Claims

1. Audio transmitter processor for generating an error protected frame using encoded audio data of an audio frame, the encoded audio data for the audio frame comprising a first amount of information units and a second amount of information units, the audio transmitter processor comprising:

a frame builder for building a codeword frame having a codeword raster defining reference positions for a predefined total number of codewords, wherein the frame builder is configured

to write the information units of the first amount of information units starting at reference positions of a first predefined subset of the codewords; and

to write the information units of the second amount of information units starting at reference positions of a second predefined subset of the codewords,

wherein the frame builder is configured to determine a border between the first amount of information units and the second amount of information units so that a starting information unit of the second amount of information units coincides with a codeword border; and

an error protection coder

for processing one or more of the codewords of the first predefined subset of the codewords to obtain a first processing result or for processing one or more of the codewords of the second predefined subset of the codewords to obtain a second processing result and for adding the first processing result or the second processing result to the predefined number of codewords to obtain a plurality of processed codewords representing the error protected frame, or

for processing the codewords of the first predefined subset of the codewords or of the second predefined subset of the codewords individually to obtain a plurality of processed codewords representing the error protected frame.

2. Audio transmitter processor of claim 1,

wherein the frame builder is configured to determine the border between the first amount of information units and the second amount of information units based on an information capacity of the second predefined subset, so that the information capacity of the second predefined subset of the codewords is equal to the amount of information units of the second amount of information units.

3. Audio transmitter processor of claim 1 or 2, further comprising:

a source encoder for generating the first and the second amounts of information units using a predefined time portion of an audio signal, wherein the information units comprise a number of obligatory information units and a variable number of residual information units, wherein the source encoder is configured for using a variable length coding rule resulting in a signal-dependent number of the obligatory information units for the predefined time portion,

wherein the frame builder is configured to build the codeword frame so that the codeword frame has a fixed size of information units, and

wherein the audio encoder is configured to determine the variable number of residual information units as an information amount being equal to the difference derived from the fixed size of information units for the codeword frame and the number of obligatory information units.

4. Audio transmitter processor of one of the preceding claims,

wherein the frame builder is configured to determine the border between the first amount of information units and the second amount of information units signal-adaptively from codeword frame to codeword frame, so that, depending on the audio signal for a codeword frame, the border represents an encoded information unit relating to different audio information of the codeword frame or being interpreted differently by an audio decoder.

5. Audio transmitter processor of one of the preceding claims,

wherein the frame builder is configured to use, as the second subset of the codewords, a second predefined number of adjacent codewords at one side of the codeword frame of the encoded audio data, to use, as the first predefined subset of the codewords, a first predefined number of adjacent codewords at another side of the codeword frame of the encoded audio data, and wherein a sum of the first predefined number and the second predefined number is equal to the predefined total number of codewords, or

wherein at least one codeword of the second predefined subset of the codewords is located between two codewords of the first predefined subset of the codewords or vice versa.

6. Audio transmitter processor in accordance with one of the preceding claims, wherein the frame builder is configured

to write the first amount of information units using reference positions of the first predefined subset of the codewords into the first predefined subset of the codewords,

as soon as the first predefined subset of the codewords is filled, to write the second amount of information units using reference positions of the second predefined subset of the codewords, and

wherein the frame builder is configured to determine the border as the information unit written into a last codeword of the first predefined subset of the codewords or as the first information unit written at a reference position of a first codeword of the second predefined subset of the codewords.

7. Audio transmitter processor of one of the preceding claims,

wherein the frame builder is configured to write the information units of the first amount of information units in a first writing direction starting at reference positions of at least two codewords of the first predefined number of codewords, and in a second opposite writing direction starting at reference positions of at least two other codewords of the first predefined number of codewords, or

wherein the frame builder is configured to write the information units of the second amount of information units in a first writing direction starting at reference positions of at least two codewords of the second predefined number of codewords and in a second opposite writing direction starting at reference positions of at least two other codewords of the second predefined number of codewords.

8. Audio transmitter processor of one of the preceding claims,

wherein the frame builder is configured to write information units of the first amount of information units and the second amount of information units, wherein at least a majority of the information units of the first amount of information units is psychoacoustically more important than a majority of the information units of the second amount of information units, or

wherein only a partial frame loss concealment is envisioned in an audio receiver processor when only information units in the second amount of information units are determined as corrupted and wherein a full frame loss concealment is envisioned in the audio receiver processor when information units in the first amount of information units are determined as corrupted.

9. Audio transmitter processor of one of the preceding claims, further comprising a source encoder for generating at least two categories of information units, the at least two categories being selected from the group consisting of fixed length side information, variable length side information, temporal noise shaping information, one or more most significant bits of a spectrum of a first frequency portion of the spectrum, one or more most significant bits of a second frequency portion having higher frequencies than the first frequency portion, one or more least significant bits or sign bits of a first frequency portion, one or more least significant bits or sign bits of a second frequency portion, the second frequency portion having higher frequencies than the first frequency portion, and residual bits,

wherein, if generated as a category by the source encoder, the fixed length side information, the variable length side information, the temporal noise shaping information, the one or more most significant bits of a spectrum of the first frequency portion, and the least significant bits or sign bits of a first frequency portion are located in the first amount of information units, and wherein, if generated as a

~~category by the source encoder, at least the one of the one or more most significant bits of the second frequency portion, the one or more least significant bits or sign bits of a second frequency portion and the residual bits are in the second amount of the information units.~~

~~10. Audio transmitter processor of one of the preceding claims,~~

~~wherein the frame builder is configured to use a first writing pointer and a second writing pointer,~~

~~wherein the frame builder is configured to increment the first writing pointer in a direction from a lower information unit position in the codeword frame to a higher information unit position in the codeword frame,~~

~~wherein the frame builder is configured to decrement the second writing pointer in a direction from a higher information position in the codeword frame to a lower information position in the codeword frame,~~

~~wherein the frame builder is configured to start the first writing pointer at a reference position indicating a start of a first codeword in a predefined sequence of codewords of the first predefined subset of the codewords,~~

~~wherein the frame builder is configured to start the second writing pointer at a reference position indicating an end of a last codeword in the predefined first sequence of codewords of the predefined first set of codewords,~~

~~wherein the frame builder is configured to write information units belonging to one or more first categories of information units from the first amount of information units at the positions indicated by the first writing pointer, and~~

~~wherein the frame builder is configured to write information units belonging to one or more second categories of information units from the first amount of information units at the position indicated by the second writing pointer until the first and second writing pointers meet each other at a meeting information unit position,~~

wherein the information unit at the meeting information unit position represents the border between the first and the second amount of information units.

11. Audio transmitter processor of claim 10,

wherein the frame builder is configured to set the first pointer to a reference position indicating the start of a first codeword of a second predefined sequence of codewords of the second predefined subset of the codewords,

to set the second writing pointer to a reference position indicating the end of a last codeword of the second predefined sequence of codewords of the second predefined subset of the codewords, and

to write information units of one or more third categories from the second amount of information units using the first writing pointer and to write information units of one or more fourth categories from the second amount of information units using the second writing pointer.

12. Audio transmitter processor of claim 10 or 11, wherein the one or more first categories of information units comprise at least one of temporal noise shaping information, and/or one or more most significant bits of a spectrum of a first frequency portion, or

wherein the one or more second categories of information units comprise at least one of fixed or variable length side information, and least significant bits or sign bits of the first frequency portion, or

wherein the one or more third categories of information units comprise at least one of most significant bits of a second frequency portion, or

wherein the one or more fourth categories of information units comprise at least one of least significant bits or sign bits of the second frequency portion and residual data.

13. Audio transmitter processor of claim 10 to 12,

wherein the frame builder is configured to use, as the one or more first category, most significant bits derived from spectral values ordered in an ascending order with respect to frequency until a spectral value or a combination of spectral values at the meeting information unit,

to use, as the one or more second category, least significant bits or sign bits derived from spectral values until the spectral value or the combination of spectral values of the meeting information unit;

to use, as the one or more third category, one or more most significant bits associated with a frequency at or above the value at the meeting information unit; and

to use, as the fourth category, least significant bits or sign bits associated with frequencies at or above the frequency value associated with the meeting information unit.

14. Audio transmitter processor of claim 13,

wherein the frame builder is configured to write the one or more first categories and the one or more second categories, or to write the one or more third categories and the one or more fourth categories in synchrony with each other, so that the at least one or more most significant bits of a spectral value or a combination of spectral values are written by the first writing pointer and the one or more least significant bits or sign bits of the same spectral value or of the same combination of spectral values are written, before information units from a further spectral value or a further combination of spectral values is written by the writing pointers.

15. Audio transmitter processor of one of the preceding claims, further comprising a source encoder for generating the encoded audio data in an intermediate representation extending from a start position to an end position, wherein the frame builder is configured to rearrange the encoded audio data in the intermediate representation into the order represented by the first and second predefined subsets of the codewords.

16. Audio transmitter processor of claim 15,

wherein the frame builder is configured to read and parse, from the start position and the end position, until a predefined amount of information units represented by a capacity of the first predefined subset of the codewords is obtained, and

to write the information units read and parsed into the first predefined subset of the codewords and to write remaining information units between the intermediate information unit obtained when the predefined amount determined by the capacity is read and parsed, into the second predefined subset of the codewords.

17. Audio transmitter processor of claim 16, wherein encoded temporal noise shaping data, side information data and the most significant data portion and the least significant data portion are read and written to the first predefined subset of the codewords and wherein the most significant data portion and the least significant data portion of spectral values above a specific frequency and residual data are written into the second predefined subset of the codewords.

18. Audio transmitter processor of one of the preceding claims,

wherein a number of codewords of the second predefined subset of the codewords is derived from a characteristic of the error protection code, and/or a total size of the plurality of processed codewords.

19. Audio transmitter processor of one of the preceding claims, wherein the error protection coder is configured

to calculate the first processing result as a first Hash value,

to calculate the second processing result as a second Hash value,

to add the first Hash value to the first predefined subset of the codewords and to add the second Hash value to the second predefined subset of the codewords, and

to apply a codeword-wise block code to obtain the error protected codewords.

~~20. Audio transmitter processor of one of the preceding claims,~~

~~further comprising an audio encoder having an arithmetic encoder generating minimum size data portions in a first granularity of information units,~~

~~wherein the error protection coder is configured to operate in a second granularity of information units,~~

~~wherein the first granularity is different from the second granularity.~~

~~21. Audio transmitter processor of claim 20,~~

~~wherein the first granularity is greater than the second granularity, and~~

~~wherein at a reference position of a first codeword of the first predefined subset an adaption amount of information units corresponding to a granularity difference between the first and the second granularity is located.~~

~~22. Audio transmitter processor of claim 21, wherein the first granularity is greater than the second granularity and in an integer ratio, and wherein the adaption amount of information units together with data located at a reference position of a codeword of the second predefined subset of the codewords represent the minimum size data portion output by the arithmetic encoder.~~

~~23~~1. Audio receiver processor for processing an error protected frame, comprising:

a receiver interface for receiving the error protected frame to obtain a received error protected frame;

an error protection processor for processing the received error protected frame to obtain an encoded audio frame, wherein the error protection processor is configured to check whether a codeword of a first predefined subset of codewords of the encoded audio frame comprises an error, and

an error concealer or an error concealment indicator configured to perform a frame loss concealment operation or to generate a frame loss concealment indication in case of a detected error in the first predefined subset of the codewords.

~~24~~2. Audio receiver processor of claim ~~23~~1,

wherein the error protection processor is configured to check whether a second predefined subset of codewords of the encoded audio frame comprises an error, and

wherein the error concealer or the error concealment indicator is configured to perform a partial frame loss concealment operation or to generate a partial frame loss concealment indication for concealing the error in the second predefined subset of the codewords.

~~25~~3. Audio receiver processor of claim ~~23 1~~ or ~~24~~2, further comprising an audio decoder for decoding the encoded audio data included in the first predefined subset of the codewords, wherein the audio decoder is configured to be controlled by the error protection processor to perform decoding when the error protection processor does not locate an error in the first predefined subset of the codewords.

~~26~~4. Audio receiver processor of one of the claims ~~23 1~~ to ~~25~~3,

wherein the error protection processor is configured to apply a block decoding operation to the received error protected frame to obtain a decoded first predefined subset of the codewords and a decoded second predefined subset of the codewords,

wherein, if the block decoding operation does not signal that an error exists, the error protection processor is configured

to calculate a first Hash value from the first predefined subset of the codewords, and

to compare the first Hash value to a received first Hash value,

wherein the error protection processor is configured to determine that an error exists in the first predefined subset of the codewords when the first Hash value and the received first Hash value do not coincide with each other or to determine that the first predefined subset of the codewords is error-free when the first Hash value and the received first Hash value coincide.

275. Audio receiver processor of one of the claims 23 1 to 264,

wherein the error protection processor is configured to apply a block decoding operation to the received error protected frame to obtain a decoded first predefined subset of the codewords and a decoded second predefined subset of the codewords,

wherein, if the block decoding operation does not signal that an error exists, the error protection processor is configured

to calculate a second Hash value from the second predefined subset of the codewords, and

to compare the second Hash value to a received second Hash value,

wherein the error protection processor is configured to determine that an error exists in the second predefined subset of the codewords when the second Hash value and the received second Hash value do not coincide with each other or to determine that the second predefined subset of the codewords is error-free when the second Hash value and the received second Hash value coincide.

286. Audio receiver processor of claim 26 4 or 275, wherein the block decoding operation comprises a Reed-Solomon decoding operation.

297. Audio receiver processor of one of the claims 23 1 to 286,

wherein the error protection processor is configured to check whether the second predefined subset of the codewords comprises an error only when the check of the first predefined subset of the codewords did not detect an error.

308. Audio receiver processor of one of the claims 23 1 to 297,

wherein the error protection processor is configured to detect, whether one or more specific codewords of the second predefined subset of the codewords comprises an error, and whether any codeword of the second predefined subset of the codewords is an error-free codeword, and

wherein the error concealer is configured to generate substitute data for the one or more specific codewords or an error concealment indication, and

wherein the audio receiver processor comprises an audio decoder for decoding audio data included in the first predefined subset of the codewords and audio data included in one or more of the error-free codewords of the second predefined subset of the codewords, and the substitute data for the one or more specific codewords, or

wherein the audio receiver processor comprises an audio decoder for decoding audio data included in the first predefined subset of the codewords and audio data included in one or more of the error-free codewords of the second predefined subset of the codewords, and wherein the audio decoder is configured to receive the error concealment indication and to take an error concealment measure in response to the error concealment indication.

319. Audio receiver processor of one of the claims 23 1 to 308, further comprising a frame reader for reading the encoded audio frame in accordance with a predefined frame-reading procedure identifying the first predefined subset of the codewords and a second predefined subset of the codewords.

3210. Audio receiver processor of claim 931,

wherein the frame reader is configured to read information units of a first amount of information units starting at reference points of codewords of the first predefined subset of the codewords until the information units from all codewords of the first predefined subset of the codeword are read, and

to read information units of a second amount of information units starting at reference points of codewords of the second predefined subset of the codewords,

further comprising an audio decoder, wherein the audio decoder is configured to decode a concatenation of the first amount of information units and the second amount of information units in order to obtain decoded audio data for the encoded audio frame.

~~33~~11. Audio receiver processor of claim ~~31~~ 9 or 10~~32~~,

wherein the frame reader is configured to use, as the second subset of the codewords, a second predefined number of adjacent codewords at one side of the codeword frame of the encoded audio data, to use, as the first predefined subset of the codewords, a first predefined number of adjacent codewords at another side of the codeword frame of the encoded audio data, and wherein a sum of the first predefined number and the second predefined number is equal to the predefined total number of codewords, or

wherein at least one codeword of the second predefined subset of the codewords is located between two codewords of the first predefined subset of the codewords or vice versa.

12~~34~~. Audio receiver processor of one of claims 9~~31~~ to 11~~33~~,

wherein the frame reader is configured to read the information unit of the first amount of information units in a first reading direction starting at reference positions of at least two codewords of the first predefined number of codewords, and in a second opposite reading direction starting at reference positions of at least two other codewords of the first predefined number of codewords, or

wherein the frame reader is configured to read the information units of the second amount of information units in a first reading direction starting at reference positions of at least two codewords of the second predefined number of codewords and in a second opposite reading direction starting at reference positions of at least two other codewords of the second predefined number of codewords.

1335. Audio receiver processor of one of claims 31 9 to 1234,

wherein the frame reader is configured to read information units of the first amount of information units and the second amount of information units, wherein at least a majority of the information units of the first amount of information units is psychoacoustically more important than a majority of the information units of the second amount of information units, or

wherein only a partial frame loss concealment is performed by the error concealer when only information units in the second amount of information units are determined as corrupted and wherein a full frame loss concealment is performed by the error concealer when information units in the first amount of information units are determined as corrupted.

1436. Audio receiver processor of one of claims 931 to 1335, further comprising a source decoder for decoding at least two categories of information units, the at least two categories being selected from the group consisting of fixed length side information, variable length side information, temporal noise shaping information, one or more most significant bits of a spectrum of a first frequency portion of the spectrum, one or more most significant bits of a second frequency portion having higher frequencies than the first frequency portion, one or more least significant bits or sign bits of a first frequency portion, one or more least significant bits or sign bits of a second frequency portion, the second frequency portion having higher frequencies than the first frequency portion, and residual bits,

wherein, if available for decoding by the source decoder as a category, the fixed length side information, the variable length side information, the temporal noise shaping information, the one or more most significant bits of a spectrum of the first frequency portion, and the least significant bits or sign bits of a first frequency portion are located in the first amount of information units, and wherein, if available for decoding by the source decoder as a category, at least one of the one or more most significant bits of the second frequency portion, the one or more least significant bits or sign bits of a second frequency portion and the residual bits are in the second amount of the information units.

~~37~~15. Audio receiver processor of one of claims ~~31~~ 9 to ~~36~~14, wherein the frame reader is configured

to use a first reading pointer and a second reading pointer,

to increment the first reading pointer in a direction from a lower information unit position in the codeword frame to a higher information unit position in the codeword frame,

to decrement the second reading pointer in a direction from a higher information position in the codeword frame to a lower information position in the codeword frame,

to start the first reading pointer at a reference position indicating a start of a first codeword in a predefined sequence of codewords of the first predefined subset of the codewords,

to start the second reading pointer at a reference position indicating an end of a last codeword in the predefined first sequence of codewords of the predefined first set of codewords,

to read information units belonging to one or more first categories of information units from the first amount of information units at the positions indicated by the first reading pointer, and

to read information units belonging to one or more second categories of information units from the first amount of information units at the position indicated by the second reading pointer until the first and second reading pointers meet each other at a meeting information unit position,

wherein the information unit at the meeting information unit position represents a border between the first and the second amount of information units.

~~38~~16. Audio receiver processor of claim ~~37~~15,

wherein the frame reader is configured to set the first reading pointer to a reference position indicating a start of a first codeword of a second predefined sequence of codewords of the second predefined subset of the codewords,

to set the second reading pointer to a reference position indicating the end of a last codeword of the second predefined sequence of codewords of the second predefined subset of the codewords, and

to read information units of one or more third categories from the second amount of information units using the first reading pointer and to read information units of one or more fourth categories from the second amount of information units using the second reading pointer.

~~39~~17. Audio receiver processor of claim 15~~37~~ or 16~~38~~,

wherein the frame reader is configured to use, as the one or more first category, most significant bits derived from spectral values ordered in an ascending order with respect to frequency until a spectral value or a combination of spectral values at the meeting information unit,

to use, as the one or more second category, least significant bits or sign bits derived from spectral values until the spectral value or the combination of spectral values of the meeting information unit;

to use, as the one or more third category, one or more most significant bits associated with a frequency at or above the value at the meeting information unit; and

to use, as the fourth category, least significant bits or sign bits associated with frequencies at or above the frequency value associated with the meeting information unit.

18~~40~~. Audio receiver processor of claim 17~~39~~,

wherein the frame reader is configured to read the one or more first categories and the one or more second categories, or to read the one or more third categories and

the one or more fourth categories in synchrony with each other, so that the at least one or more most significant bits of a spectral value or a combination of spectral values are read by the first reading pointer and the one or more least significant bits or sign bits of the same spectral value or of the same combination of spectral values are read, before information units from a further spectral value or a further combination of spectral values is read by the reading pointers.

41~~19~~. Audio receiver processor of one of claims ~~31~~ 9 to 18~~40~~,

wherein the frame reader is configured to use a first reading pointer with a first reading direction and a second pointer with a second reading direction, wherein the encoded audio frame has a frame start position and a frame end position, wherein the frame reader is configured to set the first pointer at the first pointer start position derived from a number of information units included in the second predefined subset of the codewords and to set the second pointer at the frame end position, wherein the first predefined subset of the codewords are all located at a side of the encoded audio frame having the frame end position,

wherein the frame reader is configured

to read using incrementing the first reading pointer and decrementing the second reading pointer in corresponding reading directions,

to stop, when the first and the second reading pointers meet each other at a meeting position, and

to exchange information units between the frame start position and the first pointer start position with the information units between the first pointer start position and the meeting position so that a rearranged encoded audio frame comprises, in the following order, from the start of the rearranged audio frame, information units read between the first pointer start position and the meeting point, information units of the encoded audio frame between the frame start position and the first pointer start position, and information units of the encoded audio frame between the meeting position and the frame end position, and

further comprising an audio decoder preset to decode the rearranged encoded audio frame having the encoded audio data in the order of the rearranged encoded audio frame, or

further comprising a transmitter device for transmitting the rearranged encoded audio frame to a remote location.

2042. Audio receiver processor of one of claims ~~31~~ 9 to 1940,

wherein the frame reader is configured to use a first reading pointer with a first reading direction and a second pointer with a second reading direction, wherein the encoded audio frame has a frame start position and a frame end position, wherein the frame reader is configured to set the second pointer at a second pointer start position derived from a number of information units included in the second predefined subset of the codewords and a total number of information units of the encoded audio frame and to set the first reading pointer at the frame start position, wherein the first predefined subset of the codewords are all located at a side of the encoded audio frame having the frame start position,

wherein the frame reader is configured

to read using incrementing the first reading pointer and decrementing the second reading pointer in corresponding reading directions,

to stop, when the first and the second reading pointers meet each other at a meeting position, and

to exchange information units between the frame end position and the second pointer start position with the information units between the second pointer start position and the meeting position, so that a rearranged encoded audio frame comprises, in the following order from a start of the rearranged encoded audio frame, information units between the frame start position and the meeting position, information units of the encoded audio frame between the frame end position and the second pointer starting position, and information units of the encoded audio frame between the meeting position and the second pointer start position.

4321. Audio receiver processor of one of claims 23 1 to 2042, further comprising an audio decoder having an arithmetic decoder receiving a minimum data size portion in a first granularity of information units,

wherein the error protection processor is configured to operate in a second granularity, wherein the first granularity is greater than the second granularity,

wherein, at a reference position of a first codeword of the first predefined subset of the codewords, an adaption amount of information units corresponding to a granularity difference between the first and the second granularities is located,

wherein the adaption amount of information units together with data located at a reference position of a codeword of the second predefined subset forms the minimum data size portion to be input into the arithmetic decoder, and

wherein the frame reader is configured to start reading information units for the first predefined subset of the codewords at a position in the first codeword determined by the reference position of the first codeword plus the size of the adaption amount.

44. Method of generating an error protected frame using encoded audio data of an audio frame, the encoded audio data for the audio frame comprising a first amount of information units and a second amount of information units, the method comprising:

building a codeword frame having a codeword raster defining reference positions for a predefined total number of codewords, wherein the building comprises:

writing the information units of the first amount of information units starting at reference positions of a first predefined subset of the codewords; and

writing the information units of the second amount of information units starting at reference positions of a second predefined subset of the codewords,

determining a border between the first amount of information units and the second amount of information units so that a starting information unit of the second amount of information units coincides with a codeword border; and

~~performing an error protection processing comprising:~~

~~processing one or more of the codewords of the first predefined subset of the codewords to obtain a first processing result or processing one or more of the codewords of the second predefined subset of the codewords to obtain a second processing result and adding the first processing result or the second processing result to the predefined number of codewords to obtain a plurality of processed codewords representing the error protected frame, or~~

~~processing the codewords of the first predefined subset of the codewords or of the second predefined subset of the codewords individually to obtain a plurality of processed codewords representing the error protected frame.~~

~~45~~22. Method of processing an error protected frame, comprising:

receiving the error protected frame to obtain a received error protected frame;

performing an error protection processing with the received error protected frame to obtain an encoded audio frame, wherein the error protection processing comprises checking whether a codeword of a first predefined subset of codewords of the encoded audio frame comprises an error, and

performing a frame loss concealment operation in case of a detected error in the first predefined subset of the codewords.

~~46~~23. Computer program for performing, when running on a computer or a processor, a method of claim ~~44 or claim 45~~22.