all the previous i-1 segments, i.e., the complete prefix of the source sequence with respect to the current segment. Hence the number of redundancy symbols assigned to a slice must be monotonically non-increasing in the slice index". Hence, as in document D1 and with the same notation as used in document D1, document D2 preconises again that (section I, "Introduction") $f_1 >= f_2 >= ... >= f_L$.

5.4 The appellant stressed that "UEP also protects base layer data stronger than higher layer data, but the FEC protection is performed in a non-overlapping manner".

5.5 Features (h) and (i) (defining a kind of "overlapping" of the redundancy information across the different layers as illustrated in Figure 5 of the present application) are not disclosed by the content of documents D1 or D2, both describing a UEP scheme.

5.6 Document D3 is a general overview of the scalable video coding extension of the H.264/AVC standard. It does not focus on forward error correction.

5.7 Thus, the claims are novel over documents D1 to D3.

6. Inventive step over D1 or D2

6.1 The problem to be solved by the distinguishing features (h) and (i) might be considered as how to improve the forward error correction capability of a redundancy scheme to correct the lower layers of a multilayer scalable signal, in comparison with its capability to correct them with a UEP scheme as presented in document D1 or D2.

6.2 The appellant argued that, by using overlapping, the claimed "layer aware" FEC (i.e. the FEC defined by the claims) would enable achieving a better reception quality (applying the error correction process defined by claim 9) on the receiver side at a given transmission capacity and, during the examination proceedings, submitted a pamphlet prepared by the inventors to provide evidence for this assertion.

6.3 On page 3, letter d), of the grounds for the decision, the Examining Division considered a case wherein the error correction code (ECC) for the enhancement layer is much stronger than that of the base layer, and concluded that this "obviously allows the enhancement layer code to protect both the enhancement layer data and the base layer data". It went on by stating that "this would come at the expense of a much larger ECC overhead for the enhancement layer". Then it stated that it was not clear "why this would be better or more efficient than letting each layer have its own ECC (e.g. RS)".

6.4 In its statement of grounds of appeal, the appellant stated that the "*main obstacle against a grant of the present application was the Examiner's continuous* *distrust that the present invention actually shows the effectiveness increase compared to UEP*".

6.5 The Board is of the opinion that the claims do not encompass a case where there is redundancy information associated only with the enhancement layer, but only cases where both the enhancement layer and the lower layers have each redundancy information associated therewith (for example, claim 1 specifies that "the layered information signal is forward error correction protected by each of the lowest layer portion data, the first higher layer portion data and the second higher layer portion data having redundancy information associated therewith"), as illustrated on Figure 5 of the present application.

6.6 The Board agrees with the appellant that both the redundancy data of a lower layer portion and redundancy data of higher layer portions, taken together, have to be strong enough in order to enable the FEC correction of the lower layer portion. In particular, the Board acknowledges the fact that "there are instances where even the incredibly strong enhancement layer (instances discussed by the Examining Division) [...] portions' redundancy information is not sufficient in order to reconstruct/correct the base layer [...] portion, but the additional correction hints provided by the base layer [...] portions ['] redundancy information renders a correction possible" (see page 9 of the statement of grounds of appeal). The lower layer portions' redundancy information does not appear to the Board to be "superfluous" in that case, contrary to the opinion of the Examining Division.

6.7 In view of the above, the Board considers that the subject-matter of the independent claims involves an inventive step according to Article 56 EPC over document D1 or D2.

7. *Inventive step over D3 in combination with A2*

7.1 Document D3 is a general overview of the scalable video coding extension of the H.264/AVC standard as already mentioned under point 5.6 above. It does not focus on forward error correction but it is well known to use FEC redundancy when encoding video data in the form of a multilayer media signal.

Document D3, on page 1107, left-hand side, describes "hierarchical prediction structures" enabling temporal scalability wherein "[*E*]*ach set of temporal layers* $\{T_0, ..., T_k\}$ *can be decoded independently of all layers with a temporal layer identifier* $T > k$". Figure 1 illustrates some hierarchical prediction structures for enabling temporal scalability. As an example, Figure 1(b) illustrates a hierarchical prediction structure which provides two "*independently decodable subsequences with 1/9th and 1/3rd of the full frame rate*".

On page 1108, left-hand column, of D3, it is described that: "*The coding efficiency for hierarchical prediction structures is highly dependent on how the quantization parameters are chosen for pictures of different temporal layers. Intuitively, the pictures of the temporal base layer should be coded with highest fidelity, since they are directly or indirectly used as references for motion-compensated prediction of pictures of all temporal layers. For the next temporal layer a larger quantization parameter should be chosen, since the quality of these pictures influences fewer pictures. Following this rule, the quantization* *parameter should be increased for each subsequent hierarchy level.*"

This thus describes a scaling of the video in a further dimension than the scaling in the temporal dimension, which is a scaling in the fidelity (or quality) dimension. D3 teaches, in particular, increasing the quantization parameter, thereby decreasing the quality of the pictures, for pictures of increasing temporal layers.

Figure 4 on page 1109, right-hand column, illustrates a multilayer structure with an additional "inter-layer" prediction for enabling spatial scalable coding. The first full paragraph of the right-hand side of page 1109 states that "*as illustrated in Fig. 4, lower layer pictures do not need to be present in all access units, which makes it possible to combine temporal and spatial scalability*" (underlining added by the Board).

Thus, scaling of a video signal and creating hierarchical layers in multiple dimensions is described in D3.

7.2 On page 1, lines 29 to 32, of the description of the present application as originally filed, it is explained that "*[...] first in [A2] it has been recognized, that generating protection over all depending layers also redundancy symbols of upper layers can help increasing protection for lower layers.*"

7.3 Concerning this document A2 referred to in the description of the present application, the passage of page 28 of said document, left-hand column, reads:

"*if a redundant packet protects a packet belonging to a given video frame, then it must protect all the packets of this frame and all the packets belonging to the parent frame of the considered frame*" (underlining added by the Board).

The expression "the parent frame" refers to a dependency, in a MPEG video coding (page 30 of A2):
- of a P-frame with respect to all the previous P-frames until the first I-frame;
- of a bidirectionally coded B-frame with respect to the corresponding pair of the previous and following reference frames, and with respect to all frames on which they depend.
It follows that the expression "the parent frame" is to be understood as a reference frame to which a current frame refers.

A2 proposes a scheme wherein some redundancy packet(s) protects:
- either an I-frame of a Group of Pictures (GOP);
- or a P-frame and all the previous P-frames until the first I-frame;
- or the B-frame and the corresponding pair of the previous and following reference frames, and all frames on which they depend.

For example, supposing that 15 source packets are denoted by X_1, X_2, X_3, ..., X_{15} for one GOP, one obtains, according to Table 2 of A2 on page 30: packets X_1 to X_5 constitute the I-frame of the GOP, packet X_6 constitutes the first B-frame of the GOP, packet X_7 constitutes the second B-frame of the GOP, packets X_8 and X_9 constitute the first P-frame of the GOP, packet X_{10} constitutes the third B-frame of the GOP, packet X_{11} constitutes the fourth B-frame of the GOP, packets X_{12}

and X_{13} constitute the second P-frame of the GOP, packet X_{14} constitutes the fifth B-frame of the GOP, and packet X_{15} constitutes the sixth B-frame of the GOP.

The generator matrix of A2 corresponds to (page 31, left-hand side):

$$G_{20,15} = \begin{bmatrix} & \alpha_{1,1} & \cdots & \cdots & \cdots & \alpha_{1,5} \\ & \vdots & & & & \vdots \\ & \alpha_{1,1} & \cdots & \cdots & \cdots & \alpha_{5,5} \\ & 0 & 0 & 0 & 0 & \alpha_{6,5} \\ & 0 & 0 & 0 & 0 & \alpha_{7,5} \\ & 0 & 0 & \alpha_{8,3} & \alpha_{8,4} & \alpha_{8,5} \\ I_{15} & 0 & 0 & \alpha_{9,3} & \alpha_{9,4} & \alpha_{9,5} \\ & 0 & 0 & 0 & 0 & \alpha_{10,5} \\ & 0 & 0 & 0 & 0 & \alpha_{11,5} \\ & 0 & 0 & 0 & \alpha_{12,4} & \alpha_{12,5} \\ & 0 & 0 & 0 & \alpha_{13,4} & \alpha_{13,5} \\ & 0 & 0 & 0 & 0 & \alpha_{14,5} \\ & 0 & 0 & 0 & 0 & \alpha_{15,5} \end{bmatrix}$$

Thus, multiplying the vector (X_1, X_2, X_3, ..., X_{15}) by this generator matrix $G_{20,15}$ will give first the packets X_1, X_2, X_3, ..., X_{15} (since I_{15} represents a 15 by 15 identity matrix) followed by the parity packets that can be denoted by $(P_1, P_2, P_3, P_4, P_5)^T$, "T" indicating a transposition.

This multiplication will yield results indicating that:

- P_1 and P_2 are redundancy packets over the packets of the I-frame of a GOP;
- P_3 is a redundancy packet over the data of the first P-frame and of the I-frame of a GOP;
- P_4 is a redundancy packet over the data of the second P-frame, of the first P-frame and of the I-frame of the GOP;

- P_5 is a redundancy packet over the data of all the frames of the GOP.

7.4 The Board acknowledges that A2 does not describe redundancy packets to protect a scalable or layered (video) signal, but redundancy packets to protect a single GOP. The question to be raised is whether the skilled person, in the light of Figure 1 of D3, would consider a scalable media signal comprising, for example, a base layer constituted only by the "I-frame", a first enhancement layer only by the "P-frames", and a second enhancement layer only by the "B-frames" of a GOP to apply the redundancy scheme of A2 to such a scalable media signal extending over one single GOP.

7.5 The appellant argued during the oral proceedings before the Board that this protection by redundancy packets across frames of a GOP was limited in A2 to the protection of a single GOP, whereas, in order to obtain a temporal scalability, a plurality of GOPs, and thus a plurality of I frames as "access points", would be necessary. A2 presented a single layer bitstream which had nothing to do with real video deployment. Following the construction suggested by the Board (see point 7.4 above), a single "I-frame" of a GOP was not a substitute for the scalable signal at a complete layer of a lowest quality level, for example. The encoding process of A2 was not meant to achieve scalability.

7.5.1 The Board considers that the characteristic of claim 1, that the signal is a layered information signal (i.e. a signal constituted by a plurality of layers), is indeed a distinguishing feature with respect to document A2.

7.6 The appellant further referred to Figure 2 of document A2 which illustrates the quality of the encoded video signal in term of Peak Signal to Noise Ratio (PSNR) versus the loss rate. The quality went down very fast, below the quality level of 36 dB, as soon as the loss rate increased, which created so-called "blocking artefacts".

7.7 The appellant also stated that, in document A2, one I-frame was composed of 5 packets out of the 15 packets of the GOP, i.e. one I-frame corresponds to one third of the GOP. But in SVC, I-frames constituted one eighth of the GOP. Therefore, the teaching of A2 was not suitable for application to a scalable media signal.

7.8 As the Board has been convinced by these arguments, it considers that the subject-matter of the independent claims involves an inventive step according to Article 56 EPC over document D3 even when combined with document A2.

8. Article 83 EPC

8.1 As to the requirements of Article 83 EPC, the Board is satisfied that the description provides an enabling disclosure for the following specific applications of the invention:

- to low-density parity check (LDPC) codes or linear block codes (page 30 of the description, lines 13 to 16);
- to rateless or fountain codes (LT codes or Raptor codes) (Figure 12 and page 28, line 32, to page 29, line 26; page 30, line 31, to page 32, line 8 for LT codes; and page 32, lines 10 to 25 for Raptor codes);

- to non-systematic and systematic Raptor codes as discussed from page 29, line 28, to page 30, line 11, in conjunction with Figure 13;
- to a systematic version of Raptor codes also described on page 32, line 26, to page 33, line 15.

With respect to the Board's observations on certain differences in the disclosure of the application and document D4, respectively document D5, the appellant argued, in its letter of reply dated 18 December 2018, that the present application uses an iterative, layer by layer definition approach to define or extend a matrix layer by layer, whereas D4 presents equations extending over the whole layers and seeks to define the whole matrix.

This argument has convinced the Board.

9. *Remittal for grant*

In summary, the Board considers that the subject-matter of independent claims 1 and 6 to 10 of the main request involves an inventive step with respect to either document D1 or D2, and also with respect to a combination of document D3 with document A2. This finding also applies to the dependent claims.
Hence, the decision of the Examining Division cannot be upheld.

Moreover, the claims of the main request meet the requirements of Articles 83, 84 and 123(2) EPC.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent on the basis of the following documents:
- description: pages 1 to 37, filed on 1 February 2019;
- drawings: sheets 1/18 to 5/18, and 7/18 to 18/18, filed on 22 July 2008, and sheet 6/18, filed on 1 February 2019;
- claims: claims of the main request filed by letter of 26 February 2019,

with the proviso that the applicant be given the opportunity to:
- adapt the description by replacing for the cited documents on page 3,
  "XP 11115753" by "Stankovic et al., 'Real-Time Error Protection of Embedded Codes for Packet Erasure and Fading Channels', IEEE transactions on circuits and systems for video technology, vol. 14, no. 8, 1 August 2004, pages 1064-1072" and "XP011109134" by "Dumitrescu et al., 'Globally Optimal Uneven Error-Protected Packetization of Scalable Code Streams', IEEE transactions on multimedia, vol. 6, no. 2, 1 April 2004, pages 230-239", and
- add, in claim 6, the missing article "a" in front of the words "generator" and "protector", and

- delete the final letter "s" in each occurrence of the expression "in the second dimensions" in claims 8 and 9 (see section XI above).

The Registrar: The Chairman:

M. Canueto Carbajo R. Moufang

Decision electronically authenticated